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CHANGE AND STABILITY.
NATURAL PHILOSOPHY AT THE
ACADEMY OF TURKU (1640-1713)

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*To the memory of my grandmother,
Iida Maria*

Lector Benevole,

Writing a thesis in history is basically very lonely work. This is paradoxical because there are a number of people who have provided support in many ways during different stages of the job.

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At Linnanmaa, 14th December 1994

Maija Kallinen

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Introduction

1. WHY STUDY THE ACADEMY OF TURKU?

The question of the role of universities in the 17th-century Scientific Revolution has increasingly attracted renewed attention in the history of science since the 1980's. According to the old standard view established by Martha Ornstein in the 1920's, the universities played hardly any role at all in scientific change (except perhaps by retarding it), whereas the scientific societies fought for new science.¹ This view has been revised and nowadays it is generally conceded that universities played an important role in disseminating the ideas of the Scientific Revolution. New scientific ideas were gradually incorporated into the curriculum, albeit with varying speed and to a varying extent. The significance of this is clear, bearing in mind that most of the prominent figures in 17th-century new science were actually educated in universities.² It is an important notion that the Aristotelian philosophical system was not necessarily inflexible, although the universities obviously were reluctant to change as institutions.

The way of incorporating new modes of thought in the traditional curriculum was usually a gradual and a critical process. Therefore I am less willing to employ the term "Scientific Revolution", the meaning of which has become so familiar as to suffer from depletion to a considerable extent.³ I regard the phrase "diffusion of knowledge" instead as more suitable to describe the developments in most 17th-

¹ Ornstein 1928, esp. p. 213-263.

² Brockliss 1981, 1987, 1990, p. 190-191. Gascoigne 1985, 1990. Heyd 1982. Ruestow 1973. Feingold 1991 however stresses the conservative attitude of the university institutions.

³ On the different meanings attached to the phrase "scientific revolution" see Porter 1987. For an analysis of difficulties in using this concept see Cunningham & Williams 1993.

century European universities. Indeed, for some of them the "Scientific Revolution" seems to consist of the abandonment of Aristotelian physical concepts and the acceptance of new, mainly Cartesian ones instead.⁴

Diffusion and transformation of knowledge is an integral part of scientific change. Every scientific innovation, be it a methodology, theory, hypothesis or an instrument, needs to be accepted by a wider audience in order to be able to claim the status of a scientific truth.⁵ Hence, the diffusion of ideas or "-isms" such as experimentalism, Cartesianism and heliocentrism into universities has been extensively studied in large and famous universities like Paris and Cambridge, or even Uppsala.⁶ These studies have often been motivated by the aspiration to redefine the role of the universities in this process of change. However, we generally know relatively little about how the diffusion and transformation of knowledge took place at the less well-known and smaller universities. Neither is it pointless to study what an early modern university was like for its own sake. This study will focus on both of these purposes. It will explore what natural philosophical learning was like in a provincial 17th-century university, and how the mechanisms involved in the process of diffusion of knowledge functioned there.

In 17th-century Sweden the universities played an irreplaceable role in all learning. It has been said that some of the gymnasiums almost equalled universities,⁷ but excluding these exceptions the universities were the only institutions where any kind of higher education could be obtained. There were no academies or societies promoting the advancement of new science in Sweden. It was not until Sylvester in 1710 when the first short-lived academy, *Collegium curiosorum*, was founded in Sweden by the mechanical engineer Christopher Polhem

⁴ Widmalm 1992.

⁵ The matter is naturally not as simple as this, but further essential questions and reservations can be raised such as to what extent a theory must be understood in order to be accepted? What if only some aspects of the theory are being accepted? What does it then mean 'to be accepted'? A theory may be shared by different kinds of groups: laymen, authorities, scientists in one or several disciplines, in one or several countries or laboratories, etc.

⁶ Brockliss 1981, 1987. Gascoigne 1985. Widmalm 1992.

⁷ Several new gymnasiums were founded in Sweden at the beginning of the 17th century: Västerås 1623, Strängnäs 1626, Linköping 1627, Turku and Tartu 1630, Skara and Vyborg 1641, Växjö 1643. The two first gymnasiums especially worked like a sort of provincial university. Klinge 1987, p. 48.

and the chemist Urban Hiärne. But it was only in 1739 that the Academy of Sweden was founded on the model of the French and English scientific academies. Chemistry and mechanics were to some extent studied outside the university by the copper-mining company at Stora Kopparberget.⁸ This study was clearly practice-orientated, but it did not immediately influence the theoretical teaching at the universities. Moreover, even in the 18th century the chemists and academics received their basic education at the University of Uppsala. Therefore universities are our major starting-points in studying natural philosophical thinking.

The University of Turku was one of the five universities in the Kingdom of Sweden during the 17th century, the other ones being located at Uppsala, Tartu, Lund and Greifswald. The University of Turku was slower to open its gates to new or practical knowledge than the country's main university in Uppsala. It was small compared with the leading European universities of that age,⁹ and no particularly exciting and original ideas in the field of physics emanated from there during the period concerned. The natural philosophical learning at Turku is nevertheless worth studying, not only because the University satisfied the educational needs of an almost half of the country, but also because the research provides us with a model of an early modern university. This is not to say that the processes involved in the diffusion of knowledge in other universities would necessarily be similar to those operating at Turku. Nevertheless the focus on peripheral institutions may contribute to our understanding of 17th-century learning on a larger scale.

The aim of this study is to create a detailed view of the history of learning at the Academy of Turku. (Despite its official name, the *Royal Academy of Turku*, the institution in question was a normal early modern university.) Moreover, this study will focus on one discipline only, i.e. natural philosophy or physics. Before defining the subject of this study more closely, however, let us see what has already been written on the role of the Academy of Turku and of learning there.

⁸ Lindroth 1975, p. 552-555. Lindroth 1978, p. 48 ff.

⁹ There were 600-850 students during the period concerned. Strömberg 1987, p. 308-309.

2. PREVIOUS RESEARCH

Life and learning at the Academy of Turku is a many-sided topic and many studies handling various aspects of it have been published. It is not, therefore, possible or even desirable to introduce all of them here. However, in order to relate this study to previous research I shall in the following discuss some of the most noteworthy studies of the history of the Academy of Turku and of its learning.

There are two major histories of the University in general. In the 1980's a great project was launched to write a new history of the Academy of Turku. This project, mainly motivated by the 350th anniversary of the University, has resulted in a thorough picture of its social, political and administrative developments. Most relevant for us is the first part of this three-volume series, *History of The University of Helsinki, part I, The Royal Academy of Turku 1640-1808*.¹⁰ (The University was moved to Helsinki in 1828 after a devastating fire and has since then been known as the University of Helsinki.) Because of its general character, however, this book can offer only a sketchy view of the main area of this research, i.e. the history of natural philosophy. The same thing is more true of the another major history of the University, Ivar A. Heikel's *University of Helsinki 1640-1940*.

Many of those studies which discuss aspects of learning at the University are more concerned with other subjects than natural philosophy. Seppo J. Salminen and Pentti Laasonen have discussed the history of theology in their biographies of theology professor Enevaldus Sveonius and Bishop Johan Gezelius.¹¹ These studies give us valuable information about the intellectual milieu in the University. Logic and metaphysics are subjects which have great relevance for natural philosophy too. The character of these branches of knowledge in the 1660's were studied by Jaakko Lounela in his doctoral dissertation on the teaching of logic in 17th-century Finland.¹² A wider account of philosophy at Turku, which still is very useful, was written by professor Thiodolf Rein at the beginning of this century.¹³ Rein discusses not only theoretical but also practical philosophy (ethics and politics), even making excursions into other disciplines such as physics.

¹⁰ Klinge, Knapas, Leikola, Strömberg 1987.

¹¹ Laasonen 1977b. Salminen 1978, 1985.

¹² Lounela 1978.

¹³ Rein 1908.

Rein's study was published in a series which still forms the most extensive studies dealing with the history of science at the Academy of Turku. This series, *History of Learning at the University of Turku* dates from the turn of the century when it was produced by the Society for Swedish Literature in Finland.¹⁴ It covers all disciplines from theology and philology to physics and medicine. Those parts which handle thinking in natural history, physics and mathematics only confine themselves to describing the contents of some dissertations which were considered important by the authors, O.E.A. Hjelt and K.F. Slotte. The lack of analytical spirit is, however, not the only defect in these books. Quite often they reflect the positivistic ideals of the end of the 19th century and do not therefore always meet the demands which are set for historical studies in our days.

The whiggish attitude towards bygone science, which can actually be in a way charming when found in texts dating from over ninety years ago, provokes nothing but irritation in articles written in the 1950's or later. It is not unusual to find in these studies a tone which is profoundly ahistorical. If we judge 17th-century learning by our own criteria about what proper (physical) science should be, it is no wonder that we do not find much science there to be studied. But, by doing this we easily miss the point and fail to understand these different patterns of thinking. The most striking example of this failure is the section in the authoritative *Cultural History of Finland 1*, which also deals with the early phases of learning at the Academy of Turku.¹⁵

Whereas systematic studies on 17th-century natural philosophy are still lacking, several articles on the subject do nevertheless exist. Some of these succeed in avoiding the whiggish attitude fairly well. Anto Leikola has written many articles about biological ideas in the 17th and the 18th centuries. Seppo J. Salminen has dealt with natural philosophy and Cartesianism from the theologians' point of view. One of the most distinguished works is Simo Knuuttila's and Ilkka Niiniluoto's article on the arrival of Baconianism in Finland. This study shows that Baconian ideology - even if not Baconian science in practice - really arrived in Turku only in the 18th century.¹⁶ Tapio Markkanen and Raimo Lehti have dealt with Copernicanism - and ast-

¹⁴ The parts of the series essential in this context are Heikel 1894. Hjelt 1896. Rein 1908. Slotte 1898. Fagerlund & Tigerstedt 1890.

¹⁵ Lehtinen 1979.

¹⁶ Knuuttila & Niiniluoto 1986. Leikola 1983a, 1983b. Salminen 1983, 1981.

ronomy in general - in several articles and studies, so that the overall (although partially biased) picture of the fate of heliocentrism in Finland is well covered.¹⁷

Finally, there are my own studies on natural philosophy at the Academy of Turku. In my Finnish candidate of philosophy and licentiate of philosophy theses I have analysed the contents of *Contemplationes mundi*, a textbook in natural philosophy written by a professor of eloquence, Daniel Achrelius, in 1678-82.¹⁸ Even though Achrelius' book offers a general view of the natural philosophy of its time, it still is an account of only one person's work, which in the light of the current study proves out to be more atypical than expected.

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In Sweden history of science has had a position among academic disciplines since the 1930's, and the study of 17th-century learning has been one of the fields most focussed on. In these studies natural philosophy has been placed in a more general, all-Swedish context. Unfortunately, this has in practice meant a strong emphasis on Uppsala. This has inevitably led to a situation in which the developments characteristic of Turku have attracted less attention than those at the main university.¹⁹ It is obvious from what has been said above that even if all existing studies were gathered together, an evident gap would still remain. A comprehensive study is still lacking - a study which would place natural philosophy at the second largest University of 17th-century Sweden in its proper disciplinary context. This work is meant to fill this gap. At the same time I shall try to approach the subject analytically and pose questions which hopefully turn out to be interesting in the history of science generally.

Before specifying the tasks of this study more closely, it might be appropriate to have a brief look at our sources. This is because the nature of the sources available limits considerably the number of realizable modes of approach.

¹⁷ Lehti 1979, 1984. Markkanen 1970.

¹⁸ Kallinen 1991a. See also Kallinen 1991b.

¹⁹ Lindroth 1943, 1975. Sandblad 1944, 1945. Nordenmark 1959.

3. SOURCES OF THE STUDY

A) Theses and monographs. The humanistic ideals upon which academic learning was founded emphasized promoting sublime moral and intellectual values and their polished expression. At the University, these ideals were to find their expression in orations composed by students, and in dissertations. As one of the earliest scholars at Turku put it, the purpose of preparing a dissertation was to "sharpen the reason and inquire into the truth, which are both intellectual nourishment".²⁰ A dissertation was extremely important as the culmination of academic learning. However, the process of writing and defending a thesis in the 17th century differs radically from that of our own times. Academic dissertations are unquestionably the most important sources for studying the history of natural philosophy at Turku, so that there is every reason to ask, *what was a thesis?* and to study them a little more closely.

First of all, two kinds of dissertations were being published: the so-called inaugural theses for practising argumentation tactics, and master's theses. Doctoral dissertations were extremely rare at Turku in the 17th century, and they were ventilated only in the Faculty of Theology. Indeed, there was no such a thing as a Doctorate of Philosophy before the 19th century. In the 17th century the reason for this was clear, the role of the Faculty of Arts being to provide preparatory instruction only and thus a "Doctor of Philosophy" was something like a contradiction in terms.²¹ Theses were always printed²² and

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²⁰ Alanus-Garsius 1645, Th. III "...ingenij acuendi, veritatisque inquirendae gratia, quae animi pabulum." Klinge 1987, p. 98, 103-104, 584-600, et passim, points out that the endeavour to establish Ciceronian and Erasmian-style humanistic values in Sweden was often expressed in speeches. In practice, however, this effort brought meagre results. Somewhat cynically it could be stated however that the unarticulated aims of humanistic education were nevertheless realized at least in one respect at the University of Turku. As Grafton & Jardine 1986, p. xiii-xiv, 17, 24, 136, et passim have shown, despite its high moral principles humanistic education tended to produce passive students. It was important to know the method, but not to express one's own ideas. Obviously, fluent and docile students made good officials and clergymen in this age of absolutism and religious orthodoxy. Otherwise the "humanism" Klinge is talking about seems to be more Ramistic in spirit when it emphasizes the importance of disputation and ratiocination. (Lipsius on the other hand stressed political skills as the main aim of humanistic studies.) Grafton & Jardine 1986, p. 197.

²¹ The whole concept of Doctor of Philosophy was accepted around 1800, but even dissertations for Doctor of Theology or Law were extremely rare at Turku. On

thus considered to be really public. In this context the public consisted chiefly of the readers inside the academy itself and it was perhaps only patrons and parents who otherwise had access to philosophical theses.

In any case publicity presupposed some degree of censorship, usually in the form of an imprimatur conceded by the dean of the Faculty. Instead of ensuring the thesis's adequate scholarly standard, the primary function of the censorship was to prevent publishing any material which might offend religion or the king. For this reason we can expect that dissertations usually represent the orthodox and generally accepted interpretations of theories. There were, of course, some occasions when the contents of a thesis aroused opposition.

The question of the real author of a dissertation has often been considered to be an important one. According to the general practice professors usually wrote the inaugural theses (*pro exercitio*), while the masters' theses (*pro gradu*) were more often written by the student himself.²³ Usually, when the student was the author of a thesis, it was indicated by subscription "Auth. & Resp." or something similar at the end of the dedication.²⁴ The task of the student, *respondens*, was first of all to pay for the printing of the thesis and then to defend it against the *opponens*, also a student. I shall take up the question of the real author only if there is a special reason. This is done for the following reasons.

First of all, most dissertations were probably written more or less in co-operation. It would be waste of time and effort to try to define which elements of a given thesis come from the professor's and which from the student's pen. Secondly, dissertations are usually standard works as far as their contents is concerned. They contain very few personal elements apart from the dedicatory and congratulatory poems attached to the beginning of the work. There is some point in discussing the author's real identity only in those cases when it can help to explain some special characteristics of the thesis. Most importantly, however, the fundamental idea of the disputative method in philosophy

the development of the title "Doctor of Philosophy" see Clark 1992.

²² The privileges of the university press were established in 1641, but the press itself began functioning only in 1642. Heikel 1940, p. 52-53.

²³ Klinge 1987, p. 393.

²⁴ In these cases the student was also officially regarded as the author. E.g. *Aboa Literata*, one of the earliest bibliographies on literature produced at the Academy, names students as authors of these theses. Stiernman 1990 (1719).

was that nobody was supposed to propose his own ideas, but any student should in principle be able to defend or oppose any thesis.²⁵ This principle certainly accounts for the manifest impersonality of the theses.

Writing and defending dissertations had a mainly pedagogical function. Indeed, it has been claimed very convincingly that emphasizing the pedagogical utility of thesis-writing could occasionally go as far as to influence the acceptance of certain ideas in the universities of early modern Europe. The less suitable a philosophical construct was for pedagogical functions, the more reluctant university scholars were to accept it. On the other hand, a factor which greatly contributed to the final success of the Cartesian philosophical system was its pedagogical suitability.²⁶ The main aim in defending a thesis was to teach students to master the art of arguing, i.e. the proper use of both rhetoric and dialectic. No independent thought was encouraged. For the authorities this kind of learning was perfect. Students who learned to follow the method without speculating too much themselves undoubtedly became competent and docile servants for both the church and the state.

The ideal aim of philosophical scholarship was to educate good debaters who would find the (pre-established) 'truth' by critical discussion which followed certain fixed rules. This ideal does not, therefore, contradict the fact that the corpus of the True Philosophy was thought to exist there already.²⁷ In other words, even though dissertations were rhetorical practices, the theories expressed in them were nevertheless regarded as true. This is a simple but an important point to note, because a modern reader might easily view such theses as pieces of research and judge them as such. We cannot blame 17th-century theses for not being good research (in the sense of finding out new knowledge), because that was not their objective. They were exercises in debating, which at the same time taught students the right kind of world-view, a function they obviously fulfilled.

Natural philosophy was naturally mainly dealt with in physics. However, other professors also taught the subject and wrote theses on

²⁵ Klinge 1987, p. 391.

²⁶ van Berkel 1981, p. 110-112. Gascoigne 1990, p. 212-216. The point of the pedagogical unsuitability of certain philosophies was sometimes expressly made. Gascoigne 1985, p. 396, 412.

²⁷ Klinge 1987, p. 384. van Berkel 1981, p. 112-116. Mikkeli 1992, p. 43-44, 91.

it. Many theses discussing themes which clearly belong to the field of physics were published under the guidance of other professors of the Faculty of Arts, e.g. eloquence, poetry, logic and metaphysics, and mathematics. Which principles should we then use to judge the relevance to this study of theses written in various fields? First of all it has to be noticed that even in physics some theses were written on political and metaphysical subjects.²⁸ These have been ignored in this study. Secondly, there are dissertations in almost every discipline which include chapters or *quaestiones* dealing with several branches of knowledge, including physics. The main point is that these chapters were judged as natural philosophical even by the standards of the day. But I have also included some theses, which deal with the same subject matter as physics but belong to a different discipline.

Medicine and mathematics were independent disciplines and thus not regarded as parts of physics. However, the handful of dissertations in medicine and a rather larger number in mathematical astronomy will also be considered in this study. This is because in my opinion comparing the views presented in these disciplines with each other may contribute to our understanding of the 17th-century learning as a whole. Because of the aim of comparison, purely mathematical theses like those on geometry or arithmetic, or "applied mathematics" such as calendar-making and geodesy have been left aside. Theological and metaphysical texts (about purely theological and metaphysical aspects) will also be examined only as far as it is necessary for understanding some of the more fundamental concepts in the system of knowledge. Because the relationships between physics and other academic disciplines play a central role in my argument, the subject will be dealt with more extensively in the chapter "The Academic Context of Natural Philosophy".

It will probably never be possible to scrape together every single thesis in which issues relevant to natural philosophy and/or mathematical astronomy were dealt with. Only theses which directly deal with these subjects will be considered in this study, since otherwise it is to be feared that the most genuine problems in the field would be drowned out by the multitude of dissertations dealing with matters of a less relevant sort. Obviously marking off this material is never entirely unproblematic. The following tables name the professors in

²⁸ E.g. Hahn-Schefer 1687. Hahn-Coreel 1704. Hahn-Wiising 1687.

the disciplines most relevant in respect to natural philosophy at the Faculty of Arts and the Faculty of Medicine. It also summarizes the number of theses published under their tuition.²⁹ These tables may also help the reader to orientate himself in this jungle of scholars' names later in the text. It should be noticed that some of the theses included under the column "On physics" also discuss other problems than physical ones for the reasons indicated above, so that these numbers should not be taken as an absolute guide but only as an approximation.

The total number of theses and parts of theses dealing with natural philosophical topics and subjects related to it amount to 284. However, not all of them are necessarily referred to in this study. On a chronological scale, the most active years appear to be the two decades from 1680 to 1700. While during the first ten years of the 18th century the activity of writing theses remained at a relatively high level, the numbers collapsed noticeably after 1710. Petrus Hahn for example supervised only seven theses after 1710. The cause for this is partly to be sought in the effects of the ongoing Great Northern War, refugees from Livonia bringing plague to Stockholm and Turku in September 1710, and in May 1711 a devastating fire burning down about one fourth of the town of Turku.³⁰

It is striking that the number of physical dissertations written by other professors than physics reaches its height during the period when Andreas Petraeus held the chair in physics. As Petraeus himself presided over only for four theses during his seventeen years at office, the professors of Latin language Martinus Miltopaeus and Daniel Achrelius published on natural philosophy especially. The same applies to Petrus Laurbecchius also, although he continued to publish in the field even after the nomination of Hahn in 1683. Laurbecchius also worked as an extraordinary professor of mathematics for two years from 1667 on.³¹ The professor of logic and metaphysics Simon Tålpo published a remarkable number of theses in physics or topics closely related to it. Indeed, 20.6 % of all his theses can be classified as "physical". However, in his case his diligence seems not to correlate with the period of Petraeus' professorship, so we might consider personal interest in physics as his main motive.

²⁹ The numbers are based on Vallinkoski 1966.

³⁰ Engström 1994. Tengström 1833, p. 153, 155.

³¹ Stiernman 1990, p. 63.

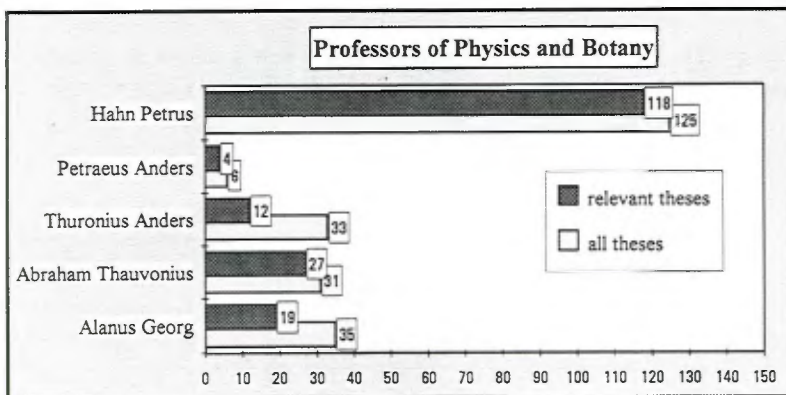


Table 1. The following tables show the number of theses per professor in each discipline considered in this study. The darker column shows the number of theses relevant to this study in each professor's oeuvre, whereas the lighter column represents the total number of theses. Alanus was professor of physics and botany during 1640-48, Thauvonijs 1649-59, Thuronius 1660-65, Petraeus 1665-82 and Hahn 1683-1718. Alanus, Thauvonijs and Petraeus became later professors of Theology.

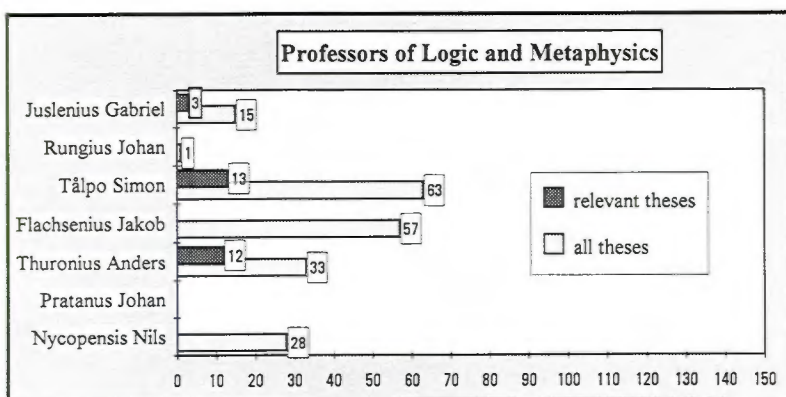


Table 2. The production of relevant theses for the study of natural philosophy was considerably less among the professors of logic and metaphysics, only Thuronius with his double professorship, and Simon Tålpo writing many theses on physics and on subjects of related interest. Nycopensis was in office 1640-50, Pratanus 1650-55, Thuronius 1656-65, Jakob Flachsenius 1665-79, Tålpo 1679-1700, Rungius 1700-01 and Juslenius 1702-17.

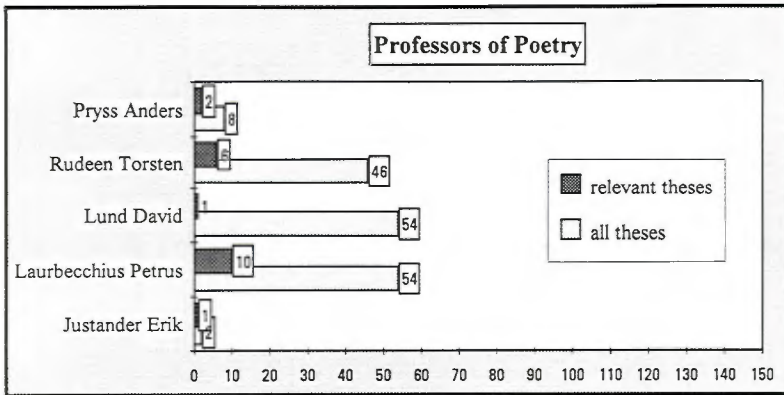


Table 3. In the Middle Ages and Renaissance poetics was usually taught either as a part of rhetoric or logic. At Turku it was first associated with logic, but in 1655 poetics became a chair of its own. The professors of poetics are as follows: Justander 1655-67, Laurbecchius 1668-88, Lund 1688-91, Rudeen 1692-1706 and Pryss 1706-46.

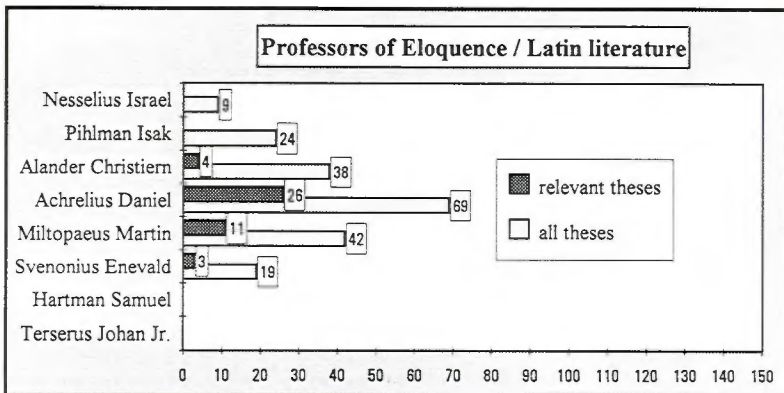


Table 4. Eloquence was one of the most important humanistic disciplines. It was regarded as useful both for would-be officials and clergymen - in the latter case because of its usefulness for the art of preaching. Terserus held the first professorship during 1640-49, and he was followed by Hartman 1649-53, Svenonius 1654-60, Miltopaeus 1660-79, Achrelius 1679-92, Alander 1692-1704, Pihlman 1704-07 and Nesselius 1707-16.

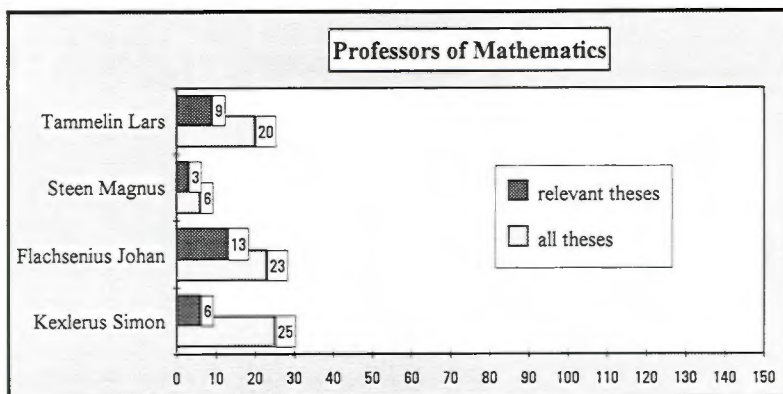


Table 5. The scope of mathematics included not only arithmetic and geometry, but also astronomy, geodesy, music, cartography and other subjects. At Turku mathematics is characterised by the long teaching periods of each professor, excluding Steen who spent only five years in office: Kexlerus stayed as professor 1640-69, Johan Flachsenius 1669-92, Steen 1692-97 and Tammelin 1698-1717.

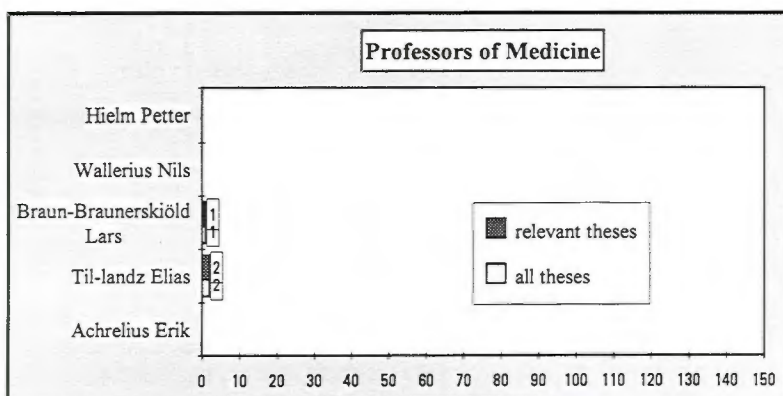
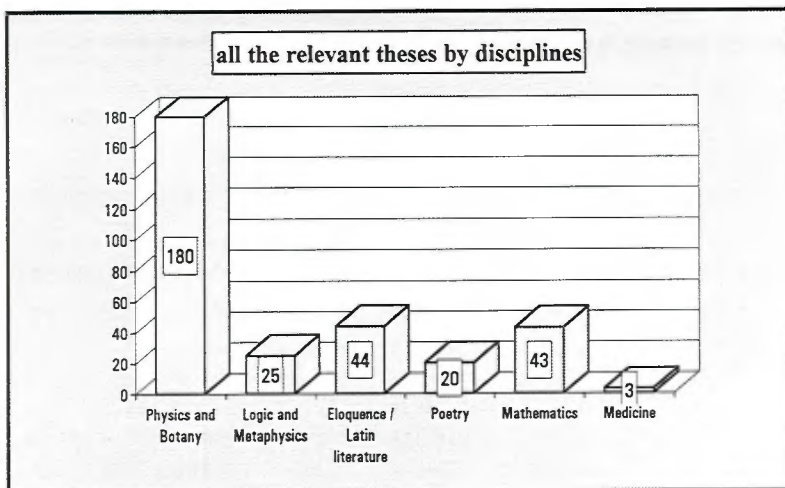


Table 6. The medics published remarkably little, which has mostly to do with the status of the medical profession. Anyone who took a degree in medicine preferred to do it abroad, e.g. in Leiden. The Faculty of Medicine had the following professors: Achrelus 1641-70, Til-landz 1670-93, Braun 1693-98, Wallerius 1699-1704 and Hielm 1705-15.



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Table 7. This table shows the distribution of the theses relevant for this study in various disciplines. As expected, the largest number of theses falls into physics and botany, which was the proper discipline for natural philosophy. The great number of natural philosophical theses in eloquence is explained by Achrelius' *Contemplationes mundi*, which was first published as a series of theses. Theses in mathematics and medicine were considered as mathematical or medical respectively, not as a part of physics.

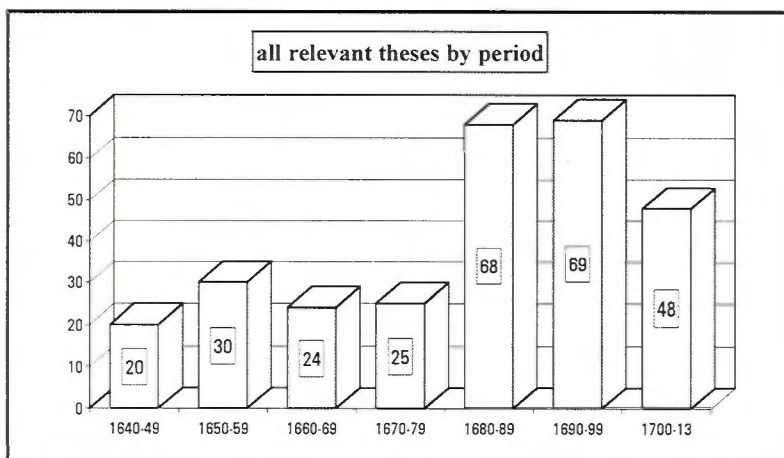


Table 8. The periodical distribution of all relevant theses shows a great increase in natural philosophical and mathematical activity in the 1680's and 1690's. The Great Northern War caused a decline in the number of theses. The fall starts from the beginning of the new century and accelerates during the last three years of the period, when only a few theses were printed: hence the last column exceptionally includes the thirteen years 1700-13.

Besides theses there was another literary genre typical of scholastic and early modern learning: the textbook. In theology, professor Enevald Svenonius produced several volumes of programmatic and pugnacious religious books.³² In mathematics, Kexlerus published books on arithmetic, chronology, and cosmological geography.³³ Andreas Thuronius published two books in logic and metaphysics, which were to become classic texts at Turku: *Institutiones Logicae* and *Compendium Metaphysicae*.³⁴ Several other books from other authors could be named in addition to these. Most of these textbooks contained only small personal contributions, as they were for the most part compilations of certain foreign authors' works.

There are, however, two books which are of more importance for this study than those mentioned above. In 1672 Bishop Johan Gezelius published his *Encyclopaedia Synoptica*, which was a wide-ranging scholastic representation of all branches of knowledge. The method and aim of this work is revealed in its subtitles: "Collected from the best and most exact writings of Philosophers and distributed in Three parts. Published for the use of diligent students, who have no money to buy the longer works of these Authors, and have not enough time to go through all of them."³⁵ Gezelius' work combines the old encyclopaedic tradition with seventeenth-century developments. Whereas the encyclopaedias were traditionally occupied with the question of the classification of sciences, the 17th-century textbooks were partly different in character. There was a growing tendency among the seventeenth-century authors to write a *cursus* covering the entire course of philosophy, or even theology.³⁶ Gezelius has a laconic style of ex-

³² On Svenonius' oeuvre see Salminen 1978, 1985.

³³ *Arithmetica triplex* 1655. *Tractatus brevis de tempore* 1661. *Cosmographiae Compendiosa descriptio et geographiae introductio* 1666. Vallinkoski 1966, p. 280-283. Slotte 1898, p. 7-8.

³⁴ *Institutio logicae* 1660-61. *Compendium metaphysicae* 1664. Rein 1908, p. 75-84.

³⁵ Gezelius 1672. "Ex Optimis & accuratissimis Philosophorum Scriptis collecta, & in Tres partes distributa. In Usum Studiosae juventutis, cui neque pretium prolixiores Autores redimendi, neque tempus eosdem perlustrandi suppetit, *Evulgata*."

³⁶ According to Laasonen 1977b, p. 373-374 and Klinge 1987, p. 594 the foreign model for Gezelius' work might have been German Johann Henrich Alsted's *Scientiarum omnium encyclopaedia* of 1630. This would be understandable because the Calvinists such as Keckermann, Timpler and Alsted were the most prominent compilers of encyclopaedias in early 17th century. However, the Calvinists' view of the ontological status of metaphysics and theology differed radically from that held by the Lutherans. Lohr 1988, p. 632-638. Schmitt 1988, p. 801-803.

pression and he concentrates on making divisions and definitions of the subject matters. In this respect his work differs from the normal natural philosophical works at Turku.

Why did Gezelius choose to write in a genre atypical of the Academy of Turku? One explanation might be that he was a bishop, and as such not directly an academic. Unlike the normal textbooks Gezelius' *Encyclopaedia* was not first published as a series of dissertations and thus there were no practical demands preventing its presentation in this form.

On the other hand another book of great significance in 17th-century physical learning at Turku was first published as a series of dissertations and only later gathered into book form. This textbook is Daniel Achrelius' *Contemplationes mundi*, which came to light as a book in 1682.³⁷ Instead of being a comprehensive study of all disciplines, it aimed to cover all of natural philosophy. As this book will frequently be referred to in this study, it will speak for itself and therefore it hardly needs further introduction here. From the 1660's to the 1680's textbooks were published relatively frequently in respect to the size and resources of the University. The last great textbooks were published in the course of the 1680's, and it was not until the 1730's that we see new attempts to write major works at the Academy of Turku. However, only two of the 17th-century textbooks have real relevance to this study. Academic theses remain the most important source materials.

B) Manuscripts, letters, minutes. Almost all that we know about learning at the Academy of Turku in the 17th century is based on information obtained from printed academic dissertations. A series of fires has destroyed the major part of other possible sources, such as private letters, manuscripts and notes made from lectures. The most notable extant manuscript, which has remained unpublished, is a 68-page treatise on astronomy.³⁸ For a long time this book has been attributed to the professor of physics and metaphysics, Andreas Thuronius, who would have written it around 1664-1665, just before his death. However, Jaakko Lounela has quite recently produced convincing evidence that this manuscript is more appropriately ascribed to the professor of mathematics Simon Kexlerus.³⁹ Another manuscript

³⁷ Achrelius 1682. On this book see Kallinen 1991a.

³⁸ UUB manuscript A 301.

³⁹ Lounela 1987.

on comet observations is, however, undoubtedly from Thuronius' hand.⁴⁰

Other manuscripts concerning natural philosophy in 17th-century Turku are hardly traceable. Most part of the official papers of the Academy are still available, however, and can be some help in this research. Correspondence between the Chancellor and the Senate, as well as letters to and from the king of Sweden have been preserved up to our day. They are for the most part easily available in printed form, as are the official records of the Senate.⁴¹ These documents are invaluable for elucidating the background to controversies at the University. All in all, however, there is relatively little background material available. Although the scope of the sources available does not allow us to look into the everyday teaching and learning at the University⁴² or to do a detailed study on boundary-work through controversies, there are yet other aspects of the life in universities that can be satisfactorily studied.

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4. DEFINING THE SUBJECT OF RESEARCH

This study deals with the thinking in natural philosophy at the Academy of Turku. It begins with the foundation of the University in 1640 and extends over seventy-three years to 1713, when the Academy of Turku was closed down, because Russian troops occupied the area. Professors fled to Stockholm and rescued the University archives and library with them. Although at some point the University tried to function even while evacuated, no regular teaching was ever achieved. Peace was made between Sweden and Russia in 1721 and the following year the University could be reopened.

It is a general assumption in the history of Finnish science that this

⁴⁰ HYK Ms/Mf 550.

⁴¹ With the exception of the years 1695-99.

⁴² For a study in which the regulations stated in the official curriculum are compared with the everyday life and teaching in universities see e.g. Brockliss 1987. Gascoigne 1985. Grafton & Jardine 1986.

break caused for political reasons involved a change in learning traditions as well. It is true that when the University started functioning again in 1722, most professors were new to their office and of a younger generation with a less scholastic training than their predecessors.⁴³ How deeply this break really influenced the learning of natural philosophy in Turku must remain outside the scope of this study. It seems that the change was not equally profound in all respects - and not even as immediate as has often been assumed. This study will provide a sound basis for analysing the question of continuity and discontinuity in this historical context, a task I wish to be able to take up in a later study.

"Natural philosophy" is a relatively vague term. It not only refers to Medieval and Renaissance natural "science", but also has an established reference to the German philosophical movement of the 18th and 19th centuries (*Naturphilosophie*). In this study, of course, we have the natural philosophy of the early modern science in mind, which in the 17th century was usually referred to by terms such as "*scientia naturalis*", "*physiologia*", "history of physical matters" and "cognition of nature".⁴⁴ Apart from historiographical correctness there is one more reason, why I prefer to use the term "natural philosophy" over "science". I would like to avoid any confusion with experimental science and thereby respect the unique characteristics of the both of these intellectual approaches. The 17th-century natural philosophy was characteristically knowledge of God and His attributes as revealed by the scrutiny of his creation, i.e. nature. In this "natural philosophy" differs markedly from later (19th-century) concepts of "natural science".⁴⁵

Generally "natural philosophy" in this study equals with the scope of the 17th-century physics.⁴⁶ The natural philosophy at Turku was not physics in the same sense as Aristotle and his commentators understood the subject matter of *Physica*. Discussions about the general and fundamental ideas such as the nature of motion and rest, change, time, place, necessity and contingency, and causation interested the

⁴³ Heikel 1940, p. 98-105.

⁴⁴ Scharfius 1646, p. 1. "Physica... alias vocatur naturalis scientia, physiologia, historia de rebus physicis, naturae cognitio."

⁴⁵ On the distinctive character of natural philosophy see Cunningham 1991. Cunningham & Williams 1993, p. 420ff.

⁴⁶ In this text the word "physics" will be used as a synonym for natural philosophy.

scholars at Turku surprisingly little. Some of these themes were dealt with in metaphysical and logical works,⁴⁷ but in physics the approved interpretations of these fundamental concepts remained preconceived ideas. Neither did the physics at Turku include study of kinematics, dynamics or things of that kind, since they were regarded as a part of mathematical sciences.⁴⁸ What we encounter at Turku is "physics" in the wider sense of the antique and medieval tradition, which concentrated upon finding the causes of all "natural bodies" (*corpus naturalis*). It encompasses theories of generation and corruption, astronomy, meteorology, and studies living, animate nature. However, defining the limits of the study only according to the 17th-century disciplinary boundaries would leave a lot of interesting comparative material aside, so that I have occasionally widened the scope of my study from "physics" to cover all ideas and theories which describe and/or explain natural phenomena.

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A word of warning might well be appropriate in talking about natural phenomena. The range of "natural" phenomena as opposite to supernatural or even non-existent ones will have to be historically defined. One source of confusion and misunderstanding between 17th-century science and later-day historians describing it is that the boundaries between these two categories have changed since. For example, by equating supernatural and unknowable we would dismiss 17th-century conceptions of sympathies and antipathies between things as something imaginary, mystical and occult. In the 17th century this was not necessarily the case, and indeed even the concepts mystical and occult had partially different meanings to nowadays.⁴⁹

It might be advisable to say a couple of words about metaphysics as well. Gary Hatfield has recently drawn attention to a distinction which in fact should go without saying for a historian.⁵⁰ In the modern sense of the word "metaphysical" often refers to presuppositions concerning the nature of reality which underlie all theoretical thinking. Certainly all philosophers made such presuppositions in the 17th century, and they do in the 20th century as well. However, the me-

⁴⁷ For a discussion on the four causes see Flachsenius 1678.

⁴⁸ Gezelius 1672. Statics is placed among the *scientias mathematicas*.

⁴⁹ Whereas in the 17th century it was understood that occult practices involved calling on demonic spirits for help in mastering nature, modern forms of occultism usually prefer to seek for contact with spirits of the dead in order to get information about the hereafter, to foresee the future, etc.

⁵⁰ Hatfield 1990.

taphysics of the 17th century was still in many ways bound up with the Aristotelian and Platonic traditions. Metaphysics was a science of the first principles of being, studying being *qua* being.⁵¹ In this sense it was prior in respect to nature, but not in the order of learning, because metaphysical concepts were ultimately abstracted from sensory images. It was a traditional Aristotelian question whether this "first philosophy" could produce the principles of the more specialised sciences such as physics. All in all the concepts defining the nature of being had to be suitable to describe spiritual entities as well, and most metaphysical terminology was modified to match the needs of Lutheran theology. Bearing this in mind we might expect the two disciplines, metaphysics and physics, to have a special kind of a relationship during the era concerned.

Not only is the lack of understanding of the historicity of concepts dangerous, but exceedingly restrictive definitions can be harmful as well, if they limit our view of the subject as a historical entity too much. My purpose here is therefore more to define loose frameworks for these concepts in order to make it clearer what this study is all about. It is also essential for us to be aware of the kind of problems and ambiguities the use of these concepts might involve. There are two more concepts often used in this study which for these reasons need specification: Aristotelianism and scholasticism. These two are such well-known cover-all concepts that their exact meaning in each context is not so readily clear. Indeed, as Charles B. Schmitt and Edward Grant have shown in their articles, during its approximately five hundred years of dominance (1200-1700) "Aristotelianism" implied such a variety of learned schools and sects that the confusion about the meaning of the term itself is more or less inevitable. Moreover, in the 16th century it was by no means self-evident that a university scholar should be an Aristotelian: Aristotelianism was not without alternatives, Platonic, Neo-Platonic, and Stoic ideas together with the humanist movement competing with it successfully.⁵² For us the term "Aristotelianism" has a sufficiently concise meaning if we define it to include such thought as in one way or another is based

⁵¹ For many Renaissance thinkers metaphysics had also been important as a science of God, the only immutable existing entity. Lohr 1988.

⁵² Schmitt 1973. Grant 1987. Kessler 1990 has shown that the Platonic and humanistic traditions were nevertheless in many ways bound to or connected with Aristotelianism.

on Aristotle's or his commentators' texts. This includes the idea of physics as demonstrated knowledge of the causes of things (*scientia*). There were some basic characteristics in natural philosophy which all "Aristotelianisms" tended to accept. Edward Grant has set them down as follows:

From Aristotle's physical treatises scholastic authors derived and justified the geocentric system, the four elements, the four causes, the doctrine of potentiality and actuality, the doctrine of celestial intelligences, the sharp distinction between celestial and terrestrial bodies and between lightness and heaviness, and other fundamental concepts.⁵³

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As we will later see, Grant's list no longer perfectly covers the features of Aristotelian natural philosophy at Turku. Schmitt's notion of the variety of Renaissance Aristotelianisms has generated a widespread research tradition since the beginning of the 1970's, in which the multiple features of Aristotelianism have been studied from different points of view.⁵⁴ My study will also join this tradition in its own straightforward way, for it will be one of its central tasks to provide the term "Aristotelian natural philosophy" with a meaning which suits this particular historical context.

In the quotation above Grant mentions "scholastic authors". But not all scholastics were Aristotelians and not all Aristotelians merely scholastics in the Renaissance and 17th-century science.⁵⁵ Scholasticism "is predominantly a method of study and of teaching developed and used within the framework of institutional instruction and pedagogy",⁵⁶ whereas Aristotelianism is a much broader concept, a system of philosophical and scientific knowledge. In northern Europe scholasticism was revived in the 17th-century as a conscious reaction to Ramism and the humanistic movement. In this revival it was ready to take inspiration from Spanish philosophers, especially Francisco Suárez.⁵⁷ Scholastic thought was very much alive at Turku too, albeit not in a pure form but at least in the sense that the structure of sciences, met-

⁵³ Grant 1987, p. 342.

⁵⁴ See e.g. articles in Henry & Hutton 1990.

⁵⁵ Schmitt 1973, p. 161. Grant 1987, p. 343.

⁵⁶ Schmitt 1973, p. 161.

⁵⁷ Trentman 1982, p. 818-824.

hods of disputation and textbook-writing had inherited various features from the scholastic tradition.

As it may be clear from the chapter in which previous research on the subject was described, one of the main aims of this study is to create a thorough view of physics in the 17th century. First of all this naturally fulfils a function in the national historiography of science. But it also aims to achieve something of a wider interest from this parochial basis. How can this be done? This study deals with natural philosophy in a distant and provincial university. It was not an innovative community, which would have played a crucial role in the rise and advancement of early modern science. No discoveries of any importance were made there. However, concentrating on one rather small university makes it possible to write a detailed history of such a wide-ranging discipline as physics was in the 17th century. The idea is to concentrate on seeing how a standard university such as this functioned, what kind of a role natural philosophy played in it and what kind of profile physics consequently got there. I shall therefore refrain from making systematic comparisons with other Swedish and Central-European universities. This study does however provide a basis for future comparative research.

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Natural philosophy is best studied in its academic context. In order to build this context it is important to determine which characteristics in the life of the Academy seem to be most formative. It might be useful to start by considering the ideology behind the very existence of the Academy. The University was founded for certain purposes, and this ideology obviously also guided the tendencies in its educational politics. Thus I shall begin the first chapter of this work with the foundation of the University. The inner structure of the Academy will then be discussed. The disciplinary structure of the University not only specified the context of its everyday work, but also mirrored the epistemological boundaries between different branches of knowledge. I shall argue later in this study that much of the discussion in 17th-century physics was about aspirations to break and attempts to maintain these boundaries. Moreover, the institutional setting binds the Academy of Turku to the more general European traditions of learning.

In the 17th century theology was the uncontested *regina scientiarum*, especially in a country where the church was pushing aggressively for orthodoxy. Obviously then the relationship between physics and theology plays an extremely important part in the context in which natural philosophy is situated. The interplay between physics, theology and metaphysics is therefore another central theme in the first chapter.

The relationships between theology and philosophy have been touched on in many studies of Swedish and Finnish history of science and ideas. There is still no study which thoroughly analyses the relationships between these two branches of knowledge. The question has been incidentally discussed in two kinds of studies. First of all, the historians of theology have dealt with the subject from their own point of view.⁵⁸ Because many of these studies are biographies, it appears quite natural that the emphasis be laid on one particular person's activity in the field. On the other hand historians of science have also dealt quite briefly with the influence of religious ideas and biblical argumentation on their respective subjects.⁵⁹

Both the historians of theology and of science have usually contented themselves with stating simply that philosophy was an *ancilla* of theology. What this relationship really meant to natural philosophy on one hand and to theology on the other is hardly ever problematised any further. Historians of theology have in general been more concerned about the question of what importance philosophy as a whole had for the development of religious thought.

It can hardly be claimed that there was any deep-seated controversy between 17th-century theology and philosophy in Finland. Despite the distinct gulf between their epistemologies, subject matters and all in all between their statuses, theology and philosophy nevertheless formed an interdependent system of knowledge. Although the intention was not to create a *physica Christiana* in the Calvinistic style (a physics entirely based on theological argument), many fundamental ideas on which the system of natural philosophy was based were nevertheless derived from religious beliefs. Theological dogmas should in turn be expressible in metaphysical terminology as well. It is hardly surprising therefore that theological beliefs strongly influenced the "right" interpretation of some of the key concepts in metaphysics. Physics was also in many ways dependent on metaphysical concepts, and conversely physical "observations" and "facts" could be used to demonstrate the truth of some theological and metaphysical doctrines.

On the other hand the 17th century was the period in Europe during which the Bible-critic, driven by upholders of philology, astronomy and other kinds of "mundane criticism", made a breakthrough for the

⁵⁸ Laasonen 1977b. Salminen 1978, 1981, 1983, 1985.

⁵⁹ Hjelt 1896. Leikola 1983. Lehti 1979. Slotte 1898. Sandblad 1944, 1945.

first time.⁶⁰ The threat this posed to the authority of the Bible was felt in the Kingdom of Sweden, too, although domestic critics of the Holy Book were still lacking. It seems possible that this threat generated a strain of cautiousness in the attitudes of both philosophers and theologians towards the mutual relationship between their particular domains of study.

In the first chapter the relations between these three branches of knowledge will be scrutinized, although only as far as they help us understand the special context in which 17th-century physics found itself. A really thorough study of the subject would demand extensive study of original sources in theology, which would be an enormous task and has to be left outside the scope of this study. The approach to the problem I have adopted in this study follows the guidelines recently drafted by J. H. Brooke. It disengages itself from assumptions according to which science and religion are either in an inherent conflict, or complementary to each other. Instead, more refined forms of interaction will be looked for. Finally it is recognised that the very concepts of "science" and "religion" must be historically redefined.⁶¹

The second chapter of this study consists of an overall description of the physical theories and concepts which were used in 17th-century natural philosophy. I shall focus on those problems in natural philosophy which 17th-century scholars themselves regarded as central. Although a need for a this kind of general national historiography, which would work as a reference for those authors who deal with other aspects of 17th-century cultural life or other branches of intellectual history clearly exists, this piece of research is also intended to go beyond mere description. Aristotelian physics at Turku was a result of a long philosophical tradition, and I intend to relate physics there to this long inheritance thus rendering some ideas which might at the first instance seem odd to a modern reader more understandable.

I have been claiming that "Aristotelianism" is far too vague a term without any further qualification, when talking about the 17th century. The fact is that in Turku also the corpus of accepted dogmas in natural philosophy was a collection of ideas absorbed from various philosophical traditions. It has been a trend in some studies published during the 1970's and 80's on 17th-century history of science in Finland to

⁶⁰ Scholder 1966.

⁶¹ Brooke 1991, p. 1-51.

trace these various influences.⁶² Because it has become common knowledge by now that the major part of learning was based on German models, acquired either directly from Protestant Germany or via Sweden, my study intends to avoid re-inventing such wheels. Furthermore I greatly doubt whether a detailed quantitative study in which positive, negative and neutral reference to European authors are listed could be carried out satisfactorily. As I have shown in one of my previous articles, the citations vary in length and importance, they may be indirect (i.e. stem from a third author's text) or often leave the origin of the model text in doubt. Sometimes it even is difficult to judge whether a citation should be interpreted as positive or neutral, and so forth.⁶³ It is evident that the quantitative method is not reliable without a thorough qualitative analysis, and analysing the entire corpus in this way would be an unreasonably time-consuming job. Something very general will however be said about the most used sources in the first chapter.

In order to get an authentic picture of learning in some period, a historian of science should not only concentrate on looking for the geniuses or dissidents of the time, who are then said to have anticipated later invented theories, or on searching for the roots of certain modern conceptions. We should most of all pay attention to those questions which were really being discussed in the period concerned. This is not to say that studying the exceptional features of a period would not illuminate important aspects of the totality of the history of science. However, we cannot even say what is new or exceptional unless we readily recognize what was usual and traditional. Therefore it is my intention to focus my description on those matters which the scholars in 17th century Turku themselves found central and important in their respective fields of study.

The third chapter of this study then goes deeper into the subject by weighing the impact of Cartesianism on natural philosophy at Turku. It was probably the most prominent and most disputed "new philosophy" both on the Continent and in Scandinavia during the 17th century, which is exactly why I regard Cartesianism as worth closer study. Tracing Baconian ideas, if not futile, would be at least much

⁶² Salminen 1978, 1985. Lounela 1978. Lehti 1979. Kallinen 1991a.

⁶³ On the practical difficulties in this methodology see Kallinen 1993. For theoretical difficulties in studies on how influences are absorbed, given or passed on, see Skinner 1969.

less fruitful than studying Cartesianism and reactions to it in greater depth, not least because the extent of Baconian influence at Turku has already been studied.⁶⁴ Cartesianism caused severe disputes at the University of Uppsala in the 1660's and 1680's, while the University of Turku remained a relatively peaceful place in this respect. Cartesian ideas were consciously and decidedly rebuffed, and this tactic was successful until the last two decades of the century. Although this philosophy was thereafter approved in principle, it did not become *the* new paradigm.

Cartesianism not only threatened the dominant position of Aristotelian philosophy. More importantly, accepting Cartesian ideas would often have presupposed renegotiation of the disciplinary and epistemological boundaries. This claim is evidenced by seeing how the different degrees of sensitivity towards ideas on different levels of epistemological and metaphysical importance were formed. We can easily imagine that there were differences in reactions to Cartesian dualism and, let us say, to the Cartesian version of the circulation of blood. Thus the third chapter of this book will not only be a how-Descartes-came-to-Finland-story, but also offers an analysis of different aspects of Cartesian theories in this particular doctrinal context. Although I shall approach the subject mainly from the viewpoint of physics, we will also have to ask what kind of role metaphysical and religious ideas played in the formation of the various attitudes towards Cartesianism. On the other hand this chapter provides substantial material for the analysis of how knowledge claims are transformed and treated in the process of diffusion of knowledge.

Studying physics in its academic context and in its relation to theology in particular, and discussing the advent and partial acceptance of Cartesianism should provide a thorough picture of the whole body called natural philosophy. The main task of the conclusion, entitled "Stability and Change", will therefore be to weigh some further questions of the nature of 17th-century Aristotelian science in general. The problematics of change and stability will dominate this chapter: we shall see which elements in natural philosophy changed and which did not. What kind of causes can we assign to change on the one hand and stability on the other? First of all I shall pay attention to the role of eclecticism in this dynamic. We shall ponder what kind

⁶⁴ Knuuttila & Niiniluoto 1986.

of pressures economic and political factors might have put upon natural philosophy, or whether these kinds of "external" factors can be used as explanations at all. Having gathered up some remarks about the general attitudes towards new ideas, or "novelties", I shall proceed to try to explain the relatively strong conservative element in natural philosophy.

The problematics of centre as against periphery falls quite naturally on a study like this. I shall begin by considering the role of the Academy of Turku in the educational system of the kingdom of Sweden. Is there something in this role which explains the character of learning at the University of Turku, or could it conversely be said that the state of learning at Turku partially assigned it a certain niche on the national level? The University of Turku was institutionally and doctrinally a bearer of old European traditions. Only as a part of a political and military superpower such as Sweden did the province of Finland and its only University become an organic part of Europe. During the 17th century the field of learning was in a state of ferment in Europe and it is of course important to know in what relation the Academy of Turku stands to all this. Therefore I shall finish this study by making some comparative remarks about the state and status of the learning at Turku in an all-European context.

The Academical Context of Natural Philosophy

1. THE AIMS AND STRUCTURE OF THE UNIVERSITY

The Foundation of the Academy of Turku

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The Reformation, which was introduced into Sweden from above as a part of political changes and the birth of national state in the 1520's, interrupted the educational traditions carried on by the Catholic church. When practically speaking all property of the church was confiscated, the new Lutheran church hardly had even the means to educate the vicars it needed. Whereas in the Middle Ages Swedish names could regularly be met in the matricles of such universities as Paris and Prague, the number of students attending foreign universities dropped drastically in the first part of the 16th century. However, the only way to obtain higher education was still to go abroad, and after the Reformation the universities of Lutheran Germany attracted some Swedish and Finnish students.¹ Although a new schooling system was gradually organized by the state, in accordance with Melanchthonian educational principles, learning on the whole was still at a very modest level. In the province of Finland there were lower schools in Turku and Vyborg (grammar and cathedral schools), but there was no functioning university in the country before the rearrangement of the Uni-

¹ Eliasson 1992, p. 29-33. Klinge 1987, p. 13-17. Strömberg (forthcoming), Ch. 5. On peregrinations before the foundation of the University of Turku see also Heininen & Nuorteva 1981. Wittenberg, Rostock and Helmstedt were the most popular universities in the 16th century, whereas in the following century Helmstedt's popularity decreased while Leiden, Leipzig and Greifswald became more fashionable.

versity of Uppsala in 1595.²

The political and military expansion of Sweden in the 17th century made increasing demands on the country. It was realized very early that in order to keep the rapidly-growing state bureaucracy going, a reform would have to be carried out; a reform which would cover the educational system in its entirety from elementary schools to universities. Moreover, it was calculated that it would be cheaper to educate students in local universities than to send them abroad. As a part of this policy king Gustaf II Adolf gave the University of Uppsala a large sum of money and other property in 1624. These grants finally enabled the institution founded in 1477 to function properly. But new universities were also founded, for example in the newly occupied Tartu in 1632 and in Lund in 1666. This educational policy brought benefit to Finland as well. It had been a part of Sweden for hundreds of years, and now for the first time the province had acquired a gymnasium which was soon elevated to a real university. This happened in the year 1640.³

Behind the great administrative and institutional reforms during the first part of the 17th century was the effort of the state to centralize and standardize the country. This policy was well summarised by the Dutch scholar, Justus Lipsius, who was one of the greatest authorities in political theory in 17th-century Sweden. As he put it: "one religion, one language, one law and similar manners are the best bonds to keep a country together with".⁴ The University of Turku was to bring this state ideology into the hearts of young students while educating them to be good officials.

It was not, however, only the practical needs of the state which formed the ideological background for the teaching at the University. The main function of the Academy of Turku was to raise the educational level of the clergy. As the quotation from Lipsius shows, reli-

² Klinge 1987, p. 18-24, 32-39. According to the Melanchthonian educational ideals even intending priests had to study mundane subjects in order to be good debaters against infidels. Kuskawa 1990, p. 41-66, et passim.

³ Klinge 1987, p. 20-32, 39-52, 60-71. The gymnasium had been founded only ten years earlier, in 1630. Lindroth 1975, p. 19, 47-56. On bureaucratization see Rystad 1983.

⁴ Lehtinen 1979, p. 102-104, 111-114, quote from Lipsius p. 103 "una religio, una lingua, una lex, iidem mores vincula optima sunt societatis". Other reforms were e.g. the foundation of The Turku Court of Appeal in 1623 and the introduction of new divisions into provinces in 1634. See Halila 1987, p. 17-21. Klinge 1987, p. 71-75.

gious purity was regarded as an important factor in standardizing the state. Of course, the Lutheran Church had a very strong position in cultural life in itself.⁵ Especially after the Peace of Westfalen in 1648, Lutheran orthodoxy of the most bigoted and aggressive kind played a dominant role in 17th-century Swedish culture in general.⁶ Although the aims of the state and the principally state-led church to raise the educational level of the Finnish-speaking clergy were thus similar in theory, they often diverged in practice. Whereas the church aimed to harness the potential of the universities to train clergy, the king and aristocracy preferred to further their respective interests by favouring a more mundane curriculum.⁷ This tension between the state and the church was to play a role in the life of the University for decades.

The aspirations of the state and the church were personified in the men who mostly promoted the actual foundation of the University, bishops Johannes Rudbeckius and Isak Rothovius, and governor-general Per Brahe. In the 1620's and 1630's Rudbeck had already vigorously opposed new laws planned by the king to exert more control over the clergy. Partly due to these controversies Rudbeck wanted to create a university which would be free from the influence of the prominent statesman Johan Skytte, one of Rudbeck's arch-rivals. This Rudbeckian university would steer clear of Ramism (a philosophy much favoured by Skytte) and teach Lutheran orthodoxy in a very anti-catholic form. Unlike the University of Uppsala, the *alma mater* at Turku would avoid any contacts with Central Europe, where young noblemen could be seduced by "calvinistic and jesuitic heresies". Bishop Rothovius at Turku was for his part eager to renew and reorganize clerical matters in Finland, and a university in his episcopal town would naturally greatly further his interests. Rothovius was therefore an active proponent of the academy before the high officials in Stockholm.

On the other hand Count Brahe also had his own feuds with the state chancellor Oxenstierna, who was the main proponent of the centralist policy. Decentralization and old-style aristocratism were closer to Brahe's heart, and he saw that a university at Turku would advance these ideals. According to Brahe an academy would also gradually spread the light of civilization and discipline to the uncultured people

⁵ Halila 1987, p. 91-106.

⁶ Hägglund 1971, p. 274. Salminen 1978.

⁷ Klinge 1987, p. 46. Schybergson 1915, p. 48-61.



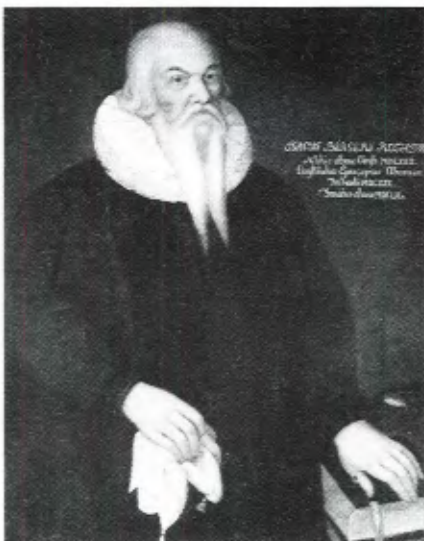
The Academy of Turku was very much a creation of Count Per Brahe. He was also the first Chancellor of the University and directed its development with a strong paternal hand until his death in 1680. Brahe was not nominated as Chancellor immediately after the foundation of the Academy, although he acted as such unofficially. Only in 1646 did the Academy get a Chancellor. In the 17th century it was a matter of prestige for a University to have a high-born Chancellor, a *patronus*.

living in the distant areas of Finland.⁸ This ideology behind the foundation of the University largely explains the voluntary intellectual isolation of the institution from developments elsewhere in Europe.

The initiative to found a university at Turku had for the first time been announced at the Diet of 1637. By 1638 the plan had proceeded so far that negotiations over practical arrangements could be started between Brahe and the privy council. Despite Rothovius' and Brahe's disapproval of the "German orientation" of Uppsala, this University served as a model for the Royal Academy of Turku.⁹ The constitution of the University of Uppsala was to be in force at the Academy of

⁸ Klinge 1987, p. 51-71, 75. Lindroth 1975, p. 50-51, 83-84. Schybergson 1915, p. 1-22. Bearing in mind the ideologies of both Brahe and Rudbeck it is easy to see why they despised Ramist philosophy, which was still in vogue in Sweden during the 1630's. Ramism not only was favourable to secular learning, 'the humanities', but it also regarded schooling as a means to achieve higher social position - an idea not approved of by Brahe. Grafton & Jardine 1986, p. 168. On Ramism in Sweden see also Sellberg 1979, p. 9-15. Sjöstrand 1940, p. 200-235.

⁹ The official name of the University of Turku was "The Royal Academy of Turku". Nevertheless it was not an academy in the sense of the new scientific academies, the term being used to refer to a normal university institution. This practice had already been adopted in the 1625 Constitution of the University of Uppsala. See Annerstedt 1877, p. 239, et passim. In this study the words university and academy are therefore synonymous whenever referring to the Academy of Turku.



Bishop Isak Rothovius aimed at renewing religious life in the bishopric of Turku. The new Academy, in which clergymen could be trained, served this purpose well. The vice-chancellor was the highest authority present at the University, although it was much up to the bishop's own authority how effectively he could actually influence the teaching and nominations at the University.

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Turku too, whenever applicable. Thus both Uppsala and Turku carried on the basic structure of the University of Paris, which was imitated in the foundation of many other North European universities as well. Four faculties were established at the new university, Theology, Law, Medicine and Arts, or Philosophy as it came to be called.¹⁰ Academic life with all its rules, traditions and ideologies was brought ready-made from Uppsala to Turku. This was confirmed by the fact that nine of the eleven professors appointed came from the mother country.¹¹

The Order of Disciplines

The most prestigious of the faculties at Turku was Theology. In Northern Europe this was normally the case, whereas in Italy e.g. law and medicine prospered.¹² Theology got three chairs in Turku. The respect-

¹⁰ In the following I shall use the terms Faculty of Arts and Faculty of Philosophy as synonymous.

¹¹ Klinge 1987, p. 75-79. Lehtinen 1979, p. 114-115. As learning at Uppsala has been studied elsewhere, I shall not here systematically deal with the kinds of theses Turku professors had defended at Uppsala. See e.g. Lindroth 1975.

¹² Schmitt 1984, XIV p. 36-39, XV p. 289. On the order of disciplines in Turku as seen through the eyes of a seventeenth-century theologian see Salminen 1978, p. 103-127.

ability of the subject was made apparent above all in the salary and professorships in theology were thus the best paid of all. Many professors from the Faculty of Arts thus endeavoured to get a promotion to the Faculty of Theology. Both the Faculties of Law and Medicine had only one professor each. Studies in law were rather practical, and the Turku Court of Appeal (founded in 1632) undoubtedly offered chances to build a career to the most gifted students, while the Faculty of Medicine did not attract many students at all.

The Faculty of Arts was the largest of the four, but its status was the lowest and its function mainly propaedeutic. While in some universities the independence of the philosophy curriculum could nevertheless grow,¹³ at Turku the development followed a pattern more typical of Lutheran education, which saw arts studies serving the training of priests.¹⁴ Natural philosophy was therefore also taught at the University of Turku as preparatory studies for priests and lawyers-to-be. For many students the master's degree remained the only one they got. In the Faculty of Arts there were chairs of political science and history, holy languages (Hebrew and Greek), eloquence (Latin language and literature), logic and metaphysics, mathematics, and physics. The Faculty got one more chair when the chair of poetics was detached from logic and metaphysics in 1655.¹⁵ On the whole, the disciplinary structure of the Academy was based on long academic traditions which were informed by the Aristotelian order of sciences. These structures also reflected more thoroughgoing differences in the subject matter and method between the disciplines.

There was a hierarchy not only between faculties, but between different disciplines inside the Faculty of Arts as well. During the seventeenth century sciences were usually divided into theoretical, practical and productive disciplines, sometimes also called arts. Theoretical or speculative sciences included contemplative disciplines such as me-

¹³ Gascoigne 1985, p. 395. Gascoigne's example is from Cambridge, where "the philosophical curriculum had become increasingly divorced from the study of theology which helped reduce (though not eliminate) theologically-based objections to changes in the philosophy curriculum. Moreover, with the growth in the importance of undergraduate at the expense of postgraduate degrees in the period after the Statutes had been drawn up, philosophy (which had been traditionally associated with the bachelor's degree) came to loom larger in the university's overall course of studies."

¹⁴ Kusakawa 1990, p. 41-66, 164-176.

¹⁵ For more detail on these nominations see Klinge 1987, p. 75-79, on poetics p. 588.

taphysics, physics and mathematics. At Turku pneumatics or the study of the finite spirits (angels) was also regularly mentioned among theoretical disciplines.¹⁶ Ethics, politics and economy were called practical disciplines because they had the task of directing human activities, or as bishop Gezelius put it "they perfect man's will by wisdom, and guide human actions to reach what is good in civil life."¹⁷ Lowest in the grade were mechanical skills such as agriculture, navigation, mining and architecture, some of which were related or subordinated to mathematics. Arts such as grammar, rhetoric and logic were often also counted among productive disciplines, i.e. they were considered to be mere instruments working for the benefit of all other intellectual activity. This view was supported by Gezelius at Turku.¹⁸ In all-European discussion the actual order of disciplines, the grounds on which these rankings should be made, and relationships of mutual (in)dependences were constantly in dispute, especially during the sixteenth century.¹⁹

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The order of the disciplines at Turku was partially sealed by the constitution of the University. The constitution of the University of Uppsala from the years 1625/6 and 1655 were also valid at the University of Turku as far as they could be applied to the local conditions. Although the University of Turku got its own statutes in 1661, they remained a mere formality since in 1675 the constitution of Uppsala was specially decreed as valid at Turku too.²⁰ In addition to the regulation of the basic functions of the institute these statutes also gave instructions about teaching, starting from the orders as to which days and which hours each professor should lecture. At the same time the statutes defined which subjects belonged to each professor's teaching duties. For some disciplines in the Faculty of Arts a detailed curriculum was defined, which sometimes included a list of books which teaching should follow.²¹

¹⁶ Thuronius-Aurelius 1661. Gezelius 1672, p. 3-5. Flachsenius 1664. Tammelin-Brumerus 1695, p. 11.

¹⁷ Gezelius 1672, p. 5, "voluntatem hominis prudentiâ perficit, dirigendo actiones humanas ad bonum civile obtinendum".

¹⁸ Gezelius 1672, p. 5.

¹⁹ Wallace 1988, p. 210-211. Mikkeli 1992. Jardine (forthcoming).

²⁰ Heikel 1940, p. 20. Klinge 1987, p. 117-118.

²¹ In all three statutes, from 1626, 1655 and 1661, the most detailed lists of books were given for teaching in history, holy languages, the Latin language and mathematics. Annerstedt 1877. Schybergson 1918 & 1920.

Theoretical philosophy (i.e. logic and metaphysics) together with political philosophy were the most prominent philosophical disciplines at Turku during the 17th century. This is so although the official guidelines given by the statutes were much more detailed for these disciplines than for natural philosophy. The statutes of 1626 stress that the teaching of logic should be based on its usefulness instead of spending time in making unnecessary distinctions. The influence of Ramism is thus evident, and he is even mentioned as an author to be favoured in teaching.²² The Ramist emphasis then disappeared from the 1655 statutes, which say that the main function of logic should be to help in composing speeches or other texts.²³ This did nevertheless not mean an immediate end to Ramist influence. In the so-called trivial schools especially a Ramist textbook could still be used. In the University of Turku Enevaldus Svenonius started a more visible polemic against the use of Ramist books in logic.²⁴

The 1626 statutes ordain three professors of mathematics, whereas the 1655 statutes mention only two. At Turku there always was only one professor of mathematics. He was told to lecture on Euclides, Ptolemy, Ramus, Sacrobosco, Peurbach and Copernicus in 1626, whereas the later statutes refrain from naming any authors.²⁵ The medics are recommended the works of Galen and Hippocrates, with the addition that "chemical authors" should also be studied.²⁶ However, nothing is said about the preferred orientation of the teaching in natural philosophy in either the 1626 or 1655 statutes.²⁷ This is most probably because the ordinances were written primarily for Uppsala, where the teaching of physics was combined with the chair of medicine. The so

²² Annerstedt 1877, p. 250-251, 280. "Logices professor perplexis scholasticorum disputationibus juventutem non fatiget de logicae genere, subjecto, fine, medii investigatione et aliis, quae plus habent difficultatis quam utilitatis." (p. 250)

²³ Schybergson 1918, p. 227. "Och då logikens bruk icke ligger ensamt i dispute-rande, utan dess betydelse främst framträder, då man vill sammansätta eller up-plösa ett tal eller en skrift, så bör logikern beflita sig om att söka giva reglerna praktisk tillämpning..."

²⁴ Svenonius 1662, p. 296. Lounela 1978, p. 88-121, et passim.

²⁵ Annerstedt 1877, p. 277-278. Schybergson 1918, p. 224-225. Schybergson 1920, p. 169.

²⁶ Annerstedt 1877, p. 249-250. Schybergson 1918, p. 224. Schybergson 1920, p. 168.

²⁷ Annerstedt 1877, 1625 statutes p. 239-254, 1626 statutes 255-282. In Uppsala physics was integrated as a part of medicine: "Medicinarum primus institutiones medicinae enarrabit cum medendi methodo, alter physicen cum herbarum et par-tium humanis corpore cognitione..." Annerstedt 1877, p. 249.

called Brahe regulations are thus the only place where an official statement is made about the preferred orientation of natural philosophical learning. This brief section can be quoted in its entirety:

The professor of physics shall deal with the principles of physics according to Aristotle or some other of the most well-known authors. He shall also lecture on botany to his audience from the books of Dioscurus and other acknowledged authors of this kind. He shall lecture in the greater auditorium at seven o'clock.²⁸

Some historians have tended to see it as odd and restrictive for the progress of science that the statutes of a University name the authors to be studied.²⁹ However, it has been shown that the form of the statutes seldom hindered actual developments as the official curriculums were not slavishly followed in other European universities either.³⁰ We have no reason to believe that this would not have been true for Sweden and Finland either: even though the statutes gave rather direct orders concerning the contents of teaching in some disciplines, everyday life turned out to be more flexible. We know, for example, that also many authors other than those mentioned in the statutes are quoted and referred to in academic dissertations. Thus we should not imagine that the statutes themselves formed an absolute rule in this respect. On the other hand, it was an important function of the statutes to define the minimum contents of a degree. In this respect they could somewhat anachronistically be compared with the modern students' guidebooks on the curriculum, which are much more detailed and restrictive, at least in the Finnish educational system. In the 17th cen-

²⁸ Schybergson 1920, p. 169-170. "Physicesprofessorerna skall behandla institutiones physicae enligt Aristoteles eller andra de mest erkända författare. Han skall även föredraga botanik för sina åhörare ur Dioscurus och de andra mest framstående författare av detta slag. Han skall läsa i auditorium maximum klockan 7." The "Dioscurus" naturally refers to Dioscorides.

²⁹ Lehti 1984, p. 222.

³⁰ See e.g. Brockliss 1987, *passim*. Gascoigne 1985, p. 396-397. "Like the teaching in natural philosophy which, to judge by the Statutes, should have been largely confined to the study of Aristotle, the curriculum of the seventeenth century medical faculty had largely broken loose from the confines of the Statutes which had prescribed Hippocrates and Galen as the basic authorities." Gascoigne is talking about Cambridge, but the same was largely true for the medicine at Uppsala too, where Paracelsus, Sennert and later the Cartesian authors became the actual authorities despite the statutes' stress on Hippocrates and Galen. Lindroth 1975, p. 387-394.

ture the statutes not only restricted learning, but were also intended to keep up with the general standards for degrees.

But there was also another kind of versatility in the teaching. Natural philosophy was to be taught by the professor of physics, but in fact theses on physics were published under other professors' guidance too, and conversely the professor of physics could publish theses on such subjects as politics or metaphysics.³¹ This bears witness to a great flexibility or even to a kind of unestablishedness between various disciplines. One albeit marginal reason for this variety was, that in some cases a special need to produce certain kinds of dissertations in other disciplines could arise if the proper discipline was not working in a satisfactory way.³²

It seems that it was not totally unproblematic to publish theses on another professor's subject, though. Occasionally there were disputes in which a professor would accuse another of lecturing or disputing over matters belonging to his discipline. For example, in 1684 the professor of political studies, Andreas Wanochius made a complaint to the Chancellor claiming that the professor of eloquence, Daniel Achrelius, was unjustly publishing theses on subjects which belonged to his discipline. The Chancellor Bengt Oxenstierna took Achrelius' side, and according to him, professors could supervise subjects belonging to other disciplines as long as they did not thereby neglect their own duties.³³ The ideals of the day stated that politics and ethics should be combined with eloquence and poetry in the education of noblemen and even office clerks. Personal feuds were quite usual in 17th-century academic life, and this example is not without this kind of cause either. Resentment and envy did not appear for the first time in the relationships between Achrelius and his colleagues.³⁴ Nevertheless, it is very indicative that the grudge was articulated as a question about crossing the boundaries of disciplines.

In what sense did the boundaries of disciplines constitute the limits of flexibility then? It was typical of scholasticism to structure disci-

³¹ It was not, in fact, unusual for university teachers to teach in various fields, even those not officially theirs. Westman 1980, p. 105.

³² Perhaps the most striking example is Andreas Petreus' professorship in physics: during his 20 years in office he published only four dissertations in physics. Prof. Achrelius especially published a considerable number of dissertations on physics in this period (see Achrelius 1682).

³³ Chancellor Oxenstierna to the Senate 18.7.1684. In Jörgensen 1940.

³⁴ Hultin 1895.

plines in a hierarchical order, but the question of the priority of one science over another had already been a much discussed theme in Antiquity. Different principles for ordering the sciences were presented by Plato and Aristotle among others. The order of sciences in 17th-century scholasticism was basically inherited from Aristotle's conceptions about subordinate sciences. This order was based on metaphysical ideas about knowledge and the proper methods for acquiring it.³⁵ Nevertheless, the 17th-century understanding of the order of disciplines was not so much a question of the subordination of sciences as such, but of a complex pattern of established socio-professional roles and academic values combined with epistemological preferences.³⁶

From our point of view it is important to note that both the subject matter and legitimate methodologies of each discipline were accurately and inflexibly defined. Aristotle had already forbidden the transference of proofs from one science to another in his *Posterior Analytics*. According to Aristotle each science would also have its distinctive subject matter and first principles.³⁷ It was central in this setting to know the criteria on which we could say two disciplines differed from each other. According to many late 16th-century authors, e.g. Jacopo Zabarella, whose views were not without importance in Turku either, two theoretical sciences differed when they had separate subject matters (*res considerata*) and/or modes or methods of inquiry (*modus considerandi*).³⁸ In addition to these the aim or *finis* of a discipline was also regarded as a distinguishing feature between disciplines at Turku.³⁹ Because of the distinctiveness of each discipline, a professor of eloquence who published a physical thesis had to apply the proper methods of physics to the proper subject matter of this discipline in

³⁵ McKirahan 1978, p. 197-204. For an example of late 16th - early 17th century order of sciences which was based mostly on the subject-matter of sciences see Wallace 1988, p. 209-213.

³⁶ Jardine (forthcoming). Westman 1980. Biagioli 1993.

³⁷ McKirahan 1978, p. 201-202. Aristotle 1975, An. Po. I.7. Aristotle 1941, NE VI.3.

³⁸ Laird 1983, p. 226-228. Mikkeli 1992, p. 20, 32-33, 35-40.

³⁹ Thauvonius-Arctopolitanus 1656, Corollaria, "1. Omnis facultas suas habet metas quas transilire non licet. 2. Omnis facultas habet Subjectum proprium in quo scilicet explicando occupata est. 3. Omnis facultas habet finem proprium, possibilem & praestantem, traditq; media ad illum consequendum sufficientia atq; facilia. 4. Omnis facultas potest comprehendere certa methodo." Alanus-Wassenius 1646, Th. X. Thuronius-Aurelius 1661.

his work. As we will see later in this work, violation of this rule was often the primary matter of dispute in controversies.

The question about the differences between disciplines was also a question of the degree of certainty of knowledge. This aspect was being increasingly emphasized in the course of the 17th century. What kind of knowledge and acquired by whom was most certain and most respectable? Thus disciplinary boundaries were at the same time epistemological and social ones. I have included in this study theses from two disciplines which partially shared the subject matter with physics. However, their ends and especially methodologies differed from those of physics. In the following I briefly survey these three disciplines: physics, mathematics and medicine, and their status in the hierarchy of knowledge.

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The most commonly offered definition of natural philosophy at Turku was that "Physics is the science of natural bodies, as far as they are natural". (*Physica est scientia corporis naturalis, quatenus naturale est.*) As "natural" they were entities which consisted of an actual conjunction of form and matter (a composite whole). Therefore any study of such beings as spirits or angels was excluded from physics.⁴⁰ What, then, constituted *scientia* and how it was to be acquired from the physical world? It was stated in Aristotelian style, that *scientia* was an intellectual *habitus*: "The Genus of the word *scientia* is used to express... *accurately* and more Philosophically a demonstrative *habitus*, by which we understand necessary conclusions [arrived at] through their causes which are real, primary, immediate, prior and better known than the conclusions themselves."⁴¹ This definition thus employs typical Aristotelian concepts of scientific knowledge. According to Aristotle, knowledge could be called scientific (*episteme*) if it had been acquired by (syllogistic) demonstration from the first principles. In this sense we could only have knowledge of necessary things, or of things that could not be otherwise. However, we should

⁴⁰ Alanus-Wassenius 1646, Th. XI. Thauvonius-Warelius 1652, Sectio Prima, Membrum I. Thauvonius-Arctopolitanus 1656, Th. VII-XVI. Thuronius-Aurelius 1661, Theorema Physicum. Hahn-Govinius 1685, Quaestio I. Gezelius 1679, p. 4, 203.

⁴¹ Thauvonius-Arctopolitanus 1656, Th. IIX. "Genus voce *Scientiae*, exprimitur... *strictè*, & magis Philosophicè pro habitu demonstrativo, quo percipimus conclusiones necessarias per causas suas veras, primas, immediatas, priores & notiores ipsis conclusionibus". Cf. Thuronius-Aurelius 1661, Theorema Physicum, II. Alanus-Wassenius 1646, Th. X. "Est nempe physica certa rerum necessariorum per suas causas cognitio." Aristotle 1975, An.Po. I. 2, 4.

be careful not to pose our readings of Aristotle too readily on the 17th century texts.

The fine definition in the spirit of Posterior Analytics quoted above is not very informative about the practice of physics at Turku. The real aim of physics was to give a definition of the causes and affections of natural bodies, either in general (*physica generalis*) or considering certain species of composite wholes (*physica specialis*).⁴² In other words the principles of natural bodies which were to be demonstrated were the four Aristotelian causes, material, formal, efficient and final. The study of the affections of each natural body on the other hand meant a survey of its accidents (quantity, quality, place, duration and movement or rest).⁴³ Although physics aimed at knowledge of the universal characteristics of bodies, knowledge of the universals could be achieved only by abstracting from individuals. This would be done best by studying nature itself. The principally empirical nature of 17th-century natural philosophy should not be exaggerated, though. Exactly because physics had the noble status of a theoretical discipline, its aim was not to "operate, but to know and contemplate natural things".⁴⁴

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The structure of the physics theses directly reflects the method used in natural philosophical inquiry.⁴⁵ All theses usually start with a dedication (to the relatives and patrons of the respondent) and a preface; the congratulatory poems written by fellow students could be placed either at the beginning or at the end.⁴⁶ There were two basic formulas for writing a dissertation. The simpler form of these was based on questions or theorems.⁴⁷ Each theorem or "thesis" formed a main chap-

⁴² Alanus-Wassenius 1646, Th. XVI-XIX. Th. XI: "Nullus etiam alius est scopus scientiae naturalis, quam cognoscere principia corporum naturalium & eorundem accidentia per suas causas..." Thauvonijs-Arctopolitanus 1656, Membrum III. Thuronijs-Aurelius 1661, Theorema Physicum, III. Gezelius 1672, p. 203. Hahn-Govinijs 1685, Qvaestio III. Hahn-Höök 1690.

⁴³ On the affections of natural bodies see Gezelius 1972, p. 213-224.

⁴⁴ Alanus-Wassenius 1646, Th. X. "...non operari, sed scire & contemplari res naturales". See also Th. VII Porisma "Scientia naturae acquiritur, naturam ipsam scrutando".

⁴⁵ On method as an order of presentation see Mikkeli 1992, p. 80-85.

⁴⁶ Writing these poems was also an important form of exercise for good literary expression.

⁴⁷ In the theses the term 'theorem' is freely used. However, in this context it did not have the meaning of a sentence deduced from axioms or a formal system, but simply any kind of argument or statement which dealt with the subject matter. This kind of thesis can usually be recognized from its title, which was of the type "Theoremata nonnulla..." or "Quaestiones quaedam...".

MANTISSA,
COROLLARIA QUÆDAM
EX AMOENISSIMO PHILOSOPHIÆ AGRO
COLLECTA, ADJUNGENS.

Conti:
Generale. Philosophia: S Theol. ministræ, heræ nunquā oppugnat.
Noologicæ. Noologia: formaliter, à Metaphysica differt.
Metaphysicæ. Non Entis nulla est scientia, nullæ prædicata.
Pneumat. Spiritus, ut sic, non habet principia.
Physicum. Materia prima figmentum est.
Astronom. In sphaera naturali non dantur orbis Reales.
Geometr. Propertio Diametri ad Peripheriam, est Triplo sesqui.
Arithmet. Dividuum ab aliquo, est minimus ab utroq. (Septima.
Mulicæ. Hemispha. sphaera, non differt à sesquialtera.
Opticum. Vis per duo diversa media videtur vero majora,
interdum etiam fracta.
Gnomon. Intervall. punctorum horariorum variantur pro diver-
sitate altitudinis circuli Azimutalis.
Historicæ. Vinum etiam ante diluvium in usu fuit.
Ethicæ. Volens non sit injuriæ.
Politice. Tres faciunt collegium.
Oecon. Virginem quam viduum ducere satius est.
Logicæ. Definitio perfecta strictior est.
Rhetoricæ. In præfando ornatus sermonis maxime studendum.
Grammat. Ubique Grammatica utendum.

DEO TRINUM
TER MAXIMA GLORIA

Both the so-called *questio* theses and others could include so-called *corollaries* or *questions* in the final part of the thesis. In this thesis by Milltopæus and Kiellinus of 1672 statements concerning all disciplines are included. The pneumatological corollary states, that "A spirit as a spirit has no principles", the physical "The prime matter is a mere figment." and the astronomical one claims that "The natural spheres [of the planets] are not real [i.e. material] orbs."

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ter in the work. The theorem or question itself was presented first, after which erroneous explications of the subject were introduced, and finally the correct opinion was supported by several arguments. This kind of thesis could either deal with one subject matter, or more typically, present arguments discussing problems from many different disciplines. In any case they took up only special aspects or problems without intending a comprehensive definition of the subject.

Obviously this method was a descendant of the *quaestio* method, which was originally a product of medieval scholasticism.⁴⁸ It must be noticed, however, that we do not meet the medieval *quaestio* in a pure form in 17th-century dissertations. Whereas medieval 'questionaries' were born to explain obvious contradictions in authoritative texts, our theses concentrate more expressly on discussing a (physical) problem or a statement. It was also typical of the medieval *quaestio* to pile up arguments regardless of their relative strength. In the theses published in Turku instead we can see some humanist influence, which stressed more precise and plausible reasoning.⁴⁹ Variations of the

⁴⁸ On *quaestio* method in the Middle Ages see Marenbon 1987, p. 10-14, 27-33.

"*quaestio* method" were often incorporated in the course of argument in theses which were structured according to a more complicated kind of a method.

The other basic formula of writing dissertations was much more common than the one described above. At its most typical the subject of inquiry was either a process (digestion, generation), phenomenon (eclipses, time) or a natural object (such as snow, earth, a dove or the senses). Only occasionally did the titles reveal a more closely defined approach to the subject, like "On the *origin* of wells". As the aim of physics was to give proper definitions of *corpus naturales*, this approach offered the most complete definition. A good definition consisted of two parts: a nominal and practical definition. Nearly every thesis started with a nominal definition of the subject matter. This "onomatologia" consisted of definitions of etymologies, synonyms and homonyms of the main term describing the subject matter.

The scholastic method in 17th-century theses has sometimes been criticised for losing itself in useless and endless nominal definitions. However, the 17th-century scholars themselves saw positive use in this activity. The purpose of the etymological definition was not clearly expressed. However, the idea obviously was that studying the origins of a term would somehow reveal the essence of the thing to us. This idea stood behind at least one medieval best-seller, the *Etymologiae* written by Isidorus of Seville. At Turku the idea is not as central and easily recognizable as in Isidorus' project, but it seems that the aim was most probably to trace something from the original language in which Adam had named all species.

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Thus, it says in Gen. 2.20, that Adam, acting as the most perfect Philosopher, gave proper names to all living creatures, to all birds in the sky and all beasts upon the earth. This naming did not happen at random, but it was made in accordance with certain understanding, which originated from perfect knowledge of the whole nature...⁵⁰

⁴⁹ For medieval and humanist traditions of *quaestio* see also Kristeller 1988, p. 136. Murdoch 1990, p. 171.

⁵⁰ Alanus-Wassenius 1646, Th. II. "Habetur ergo Gen. 2,20, quod Adamus, absolutissimi Philosophi fungens officio, animantia cuncta, universa volatilia coeli & omnes bestias terrae genuinis suis appellâvit nominibus. Quae nominum impositio cum non temerè, sed certo consilio fuerit facta, & ex perfecta-totius naturae cognitione manaverit..."

Hence names were not given at random, but described something which belonged to the essence of the thing they referred to.⁵¹ If the main aim of scholastic science was *definitio entis*, and the intellectual control achieved by this definition, this kind of scrutiny was not without importance either.

On the other hand, the authors at Turku were much clearer about the aim of studying synonyms and homonyms of words. The intention was to specify the meaning of each term and thereby to prevent misunderstandings. Equivocation was a source of errors in philosophical reasoning which was most specifically fought against. One author typically remarks: "Having presented the Etymology we shall now join in *Homonyms*, so that we may proceed the more successfully, because equivocation usually generates errors. But this is done easily, because the word 'thunderstorm' allows very few significations in addition to the genuine and proper one."⁵² Whether equivocation could always be avoided is another matter, for even the authors themselves occasionally fell into the very same trap they tried to eliminate.

The major part of each thesis consisted of *definitio realis*, the real definition or "pragmatologia". The real definition was not concerned with the concept and its meanings but with the natural object it referred to. The somewhat complicated structure of the theses in this section was in many ways based on the ideas Aristotle presented in his *Topics* and *Categories*. The disposition of the theses followed the doctrine of predicables as presented in the "Porphyrian tree".⁵³ The order outlined by predicables is then combined with the doctrines of

⁵¹ In the seventeenth century there really was some discussion about a universal 'natural language', in which the words would actually provide an accurate description of the things signified. This idea was hardly accepted as such at Turku, since it was often emphasized that concepts were abstractions of singulars, and only as such did they refer to the things themselves. On the other hand the language Adam spoke was the first universal language of the mankind, and some traces of it might have survived even Babel - thus the study of etymology. There was, however, disagreement about what was the language Adam spoke and whether it was a natural or an artificial language. Knowlson 1975. Ashworth 1981.

⁵² Hahn-Heurlin 1702, p. 2 "Proposita Etymologia, *Homonymiam* subiungimus, ut eo felicius procedamus, cum errorum genitrix Aequivocatio esse solet, & id eo facilius, cum paucissimas admittit significaciones, vox Tonitru, praeter propriam & genuinam."

⁵³ Henry 1982, p. 128-129. The list of predicables would usually contain things such as *genus*, *species*, *differentia*, *proprium* and *accidens*. On the other hand categories included: substance, quantity, quality, relationship, place, time, position, equipment (*habitus*), activity, passivity.

categories and the four causes on different stages of the presentation. Following the doctrine of predicables the two main parts of a real definition were *genus* and *differentia*. *Species* seems to have dropped out from explicit conceptual apparatus in use, but the idea was that *genus* and *differentia* together formed a definition of a natural body of some *species*.⁵⁴ Genus simply stated in which category of being the object under scrutiny belonged, i.e. whether it was substance, accident or possibly a state of being such as motion or rest. The discussion of the *genus* hardly ever extended beyond a brief definition. As the name itself shows, the latter part of the real definition, *differentia*, considered those characteristics of the species which distinguished it from other species within the same *genus*. This discussion was also divided into two parts, both including several subdivisions.

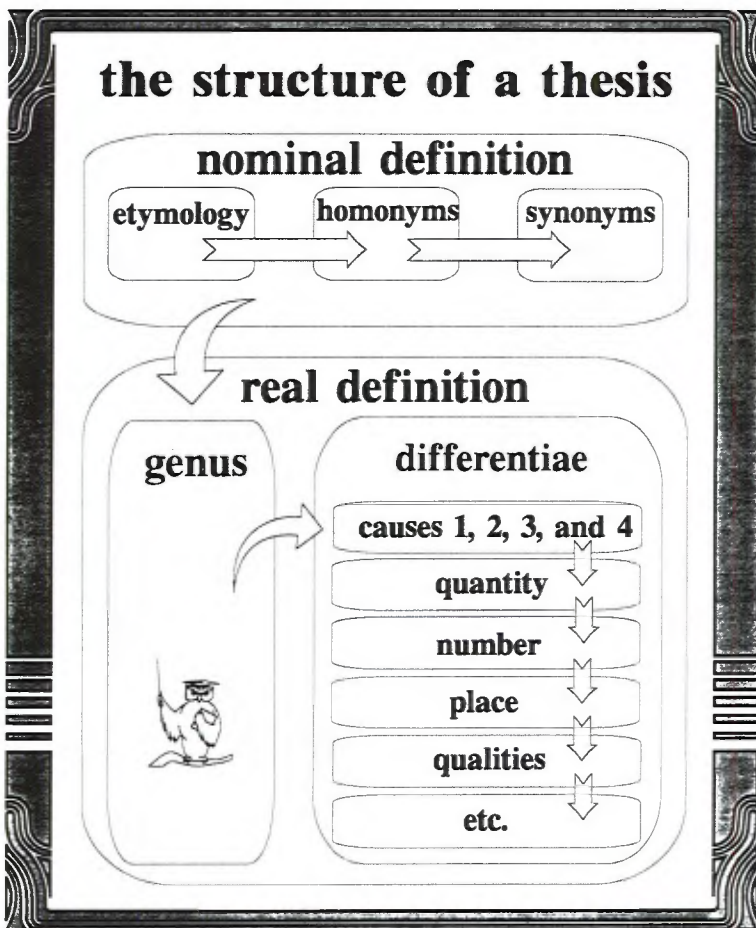
The first part (*causae*) consisted of discussion of the four Aristotelian causes, material, formal, effective and final causes (usually in this order). However, the discussion of what these causes were was not subject of physics, but of logic and metaphysics. Generally, a cause was considered to be "a principle which influences the essence of the effect".⁵⁵ All causes could stand in different relations to the effect. There were more *immediate* and more *remote* causes, the latter of which could have effect only through the proximate causes. Usually these causes were *subordinated* to each other, for example so that the Sun was subordinated to God as an efficient cause of man's generation, and man himself as the immediate cause was subordinated to both God and the Sun. The general apparatus of causation was further strengthened by the notion that some causes were *total*, i.e. they could alone stand for a certain effect, whereas *partial* causes needed to be conjoined in order to bring forth an effect.⁵⁶

These divisions brought delicacy and subtlety to the Aristotelian understanding of causation and thus also to physical explanations.

⁵⁴ The word *species* was predicated only of individuals belonging to that *species*. Hence, *man* is a *species*. On the other hand, if we say that "man is a rational animal", then "animal" is the *genus*. It is predicated of its various *species*. Henry 1982, p. 130. Risse 1964, p. 91-92.

⁵⁵ Thuronius 1660, *Institutiones Logicae* I, p. 143. Thuronius 1664, *Pars Generalis*, p. 215-217. Flachsenius 1678, *Collegium Logicum* I, p. 284. "Causa autem realiter considerata, est principium influens in esse causati."

⁵⁶ Thuronius 1660, *Institutiones Logicae* I, p. 143-154. Thuronius 1664, *Pars Generalis*, p. 217-219. Flachsenius 1678, *Collegium Logicum* I, p. 289-290. The terminology and division of the causes varies a little between these authors.



Each of the four causes were in addition divided into several other types of causes. For example the efficient cause, one of the so-called external causes of things, could function *per se*, accidentally, voluntarily or involuntarily; solely or connected with other efficient causes, impulsively or instrumentally, etc.⁵⁷ It is not reasonable for us to go into all these details, but it is worth remembering that there were several different modes in which a cause could operate. Physically the efficient cause brought effect into being by real action, be it either by necessity of nature or by intention.⁵⁸ Matter and form as causes were less problematic, for they could rather be directly associated with the form and matter of a substance.⁵⁹ The role of the final cause is perhaps most difficult to understand for modern readers, because the functions of the final and efficient causes tend to be confused. Every efficient cause operates *for* a final cause, which defines for what purpose (*cujus gratia*) something exists. Several modes of finality could be discerned, just as for efficient cause as well.⁶⁰

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In physics the greatest attention was usually paid to the effective causes of an entity, whereas material and formal causes were discussed less. If the final causes were treated in a "scholarly" tone, they were usually passed over with only a few words and the natural function of the research-object was clarified. Sometimes the literary style changed, however, and an eloquent praise of the blessings which this or that particular entity brought to man and nature followed. In addition to the four Aristotelian causes the scrutiny of differences included an analysis of the accidents of the *corpus naturalis*. These so-called *affectiones* each belonged to a different category: place, movement, quantity, qualities (*siccitas, firmitas, caliditas* etc.), temporality, figure, etc., and they were discussed to a varying extent depending on the subject matter.

Following the proper order of presentation was considered impor-

⁵⁷ Thuronius 1660, *Institutiones Logicae* I, p. 155-173. Thuronius 1664, *Pars Generalis*, p. 224-229. Flachsenius 1678, *Collegium Logicum* I, p. 301-310.

⁵⁸ Flachsenius 1678, *Collegium Logicum* I, p. 310. "*Causa Physica* est, quae vere & realiter agit, sive id fiat ex necessitate naturae, sive consilio, ut ignis urit, homo ambulat." The necessity of nature here refers to the thought that if all natural causes are present and there are no obstacles, the effect will follow necessarily. Flachsenius 1678, *Collegium Logicum* I, p. 321-322.

⁵⁹ Thuronius 1660, *Institutiones Logicae* I, p. 173-186. Thuronius 1664, *Pars Generalis*, p. 220-224. Flachsenius 1678, *Collegium Logicum* I, p. 325-347.

⁶⁰ Thuronius 1660, *Institutiones Logicae* I, p. 187-199. Thuronius 1664, *Pars Generalis*, p. 229-234. Flachsenius 1678, *Collegium Logicum* I, p. 347-355.

tant. A thesis which did not follow it risked being dismissed as not a scholarly work. One of the most conspicuous examples of this was Achrelius, who had to defend his omission of the normal routine in the preface of his *Contemplationes mundi*. Achrelius indirectly labels the canonized method as hair-splitting and exhorts his critics to write a better book themselves.⁶¹ Another sign of the importance of the order of presentation is that it was also preserved in many Cartesian-influenced theses in the last two decades of the century.⁶²

Mathematics was a very many-sided discipline in 17th-century Turku. The various statutes required teaching of not only geometry, arithmetic, etc., but also of subjects which were not mathematics in the strict sense, as *scientia circa quantitatem*. Such "applied mathematics" were *computus ecclesiasticus*, geodesy, geography, optics, gnomonics (construction of sundials), architecture, navigation and astronomy.⁶³ There was only one professor of mathematics at Turku, and it is hardly probable that one man could teach all these subjects. Teaching seems to have concentrated on the basic subjects of mathematics, and no theses were published on the more technical subjects.⁶⁴ Especially in the field of astronomy, theses were written which are relevant to this study of the learning in natural philosophy. Mathematical and philosophical astronomy had been methodologically and functionally separated since Antiquity. In principle, the mathematician's task was to calculate the movements of the planets, but he was not supposed to say anything about the physical reality of the heavens. This job was reserved for the physicists. In a way this dichotomy was due to the endeavour to maintain both Aristotelian and Ptolemaic views on the heavens. These mutually contradictory theories could not both be preserved without making a category distinction between them.⁶⁵

It can, and should be questioned how far we can maintain this Duhemian dichotomy between physics and mathematics when approaching the 16th and 17th centuries. Obviously mathematicians also had their views on the physical structure of the world, and on the

⁶¹ Achrelius 1682, Cordate et Candide Lector b4.

⁶² Kallinen 1993.

⁶³ Klinge 1987, p. 357-358. Annerstedt 1877, p. 249-250, 277-278. Schybergson 1918, p. 224-225. Schybergson 1920, p. 169. On mathematics and its subdisciplines see Thuronius-Aurelius 1661, *Theorema Mathematicum*. Gezelius 1672, p. 4.

⁶⁴ Vallinkoski 1966, p. 135-139, 280-283, 474, 501-503.

⁶⁵ For a classical representation of this view see Duhem 1969.

compatibility of mathematical theories with them.⁶⁶ Nevertheless, the gulf between physics and astronomy/mathematics indisputably existed at the level of epistemologies. Natural philosophers were generally still reluctant to guarantee mathematicians a position which would have raised the status of mathematical knowledge. In the eyes of natural philosophers a mathematician could not legitimately draw conclusions about the physical world from his calculations.⁶⁷ This distinction was severely disputed in the 16th and 17th centuries, along with the work of Copernicus, Tycho Brahe and others. (The system of Brahe shows that he also considered that astronomical constructs should correspond to the observations of physical reality.) At the same time the social role of the astronomer changed, especially through the work of Galileo on one hand and the Jesuits on the other,⁶⁸ but even if the adaptability of mathematical calculations to the study of *physis* had been accepted there would still have remained the problem of how to interpret these calculations correctly.

At the University of Turku the old distinction between physics and mathematics was alive and well throughout the 17th century. Most often it was used to discount the competence of arguments defending Copernicanism. However, it seems that especially towards the end of the century some mathematicians were sometimes quite happy to use this distinction as an excuse for not committing themselves to any definitive physical truths, whatever their mathematical views might have suggested.⁶⁹

Medicine went through many notable changes during the 16th and 17th centuries. What interests us here is the relationship between medicine, botany and physics. From the Middle Ages on botany had developed as a part of medicine, although in Italy especially it had already developed as an independent discipline during the 16th century.⁷⁰ The pharmacological use of herbs was of course acknowledged at Turku too. Nevertheless, botany was officially combined with physics at Turku, while at the "mother-university" Uppsala not only botany but the whole of natural philosophy remained as an integral part

⁶⁶ Westman 1980, p. 106-107. Jardine 1979 & 1988b.

⁶⁷ Jardine 1979, 1988, p. 693-702. Dear 1987.

⁶⁸ On Galileo's new role as a court astronomer see Biagioli 1993. On the astronomer's role in general see Westman 1980. Jardine 1988b.

⁶⁹ See sections "Ptolemy, Copernicus and Brahe" and "The Status of Astronomical Hypotheses" of this study.

⁷⁰ Morton 1981, p. 83-100. Schmitt 1989, XIV p. 39 ff.

of medical teaching. The decision to combine botany with physics was remarkable enough to be noticed in the title of the professorship which reads as "*Physices & Botanices professor*". In 1646 the professor of physics Georgius Alanus defined the different approaches of medicine and physics to botany as follows:

We should leave medicine to the Physicians and physics to the Physicists. A Physicist examines plants as species of living natural things, but the Physician considers them in relation to medical practice, and uses them for expelling and eradicating the horrors of periculous diseases.⁷¹

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Alanus' remark illustrates the difference the two disciplines had in their aims (*finis*). But natural philosophy and medicine also overlapped each other as did anatomy and physiology especially. Indeed, it has been said that the boundary between medicine and natural philosophy was "porous" throughout the 17th century.⁷² This is first of all due to the fact that natural philosophy had long served as preparatory studies for future physicians. For example, Jacopo Zabarella emphasised that philosophers' discussions on life, growth and the soul would benefit medical studies. On the other hand the anatomical facts in the new Vesalian anatomy were still interpreted in the Aristotelian natural philosophical framework.⁷³ In the Lutheran universities of the sixteenth century the coalition between medicine and natural philosophy temporarily received a more religious emphasis: anatomy was to recognize God's handiwork in creation, and to show how the faculties of man's soul worked.⁷⁴ Medicine at Turku did not however place religious and moral values in such a central position. On the other hand the rapid growth of medicine could on some occasions challenge natural philosophical teaching, and even its institutional position. As John Gascoigne has shown, the growth of medicine and other sciences

⁷¹ Alanus-Wassenius 1646, Th. XV. "Medica nempe medicis, Physica physicis relinquenda. Plantae à Physico considerantur, quatenus sunt species corporis naturalis animati: à Medico vero ad praxin medicam, & diros morborum periculosissimorum eruciatus profligandos adhibentur."

⁷² Gascoigne 1985, p. 402. As Gascoigne remarks, the word "physiology" was often flexibly used to refer to both natural philosophical and medical knowledge. This variance is obvious at Turku, too. See Alanus-Wassenius 1646, Th. XIX.

⁷³ Nutton 1993, p. 24. Schmitt 1985, p. 7-8.

⁷⁴ Nutton 1993, p. 20, 23, 25, et passim. Kusakawa 1993.

associated with it at the University of Cambridge weakened the hold which the traditional curriculum had on natural philosophy.⁷⁵

The relationships between medicine, botany and physics were thus in many ways more flexible than those between natural philosophy and mathematics. Although medicine was considered as *ars* and physics *scientia*, the two interacted in many branches of knowledge. At Turku the utility of natural philosophy for medicine was noted in the statutes as well.⁷⁶ The main difference between the disciplines remained in their aims. The view had already been expressed by the professor of physics Georgius Alanus, and by the professor of medicine, Laurentius Braun in a dissertation in 1695:

It should be noted that the difference between Physical and Medical Physiology is not in their subject matters, which is the same for both of them, but in their forms or the mode of consideration. This is because the Physician does not consider all this in a simple way as the Physicist does, but speculates on it as leading to a certain aim.⁷⁷

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Dissertations on anatomy and physiology were actually published more often in physics than in medicine at Turku. This mirrors the fact that the Faculty of Medicine at the University of Turku was not really for training medical doctors. It had been founded because the model of the University of Paris so demanded. All "real" universities would have a medical faculty. Of course, the lack of proper medical training was also a question of resources as well as attitudes. Although the guild of medics was organised in the middle of the 17th century in Sweden, appreciation of the occupation was still low,⁷⁸ as is shown

⁷⁵ Gascoigne 1985, p. 396-401.

⁷⁶ Schybergson 1918, p. 224. "De [= professors of medicine] skola även draga försorg om att kemiska arbeten utföras, för att den nytta som fysiken har för medicinen må så mycket klarare skönjas."

⁷⁷ Braun-Stecksenius 1695, p. 30. "Observandum heic discrimen inter Physiologiam *Physicam* & *Medicam* non esse in *materiali*, qvod unum idemque in ambabus est, sed in *formali* seu [?] h.c. considerandi modo, qvatenus Medicus haec omnia non simpliciter, prout Physicus, sed ut ad finem ducentia speculatur."

⁷⁸ Lindroth 1975, p. 378-386. The *Collegium medicum* was founded in 1663. The fact that the medical tradition at the University of Uppsala was exceptionally vigorous does not contradict the arguments expressed above. The tradition at Uppsala had more the character of a general research tradition and did not altogether aim at training practising medics.

by the fact that some students gave up medicine and made a career in the state service.⁷⁹ Moreover, there were extremely few places for the doctors: in a society where surgeons and midwives did most of the healing there was hardly any demand for more extensively educated medics. Only in the 18th century did the social and academic status of the occupation rise so much that medical training started to develop in earnest at Turku.⁸⁰

However, it was neither the relations between mathematics and physics nor between medicine and physics, which played the most dominant role in 17th-century natural philosophy. If we want to study what natural philosophy was like in the 17th century we must also consider it in relation to the most important discipline of the era. From a more general point of view it was also a question of the relations between knowledge and faith. It tells us quite a lot about the self-image of physics to know what kind of opinions the teachers at the University had about these matters. It tells us where the limits of natural philosophical knowledge stood.

2. THE INSTITUTIONAL CONTEXT OF THEOLOGY AND NATURAL PHILOSOPHY

The institutions of church, state and university were interrelated in 17th-century Sweden. Although their tasks and functions were in many ways different and therefore not all clashes could be avoided, they also shared a great many of their interests. For the state a strong religion and a coherent church were valuable allies in maintaining the centrally led, absolutist super-power. Although the church was not officially state-led, it was very closely bound to the crown.⁸¹ The church, for its part, exercised with pleasure its hegemonous power in religion and aimed to do the same in cultural life in general.⁸² The

⁷⁹ Perret 1983, p. 73.

⁸⁰ Leikola 1993. Leikola 1987, p. 574. Klinge 1989, p. 371-380.

⁸¹ Pirinen 1991, p. 274-277. Bergendorff 1967, p. 130-132.

last of the three institutions, the universities, were supposed to produce both clerical and civil servants to meet the needs of the state and the church. Although in principle autonomous institutions (with the right to their own legal procedures and taxation of the prebends), the universities were closely connected to both of their "big brothers". On the inter-institutional level it is the relationship between the University of Turku and the Bishopric of Turku especially (as the representative of the Swedish church) which interests us.

The king of Sweden was in principle the highest authority of the Royal Academy of Turku. He could influence the university most through the nomination of professors, in which he exerted the ultimate power. The king's decisions were nevertheless always based on proposals made by the Chancellor and the senate. He could also regulate the functioning of universities by sending them directions and circulars, which could cover a great variety of matters. However, the king had very little to do with the everyday life of the University. The control of the state over the University was personified in the chancellor, who represented the more aristocratic view on matters of learning. The chancellor also played an important role in the nominations, and the Senate of the Academy reported to him regularly on the state of the institution. Being a high authority, the chancellor often had to resolve controversies within the University. Because the chancellors were usually high-ranked noblemen living in Sweden on the other side of the Gulf of Bothnia, they did not visit the Academy very often. The highest authority of the University present was the vice-chancellor. The bishop of Turku had acted as the vice-chancellor of the University since its foundation in 1640.⁸³ Thus the control exerted by the two other institutions was personified in the chancellors; the vice-chancellor representing the church and the chancellor representing the state.

⁸² The nobility's interest in French and other Central European culture especially was of constant concern to the church. See Göransson 1951.

⁸³ The bishop of Turku was given the powers of a vice-chancellor in the opening ceremonies of the Academy. Count Brahe acted as a chancellor from the outset, but officially he was nominated chancellor only in 1646. Klinge 1987, p. 89, 101. In the 1625/6 constitution the archbishop was ordered to assist the chancellor of the University of Uppsala in his absence, and the same applied naturally to Turku. Annerstedt 1877, p. 239-240. Because the relationship between the chancellor and vice-chancellor remained largely unregulated, disagreements could not always be avoided on this front either. Göransson 1952, p. 47-50.

According to the constitution the vice-chancellor had many duties and rights in supervising the University.⁸⁴ In practice, it depended greatly on the bishop's own diligence and authority how much he could actually influence the University. For example in questions of appointments the vice-chancellor had some say, although it was the senate, chancellor and finally the king who made the real decisions.⁸⁵ During the period concerned there were five bishops/vice-chancellors in Turku: Isak Rothovius (1640-1652), Aeschillus Petraeus (1652-1657), Johannes Terserus (1658-1664), Johannes Gezelius Sr. (1664-1690), and Johannes Gezelius Jr. (1690-1718).

The relationship between the vice-chancellor and the university senate was not always a harmonious one and some disagreements arose, primarily in theological issues, matters of prestige and administrative matters. For example in 1664 Professor of Theology Enevaldus Sveonius heavily accused Bishop Terserus of supporting syncretistic views. As a consequence, Terserus was dismissed.⁸⁶ Bishop Gezelius was in 1676 at odds with two members of the University staff, professor Petraeus and secretary Achrelius. He accused both of them of defamation.⁸⁷ But this kind of incidents have mostly to do with the confrontations among theologians themselves and personal matters: libel suits were often brought into court during that century. It interests us how closely the church strove to control the university in general and philosophy in particular at the theoretical level. Only on rare occasions did the vice-chancellors interfere directly in philosophical issues. For example, during the 1690's Gezelius Jr. got involved in a discussion over Cartesianism when he tried to prohibit the printing and public examination of Torsten Rudeen's Cartesian theses.⁸⁸ Although the bishop acted as the vice-chancellor in all these occasions, he nevertheless represented the views of another institution, the church.

In the administrative system of the church, the chapter worked as

⁸⁴ Annerstedt 1877, p. 240.

⁸⁵ On the vice-chancellor's duties and especially Gezelius' actions see Laasonen 1977b, p. 286-344. On nominations in the University see Kuusi 1935, but *cum grano salis*.

⁸⁶ Salminen 1978, p. 293-354. Göransson 1952.

⁸⁷ Laasonen 1977b, p. 307-318. Hultin 1895, p. 263-267. Gezelius was also in disagreement with the Senate in some questions of nominations, finance and discipline. Laasonen 1977b, p. 288-301.

⁸⁸ On this incident, please see the section "The Breakthrough of Cartesianism".

an advisory organ beside the bishop. There also was a close connection with the University: the three professors of theology were entitled to be members of the chapter *ex officio*. Thus, the church had several channels to influence and control teaching at the University, and *vice versa*. It seems, however, that the church only seldom directly censored or gave orders to the proponents of natural philosophy. Besides, because the University had an autonomous position, it was the Faculty of Theology which was responsible for advocating the religious points of view inside the University. One can say that the control used by the church aimed at securing the needs which the local bishopric had for training priests.⁸⁹

At the intra-institutional level philosophy and theology meet first of all as different faculties. The Faculty of Theology was the highest and most respected of the four faculties at the University of Turku. The three professorships of theology were all positions very much aspired to because of the social respect and better salary they attracted. Most professors of theology were promoted to this position from the Faculty of Arts. Of the professors of physics Georgius Alanus (in 1648), Abraham Thauvonius (1659) and Andreas Petraeus (1682) achieved a chair in the supreme faculty. Among professors of mathematics only Johannes Flachsenius got this desirable nomination (1692), but of the professors of poetry and especially logic and metaphysics several became professors of theology.⁹⁰ The pinnacle of one's career was, moreover, to become a bishop, which some people who had begun their career in philosophy were also able to do.

What does all this mean in respect to physics then? Firstly, all theologians had at least studied, most of them also taught philosophy. Therefore we can expect that they were well-versed in natural philosophy as well and could recognize legitimate physical argument. On the other hand it has been said that this striving for advancement was a major factor in natural philosophers' reluctance to accept new ideas.

Scientific/scholarly work was retarded in all other areas except theology, because most professors in the Faculty of Arts... tried to get a promotion to the Faculty of Theology as quickly as possible. This

⁸⁹ Klinge 1987, p. 173-174.

⁹⁰ From poetry: Petrus Laurbecchius 1688, David Lund 1691, Torsten Rudeen 1706; from metaphysics: Nils Nycopensis 1650, Jakob Flachsenius 1679, Simon Tålpo 1700, Gabriel Juslenius 1717.

was because those professorships were more respected and better paid. The aspiration for promotion meant that the interest of many professors was more directed to theology from the beginning than to their own subject, for which reason the study of their own subjects was only a matter of temporary dabbling.⁹¹

This claim hardly holds true for physics and mathematics. In fact all professors who were promoted to the Faculty of Theology were actively teaching their own subject (except Anders Petraeus).⁹² Besides, it was one's years in service which counted most for promotions. It is also a common notion that this aspiration for a better office would have bound the professors' tongues:

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Until the 19th century the professors of physics were usually elevated to better positions, i.e. to professorships of theology and to bishopric, and therefore did not want to spoil their opportunities in advance.⁹³

This argument presupposes that the physicists would have had things to say which were contrary to theology. This first undermines the fact that physicists and mathematicians most probably had personal religious convictions. It does so because it takes for granted the idea that science (true knowledge) and religion are necessarily in opposition with each other. We hardly can support conclusions claiming this kind of opportunism. However, at the same time we have to notice that just because these people were good, believing Christians they would not have accepted just any anti-theological ideas, or ideas con-

⁹¹ Myrberg 1950, p. 10. "Tieteellistä työskentelyä muilla kuin jumaluusopin alalla oli omiansa ehkäisemään se, että useimmat filosofisen tiedekunnan professorit... pyrkivät mahdollisimman nopeasti siirtymään teologiseen tiedekuntaan, jossa professorin virat tuottivat suurempaa arvontaa ja enemmän tuloja. Tästä syystä monien professorien mielenkiinto suuntautui usein jo alunperin teologiaan ja oman alan tutkiminen jäi tilapäisen harrastuksen varaan." In Finnish there is no difference of expression between scientific and humanistic scholarship.

⁹² See Vallinkoski 1966 for the list of academic dissertations. The same holds true for most other professors e.g. in theoretical philosophy, who advanced to the Faculty of Theology.

⁹³ Niini 1953, p. 2. "1800-luvulle asti fysiikan professorit tavallisesti siirtyivät myöhemmin parempiin, ts. teologian professorin ja piispan virkoihin eivätkä tietysti ennakolta halunneet pilata ylenemismahdollisuuksiaan." See also Heikkinen 1969, p. 93.

sidered to be that. Moreover, putting forward new and controversial scientific ideas was not necessarily an obstacle to becoming a theologian. For example, two theses of Torsten Rudeen aroused heated discussion in the 1690's because they proposed Cartesian dualism. Dualism and other ideas which he defended in his theses were still not accepted by the church by the time he became a priest in 1699. Rudeen advanced to professor of theology in 1707, and he ended his days as a bishop of Linköping.⁹⁴

Although elements of theology were obligatory for all students, natural philosophy was studied by most students who wanted to be ordinary clergymen. In fact, many students never took a degree in theology. A certain amount of philosophical study was thus a requirement for deeper studies in theology, law or medicine.⁹⁵ This demand for reciprocity was set down in the 1661 statutes as follows:

Anyone who presents for an exam in jurisprudence, medicine or philosophy may not take the exam unless he has proof from the theological faculty that he has the necessary knowledge of the principles of faith. In other words he must rightly understand the main dogmas of the Christian faith as they are expressed by its symbols and the confession of the Swedish church. And he must also understand dogmatics, as it is taught by the author which the academy has accepted, so that he can also show the primary ground of the dogmas in the Holy Scriptures. He must also have some knowledge of the biblical history of the Old and New Testaments. Conversely, anyone who wants to take some degree in theology, jurisprudence or medicine, must have evidence from the philosophical faculty that he has the necessary knowledge (which must be in accordance with his aim) in general history, languages and the philosophical disciplines.⁹⁶

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⁹⁴ Heikel 1940, p. 61, 86-87.

⁹⁵ On the significance of the arts course see e.g. Ong 1983, p. 132-133.

⁹⁶ Schybergson 1920, p. 150. "Var och en som komma till examen i juridik, medicin eller filosofi, skall icke få avlägga den, om han icke har vittnesbörd av teologiska fakulteten om en nödvändig kunskap i trosartiklarna, nämligen att han rätt förstår såväl själva den kristliga trons huvudsyften efter symbola och den svenska kyrkans trosbekännelse, såsom ock den vid akademien antagna auktor i dogmatik, och att han tillika kan uppvisa deras förnämsta grund i den heliga skrift, jämte det han också har någon kunskap i gamla och nya testamentets bibliska historia. Och omvänt skall den, som vill taga någon grad i teologi, juridik eller medicin, hava vittnesbörd av filosofiska fakulteten om en nödig kunskap, i överensstäm-

It was no small amount of theological knowledge which was demanded of the arts students. This regulation is first met in the 1655 statutes, and it was not accepted without a formal objection by the Faculty of Arts at Uppsala.⁹⁷

Future theologians were thus supposed to have basic knowledge of the philosophical disciplines. Therefore what was taught in natural philosophy was not unimportant either. Although it was only an 18th-century phenomenon that country priests would practise all kinds of natural philosophical subjects (in order to gain economic utility for the nation), basic knowledge of the arts course was useful for the 17th-century clerics as well. Mathematics was important for the *computus ecclesiasticus*. On the other hand natural philosophy was part of the general studies, which taught disputation (an indispensable skill against heretics!) and accustomed the student to arranging and presenting knowledge by the right method. Natural philosophy was basically knowledge of God's creation, the book of nature, which would ultimately lead man to admiring God. Knowing the causes of things also undoubtedly helped to recognize and fight superstition and sorcery. What is more, religious dogmas could be supported by physical "facts" too, as we will see in the next section.

melse med hans mål, i allmänna historien, språken och de filosofiska disciplinerna."

⁹⁷ The demand for philosophy students to participate in theology courses was motivated by the fear that students ignorant about the fundamentals of the Lutheran religion, especially those who studied abroad, might be easily seduced to Catholicism or Calvinism. See Göransson 1951. The Philosophical Faculty at the University of Uppsala sent a memorandum to the Chancellor on 7.3.1655 opposing the draft of the new regulations, which would have made theology studies obligatory for arts students. The proposal was opposed on the grounds that this was not the habit in other universities and that an increasing number of students would leave off their studies without a degree, or at least that getting one would be severely delayed. Annerstedt 1910, p. 20-22.

3. THEOLOGY AND PHILOSOPHY - SUBORDINATION OR SUBMISSION ?

Angels or Villains of the Philosophical Enterprise?

Historians of science have typically despised theological elements in 17th-century science, and regarded theological arguments as something inferior to physical arguments, even if only Aristotelian ones. For these positivistic-minded historians, being a handmaiden of theology really seems to mean a prostitution of philosophy. On this view the 17th-century Scientific Revolution is considered to be a liberation of Real Science not only from scholasticism but most of all from the dominance of theology. It is then claimed that in Finland this liberation was delayed because of the tight control exercised by the theologians.⁹⁸

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It can be asked, however, whether physical and non-theological reasoning should be preferred over theological when talking about the *history* of science. In fact, by appreciating non-theological reasoning more we evaluate the past in terms of our own views, which leads to the hazardous way of anachronism and presentism. Previous science is to be assessed by its own criteria. If theological arguments were being accepted as relevant in physics at a certain time, it was not despicable for the scholars of that time to use them. Indeed, it would have been more odd for them *not* to use theological arguments whenever it was habitual to argue in that way. The use of theological argument in physics was nevertheless not without specific limitations. What is more interesting is the less direct forms of interaction between theology and physics, which not always are so readily recognized.

Historically speaking the question is often about the formation and rearrangement of the boundaries between the proper fields of physics and theology. A major discovery in either of the fields usually demands some sort of renegotiation of these boundaries, so that it is of great importance to study periods of transition when different scientific (and theological) views and values compete. This helps us to find out

⁹⁸ Salminen 1983, *passim*. Myrberg 1950, p. 9-10. Niini 1953, p. 2. Sandblad 1944, p. 179-180, *et passim* & 1945, p. 118, *et passim*, takes a somewhat more neutral position. Rein 1908, p. 60-63, *et passim*. Forsström 1904, p. 182-183, 186-187, 287, 289. Slotte 1898, *passim*.

when and especially *why* and *how* a new attitude towards these boundaries is embraced. As regards the relationship between science and religion, the Scientific Revolution did not generally mean the separation of faith and knowledge altogether, but rather a rearrangement of their mutual relationship.⁹⁹ In studying the situation at Turku in the 17th century we will also have to look at the two parties as historical entities and not define their boundaries according to modern criteria.

It should not be understood as undermining the above that in reality there certainly is some truth in the ideas of an obstructive and "anti-scientific" attitude of the conservative church. Clutching at the authority of the Bible, theologians certainly tried to discourage the acceptance of the Copernican world view and changes in scientific thought. On the other hand, in the 18th century the attitudes of the clerics changed in this respect and natural philosophy became a new kind of ally of religion in the form of so-called natural theology.¹⁰⁰ We ought to ask why did theologians adopt these strategies? Obviously these attitudes were created by a complex of social, intellectual and religious causes, stemming both from the desire to maintain existing socio-professional and epistemological structures and from new challenges set for theology by new religious and philosophical movements. Changes were thus brought about by profound rearrangements in society, politics, and academic life, including religious thought itself.

Another type of approach to the relationship between science and religion has been that religion has in some essential way contributed to the progress and development of science - or the transformation of natural philosophy into science. The milder interpretations of this view claim that some churches just were less obstructive than others.¹⁰¹ On the other hand, the stronger versions of this assertion presuppose that there are some intrinsic characteristics in certain denominations which are especially favourable to science. This view is best known in its extreme form as the so-called Merton thesis, according to which puritan values played an important role in triggering off the rise of empirical science in the 17th-century England.¹⁰² This view has inspired

⁹⁹ Brooke 1991, p. 52-81.

¹⁰⁰ Brooke 1991, p. 155-161, et passim. For natural theology in Sweden see e.g. Lindroth 1978, p. 217-228. Klinge 1987, p. 668-675.

¹⁰¹ Deason 1986 tries to show that the 17th-century mechanists' conception of passivity of matter was supported by the Protestant idea of radical sovereignty of God. He does not, however, claim any causal connection between them.

¹⁰² The Merton thesis has been criticised, with good reason. On Merton and the

and motivated decades of discussion and research, which tries to compare the relationships which different Christian churches had towards generation and diffusion of the new science.¹⁰³ Differences have been sought not only in dogmatic structures between Protestant and Catholic confessions, but also in their general attitudes towards new ideas, including their relative willingness to use censorship.

One of the more specific claims which the discussion around the Merton thesis has produced concerns the possible interdependence of certain confessions and the progress of science by examining a single development, namely the acceptance of the Copernican system in different countries. It is supposed that the Protestants (thus not only Puritans) would have adopted the new theory more readily than the Catholics. When this hypothesis is tested it proves to be quite untenable.¹⁰⁴ The case of Finland seems to challenge the view of Protestantism as especially favourable even to Copernicanism strongly. Although a Protestant province, Finland was nevertheless persistent in resisting new philosophical and astronomical ideas in the 17th and 18th centuries. This confirms the idea that other explanatory factors than religion must be sought to explain processes of change - or stability - in 17th-century science. But this also invites us to turn our attention to the fact that in the 17th century the function of the universities was not to create new knowledge, but to relay existing knowledge to new generations.

In more recent studies of Finnish history of science the problem of the relations between science and religion has been set aside and more emphasis has been laid on the role of Aristotelian physics in retarding scientific change.¹⁰⁵ However, it is not the aim of this chapter to examine whether religion inhibited or accelerated scientific change in Finland, but to show how these two were intertwined and where the boundaries between them were drawn.¹⁰⁶

discussion of his thesis see Cohen 1990, especially the article of A. Rupert Hall of 1963 reprinted in it. Brooke 1991, p. 4, 83-116. Brooke also produces an extensive bibliography on the discussion of various sides of the problem related to the Merton thesis, p. 361-366. Henry 1992.

¹⁰³ See e.g. Ashworth 1986. Shea 1986. Webster 1986. Westfall 1986.

¹⁰⁴ For a thorough examination of the theme see Westman 1986. Brooke 1991, p. 89-94. Questions arise such as in what sense was the theory accepted, as a physical reality or as a hypothesis? Which parts of the Copernican system were embraced? Which other factors apart from religious ones played a role in this process?

¹⁰⁵ Lehti 1979. Klinge, Knapas, Leikola, Strömberg 1987.

¹⁰⁶ For an analysis on the possible causes of stability see Conclusion.

"Science" and Religion as Knowledge and Faith

"Religion" generally refers to an organized institution, which through the practice of certain rituals exerts authority over beliefs about such things as the supernatural, right morality, and human destiny after death. Denomination, on the other hand, is the preferred orientation of these beliefs.¹⁰⁷ Orthodox Lutheranism, which prevailed in North Germany and Scandinavia, adopted a very controversial policy against other Christian churches after 1648.¹⁰⁸ Curiously enough, this *ecclesia militans* arose only *after* the end of the Thirty Years' War, which had been propagated as a religious war both by Protestant and Catholic leaders. At Turku this strong orthodox tendency was strengthened from the 1660's on especially by the active appearance of the professor of theology, Enevaldus Svenonius.¹⁰⁹

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Orthodox Lutheranism was characterized by fundamentalism, literal reading of the Bible and quarrelsome opposition to other religious confessions.¹¹⁰ The Catholic and Calvinistic churches and a large group of more or less systematised "heresies" (such as syncretism and socinianism) especially were seen as threats and repeatedly attacked in order to keep the purity and consistency of the national Lutheran church. At the same time this tactic brought coherence to Lutheran theological thinking and forced it to refine its doctrines. In this study I would like to preserve a relatively wide meaning for the concept "religion". Religion was a factor permeating the whole society and as such it certainly affected every scholar of natural philosophy. We can not disregard the fact that every scholar must have had some kind of religious conviction since atheism as denying the existence of God was hardly known in 17th-century Lutheran culture.¹¹¹

Thus, if "religion" refers to a larger set of beliefs and practices,

¹⁰⁷ On slightly different ways of defining "religion" and on the dangers of defining it too restrictively, without reference to the historical context, see Brooke 1991, p. 6-11.

¹⁰⁸ Hägglund 1971, p. 274, 279.

¹⁰⁹ Salminen 1978.

¹¹⁰ Ratschow 1964, p. 82, 100, 106-116, et passim.

¹¹¹ Laasonen 1977a, according to whom "an atheist" became a common name for all proponents of divergent religious beliefs. On the other hand, the "practical atheists", i.e. people living in godlessness and impiety, were the most common type of atheists, whereas only few theoretical atheists really denied the existence of God and the godhood of Christ. On the possibility of non-religious life see also Febvre 1982.

which build the framework of Lutheranism, "theology" is a more limited concept. It includes the study and maintenance of the dogmatic core of the religion. In this *pièce*, the role of the faith is played mainly by theology, whereas religion forms a part of the setting. It is, after all, for the most part a question of the relation between the conceptual frameworks of philosophy and theology which are scrutinised in this study.

The other part of the relationship in question is philosophy. The exact scope of the term "philosophy" has not always been defined when talking about the relationships between theology and philosophy; this is true of both 17th- and 20th-century authors. However, in this study we are not concerned with the philosophy as a whole, but with certain parts of it: natural philosophy or physics, and metaphysics to a lesser extent. Although physics was considered to be a philosophical discipline, it is important to make a distinction between the two. It is evident that the relation between metaphysics or logic and theology for example, or between ethics and theology was different from that between natural philosophy and theology. The importance of this difference will be further demonstrated later in the text.

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Thus in this chapter we will examine what the relationship between theology and philosophy (or natural philosophy, whenever the difference can be drawn) really was like at the 17th-century University of Turku. Was it more a relationship of domination or of collaboration? Or can it be described as either of them at all? What forms did their mutual intercourse take on the theoretical level? After some general remarks I shall start with an examination of the attitudes which the proponents of theology and natural philosophy respectively themselves had towards the relationship between their disciplines. Theological, metaphysical and physical theories formed a network of knowledge in which different arguments were strongly interrelated and dependent on each other. At the end of this chapter I shall concentrate on the problem at the level of natural philosophical theories.

Theologians on Philosophy

Theology has two basic strategies towards philosophy, which it has adopted during varying cultural tendencies. This is a coarse generalisation, and obviously the motives for this have varied in different historical contexts as have the means used by theologians for achieving their respective goals as well. At times theology has tried to separate itself from philosophy and other disciplines. This "Augustinian" tendency prevailed especially during the Reformation because of

the desire of the reformers to keep theology untainted by mundane knowledge or "philosophical hairsplitting". According to this view, knowledge cannot usually bring any essential help on the road towards salvation, which is dependent on faith alone. This kind of view tends to disregard mundane knowledge such as natural philosophy as less important or even futile.¹¹²

However, for the most part of the western world's history theology has adopted just the opposite view in its relation to other disciplines. Theology has been the queen of sciences, making use of other disciplines by subordinating them as its "servants". What this servitude has meant, then, has greatly varied in detail, but in general knowledge has been regarded as able to aid faith - or at least help in organising theological knowledge. Indeed, the very existence of certain disciplines has occasionally been warranted because of the support they offered to theology.¹¹³ Nevertheless we can hardly talk about any fusion of theology and philosophy. Different forms of conceptual justification for being subalternate had already been developed during medieval scholasticism, usually based on some interpretation of Aristotle's notion of subalternate sciences.¹¹⁴

St. Aquinas' ideas on the relationship between philosophy and theology were influential in medieval philosophy. Aquinas thought that matters of faith could be clarified by analogies with philosophical doctrines. Thus philosophy as a sort of purified reason and combined with revelation could help in establishing theological truths, but Aquinas' philosophy was guided by his religious principles.¹¹⁵ Whereas Aquinas had little reverence for the consistency and integrity of philosophical conclusions except if they were suitable for theological use, William Ockham for example carefully preserved the autonomy of natural philosophy in his works. Certainly he gave preference to revelation whenever it was in contradiction with philosophy, but he did so without destroying the integrity of philosophical ratiocination.¹¹⁶ The alliance of natural philosophy and theology did not come to an end with the fall of scholasticism, only the modes in which they were

¹¹² Of course, when Luther attacked against scholastic Aristotelianism he did so because he saw it as representing and maintaining the power of the pope. Kusakawa 1990, p. 23-41. Kusakawa 1992, p. 36.

¹¹³ Brooke 1991, p. 59.

¹¹⁴ Sylla 1975, p. 355-356.

¹¹⁵ Sylla 1975. Copleston 1985 II, p. 312-323. Brooke 1991, p. 60-61.

¹¹⁶ Sylla 1975.

related to each other changed.¹¹⁷ For example in the 18th- and 19th-centuries it was common to see natural science as revealing the Book of Nature, for the majesty of the Creator could be seen in his work.

The strategy of subordination and use of philosophy for the benefit of theology was the prevailing attitude at the time this study is concerned with. The way theologians at Turku viewed philosophy must be considered in a wider context, and in relation to the discussions about the relationship between faith and knowledge. This aspect had been widely discussed in the Lutheran world. One of the most central demands of Luther's reformation was to make a clear distinction between revelation and rational knowledge. This separation was to a great extent a heritage from the Occamist tradition.¹¹⁸ Luther maintained that man's rationality was feeble because his nature had been spoilt in the Fall. Therefore he had to rely on faith, based on the truths found through revelation, which was the only way to God's mercy. On the other hand his revolt against the scholastic forms of the Catholic theology demanded purging religion of philosophical "hair-splitting" and "nonsense".

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Not even the reformationists, however, were unanimous on this matter. For example Melanchthon was more ready than Luther to accept philosophical representation and analysis of religious knowledge, provided the philosophy used had been transformed to meet the special requirements of the Lutheran faith.¹¹⁹ Around the middle of the 17th century this tension finally lead the Lutheran world into two contending parties between the Wittenbergian and Helmstedtian schools, of which the former stood for a wider use of philosophy in theology. Wittenbergian theology regarded philosophy as worthless in itself, but useful as an instrument in theology. Contrary to this the so-called Helmstedt school respected the difference between theological and philosophical disciplines.¹²⁰

¹¹⁷ Brooke 1991, p. 52-81.

¹¹⁸ Risse 1964, p. 81.

¹¹⁹ Kuskawa 1992, p. 33-34.

¹²⁰ Kuskawa 1990, p. 23-66. Preus 1970, p. 129. Salminen 1987, 234-236, et passim. In my opinion Kuskawa fails to pay enough attention to the point that the question of whether philosophy was applicable to theological use was also very much one of principle. One should also be careful about saying in what respect philosophy was "rehabilitated" in practice. Although philosophy became the basis for moral law, and the study of nature showed the Providential Plan of God and thus proved His existence, limitations on the use of philosophical terminology in theology still remained even after Melanchthon's new arts curriculum had been

The orthodox Lutheran movement, which began around 1600, was based to a great extent on Neo-Aristotelianism and Neo-Scholasticism. It actually discarded Luther's opinions on philosophy, and after 1648 philosophical argument especially played a major role in theology. Orthodox Lutheranism was eager to employ especially metaphysics and logic in order to fight other confessions (especially the Jesuits) with their own weapons.¹²¹ The rank of the discipline was thus determined by its ability to aid theology in its great crusade. This is a strikingly different motivation from that of Melanchthon, who stressed the importance of philosophy as the basis for moral law and knowledge of the existence of God. It was a conspicuous feature in the attitude of the orthodox Lutheranism, as represented by the Wittenbergian theologian Abraham Calovius that elaborate argumentation was developed to show that theology and philosophy were not mutually contradictory.¹²² This was, of course, necessary, because nothing contradictory to theology could assist it. The fact that Calovius needed to argue for the compatibility of philosophy and theology also shows that the anti-philosophical attitude of Luther was still very much alive. Many of the arguments used by Calovius we shall also meet in discussions at Turku.

During the first two decades after the foundation of the University of Turku the relation between theology and other disciplines was discussed only seldom. Theology was the highest and most respected of all disciplines, but its position was self-evidently so without any further argument. A new kind of emphasis on religious purity appeared in the statutes of 1655 and 1661, which made theological studies obligatory for all students. Obedience to the main dogmatic document of the Lutheran church, the so-called Augsburg confession was stressed, and the ceremonial oath sworn in the magisterial promotion set the Word of God as the primary criterion of philosophical truth.¹²³ In 1662 we hear for the first time a theologian claim hegemony for his discipline. Enevaldus Svenonius presented in the last disputation of

introduced to Lutheran universities. (Kusukawa 1992, p. 38-42.)

¹²¹ Häggglund 1971, p. 192, 274-281. Lewalter 1967, p. 7-9.

¹²² Preus 1970, p. 130-133.

¹²³ Schybergson 1920, p. 112, "Stadgar och förordnar Kunglig Majestät, att ej något annat vid Åbo akademi offentligt och enskilt skall läras eller framställas av någon, av vad stånd han vara må, än det som överensstämmer med den Heliga Skrifs grund och med den oförändrade Augsburgska bekännelsen, som vid Upsala möte år 1593 blivit vedertagen.", 155-156.

his *Gymnasium capiendae rationis* severe demands for the proper role of philosophy. Philosophy should be humble and serve theology "like Hagar had served Sarah", i.e. like a slave her mistress. Any philosophy which thought itself competent to judge matters of faith and criticize the foundations of the Orthodox dogma by mere reason, was regarded as foolish and presumptuous because reason was blind.¹²⁴

Although Svenonius regarded philosophy as a valuable servant of theology, he carefully emphasized the dangers of excessive philosophizing.

We learn from Cicero that in the old times the *Stoics*, such as *Zeno*, *Diogenes* and others, exceeded moderation in their philosophizing. The Scholastics were not better than them: *Thomas [Aquinas]*, *Scotus*, *Suarez*, *Bonaventura*, *Ockham*, *Vasquez*, *Lombard* and others who had the most pernicious desire to wallow in obscure terminology and various useless distinctions. And they pursued a practice - as do the followers of the papists even today - which makes difficult things even more difficult with their complicated questions; and the obscure things they envelop all the more tightly under the cover of questions and dreadful-sounding ambiguities of words.¹²⁵

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Svenonius claims that the scholastics "had such a desire for controversy" that they substituted academic subtleties for religious truths.¹²⁶ Obviously this was the greatest danger in excessive use of philosophy, but even the pagan philosophy was not without other (moral) hazards. Following Calovius' opinion Svenonius recommended that certain books of antique authors should be replaced by Christian authors' works. This would bring the advantage that the students would learn matters of piety and religion at the same time as they

¹²⁴ Salminen 1978, p. 236-269. Svenonius 1662, p. 326. "Magnum est periculum, res fidei humanis committere rationibus. ...Mysteria fidei, Rationi humanae stultitia sunt."

¹²⁵ Svenonius 1662, p. 2-3. "Fuerunt igitur, ut ex Cicerone patet, modum in Philosophando excedentes olim Stoici, qualis fuit *Zeno*, *Diogenes*, *aliique*. His non meliores Scholastici fuerunt: *Thomas*, *Scotus*, *Svarezius*, *Bonaventura*, *Occamus*, *Vasquez*, *Lombardus* & *similes*, quibus pruritus terminorum obscurorum variarumque inutilium distinctionum perniciosissimus infelicitè affricus fuerat, quibus id egerunt, hodieque agunt imitatores Pontificij, ut quae difficilia sunt, reddant spinosis suis quaestionibus difficiliora, quae vero obscura, quaestionum involucris & horronis verborum ambagibus magis involvant."

¹²⁶ Svenonius 1662, p. 6-7.

strove to learn the language. If pagan authors were to be read for the sake of the Latin language, the works in question had first to be rendered suitable.

Thus, as we see that it is dangerous to study Philosophy from pagan philosophers' books, we shall publicly promise, in accordance with the Senate of the Academy, that using Aristotle as the leader in Philosophy and Cicero in rhetoric will be permitted only if profanities have thoroughly been marked beforehand, attention paid to decent remarks, inducements to sin have been removed and all other changes are done.¹²⁷

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Svenonius thus aimed to redefine the areas of competence of the two disciplines. His rejection and outright mutilation of antique authors in favour of religious views is a clear indication of this. Svenonius goes on to define what kind of use the various parts of philosophy would have for theology. Logic would be necessary for clear thinking and consistent phrasing of religious arguments; the premises should nevertheless be based on the Holy Scripture, because even formally valid reasoning could occasionally lead to false conclusions. Whereas metaphysics produced some of the most important general concepts, mathematics, for example, was useful for deciding chronological disputes and interpreting (astrological) signs of future events.¹²⁸

In 1656 (when he was still a professor of Latin) Svenonius had already claimed in a disputation that the prime function of metaphysics should be rendering philosophical terminology appropriate for theological use. All deficiencies could be removed from philosophical concepts, but this would presuppose eliminating and adding them, and amplifying their meanings. Aristotelian philosophy would not as such be suitable for theological use. All in all philosophical knowledge should be modified to serve theology, because as such it was not suitable for solving theological questions. Therefore it was theology

¹²⁷ Svenonius 1662, p. 11. "Ideoque cum videamus periculosum esse Philosophiam discere ex libris Ethnicorum, non nisi fideliter significatis abominationibus, observato decore, amputatis scandalis, mutatisque mutandis, principem Philosophorum Aristotelem & ducem oratorum Ciceronem juxta consist. Acad. publicè profiteamur."

¹²⁸ Svenonius 1662, p. 300-302, 304-306. "Mathesis... controversijs Chronologicis decidendis & finiendis, signis variorum eventuum solide dijucandis ac observandis afferat..."

which should have the last word about the contents of philosophical disciplines.¹²⁹

In his *Gymnasium* Svenonius praises the study of physics as a lovely and suitable exercise for sharpening one's wits. But just like everything else, physics was most useful for disputing heretical views. Svenonius names several physical questions in which the accepted theory differed from the Calvinists' views, for example "Whether the bodies of the blessed are immobile and whether they can be where ever they want to in an instant? We Agree, Calvinists Deny", "Whether God is the place of the world? We Agree, Calvinists Deny" or "Whether an Empyrean heaven exists? We Deny, Calvinists Agree."¹³⁰ Needless to say, it was not up to physicists to decide which interpretation was right from the theological point of view. Moreover, only few of the questions named by Svenonius were actually discussed in physical dissertations.

According to Salminen, Svenonius possibly seems to have meant that philosophy, which was in no way connected to theology, should not be admitted to the University. In any case it was Svenonius' aim not only to exclude philosophers from theological discussion but to subdue theoretical thinking in philosophical disciplines to the control of theology.¹³¹ In his view, "The human reason must be captured, so that it will obey faith."¹³² In other words he regarded unfettered reason as dangerous, because it could end up doubting matters of faith. Captured and harnessed to theology philosophy could still be useful for achieving higher goals.

Enevaldus Svenonius was a dominant figure at the University from the 1660's until his death in 1688. His polemics was a part of his larger programme to establish the so-called Wittenbergian school of theology in Turku. Moreover, the introduction of Wittenbergian theology to Turku is connected with the controversies on syncretism, which raged in Uppsala and Turku during 1660-1664. For example bishop Terserus, who was heavily accused by Svenonius of syncretistic views, preferred Helmstedtian theology in this respect.¹³³ Terse-

¹²⁹ Salminen 1978, p. 228-237.

¹³⁰ Svenonius 1662, p. 303-304. "An corpora gloriosa sint immobilia, & in momento esse possint ubi voluerint? Nos A. Calv. N.", "An Deus sit mundi locus? Nos N. Calv. A." or "An detur coelum Empyreum? Nos N. Calv. cum Pont. A."

¹³¹ Salminen 1978, p. 268-269, 416.

¹³² Svenonius 1662, p. 326-327. "Ratio humana erit captivanda, ut fidei obediat."

¹³³ Salminen 1978, p. 234-236. Göransson 1952.

rus was dismissed in 1664 as a result of the process initiated by Svenonius. After this it was Svenonius' opinions which determined theologians' attitudes towards philosophy. As Salminen puts, "...the Lutheran Orthodoxy and variations of scholastic Aristotelianism, which was modified to meet the needs of theology, formed a coalition. This coalition reigned supreme over Finnish scholarship, and hardly any deviations from it were tolerated."¹³⁴

The relationship between theology and philosophy was not, however, as simple as this. The new regulations especially written for the University of Turku in 1661 included a stipulation, according to which the professors were entitled to dispute only over such matters that belonged to their own faculty. Making theological statements was expressly forbidden for non-theologians.¹³⁵ The regulation handed down by queen Christina in 1651 was also aimed at establishing a certain distance between theology and philosophy. This regulation denied the nomination of theologians or priests to any position in the Faculty of Arts, and conversely taking holy orders was prohibited for philosophers.¹³⁶ It seems that this regulation was not always followed at Turku, because Svenonius for example was a well-advanced theologian when he was nominated professor of eloquence in 1654.

As early as 1666 there was a serious wrangle between two professors of the University, which indicated that theology was not supposed to have too close a friendship with philosophy after all. In April 1666 the newly-appointed professor of theology Petrus Bång published a dissertation *De ecclesia militante in genere* in order to get the degree of Doctor of Theology. The professor of eloquence, Martinus Miltopaeus had been invited to be one of the opponents. Miltopaeus, it was later reported, used very harsh language and claimed that the arguments in Bång's thesis were absurd and contradictory to other Luthe-

¹³⁴ Salminen 1981, p. 93. "...luterilainen täysortodoksia ja teologisia tarpeita varten modifioitu skolastinen aristotelismi eräine muunnelmineen muodostivat suomalaista tieteenharjoitusta suvereenisti hallitsevan koalition, josta ei juuri poikkeamia sallittu." On syncretistic controversies see also Göransson 1952.

¹³⁵ Schybergson 1918, p. 216 "Alla ordinarie professorer skola sammanskriva och hålla sina vissa disputationer, åtminstone en om året, vilket rektor skall driva på. Men var och en skall bliva inom sin fakultets termer och uttryckssätt.", p. 217 "Ingen utom teologiska fakulteten skall efterlätas att i sina teser inblanda några teologiska teser eller tillägga korollarier, som höra till teologin, och vilka nämligen på intet annat sätt än genom guds särskilda nåd äro uppenbarade."

¹³⁶ Annerstedt 1877, p. 398. Christina to the Senate of the University of Uppsala 8.11.1651.

ran theologians' writings. Because the Faculty of Theology had already vetted Bång's thesis and accepted it, it seemed as if Miltopaeus' attack was targetted at the whole University (i.e. at the proponents of the highest faculty of the University). The quibble continued in later disputations and even the students were called on to take sides in the controversy. The disagreement was settled only by the interference of Chancellor Brahe himself.¹³⁷

This incident is remarkable in view of the relationships between theology and philosophy. What Miltopaeus seems to have attacked in Bång's thesis was primarily the scholastic terminology it used. It seems to have been debatable what was to be regarded as "right" philosophy, and whether and to what extent philosophy should be used in theology.¹³⁸ The controversial questions really employed scholastic terminology and included the following problems: in what sense can God be said to be the primary instrumental (i.e. efficient) cause of the Church? In which sense can He be said to be *causa ministerialis* in salvation? Was the Holy Trinity in its entirety the efficient cause of the Church? and in what sense can the congregation be said to have a double form (i.e. internal and external forms)?¹³⁹

In his resolution of the case Chancellor Brahe did indeed warn Bång for using "unnecessary" metaphysical concepts in a theological dissertation. Brahe was in accordance with the old Lutheran tradition which generally stood against introducing metaphysical concepts into theological discussion. On the other hand, Miltopaeus, "a mere philosopher", was reproached for getting into theological problems, which

¹³⁷ For more detailed descriptions of this controversy, see Laasonen 1977b, p. 301-307. Simolin 1912, p. 37-43. See also Gezelius' report to Brahe, "Status controversiae" 25.8.1666. UUB manuscript N 65.

¹³⁸ In addition to Laasonen 1977b, p. 302-303, see the appendices to Gezelius' report written by Bång and Miltopaeus, UUB N 65.

¹³⁹ These questions are discussed by professor Svenonius in his "Iudicium theologicum" sent to Chancellor Brahe, UUB N 65. Svenonius sees nothing troublesome in the answers provided by Bång to these questions although other theologians in Turku (Gezelius and Abraham Thauvonius) had considered some of the terminology "novelties". Laasonen 1977b, p. 303. In his report Svenonius recalls the need to revise philosophical concepts: "Denique dum Termini philosophici, physici, Metaphysici [?] usurpantur ad explicandum res Theologicas, dicuntur oppido liberandi [?] ab omni impuritate quae rebus naturalibus adhaerescit, exemplo Jacobi Martini in Partitionibus Metaphysicis, Scharfij in peculiari Dissertat[i]one et aliorum, imprimis contra Socini fratres [N]eo photinianos, ut et Calvinianos." Svenonius UUB N 65.

were not in his area of competence.¹⁴⁰ Once again, from the theologians' point of view the relationships between theology and other disciplines were basically a question about the power and authority of portraying and interpreting religious knowledge.

Miltopaeus' attitude in this controversy is extraordinary for a 17th-century Finnish discussion. In his letter to Chancellor Brahe Miltopaeus defended his doings by claiming his freedom of speech. He asserted that if an invited opponent was not allowed to express his criticism, academic learning would not be advanced. Stagnation of learning would also be imminent, if all dissenting opinions were immediately labelled heretical.¹⁴¹

If there is no liberty at all to freely express oneself against theses in public disputations, and say what seems to be relevant (to the subject) and truthlike, then everything will become dull and childlike. And it will not be of any glory (to the academy) or constructive for the listeners. What is true stays true irrespective of what the opponent says against it.¹⁴²

Liberty is a gift of God and his principle in order to make the free sciences flourish. But if anyone applies this practice to academic exercises, he will soon realize that one cannot disagree the least bit with the ideas written in these authorized booklets without being called a heretic, seducer (of youth) and whatever infamies...¹⁴³

Miltopaeus' claim for more freedom of speech is, on the one hand, certainly a protest against the tightened control of Orthodox Lutheranism. On the other hand, however, it is against the increased use of philosophical terminology in theology, which Miltopaeus regards as harmful - most probably to theology itself. Thus we can see here a

¹⁴⁰ Laasonen 1977b, p. 302-303.

¹⁴¹ Laasonen 1977b, p. 304.

¹⁴² Miltopaeus to Brahe 7.7.1666. PBB II: 2, p. 78. "Om man inthet in disputationibus publicis hahr den Libertet, att man frijt får säija emot theses, hwad som skäligt och sanningen lijkt synes wara, så skeer alt frigidé och pueriliter, och med ingen hedher, eller medh Auditorij upbyggelse. Sant blifwer ändoch sant, ehwad man der emot tanquam opponens sägher."

¹⁴³ Miltopaeus in UUB N 65. "Qvod artes liberales floreant, Dei munus ac principis liberalitas est: Verum si exercitijs Academicis hanc vim inferas, ut ne latum quidem unguim a consignatis in charta sententijs disceden[dum] liceat, nisi quis mox haereticus, seductor & quidquid infamiae et opprobrij est, audiat..."

chasm both between two Lutheran traditions - the old Lutheranism and the Orthodox Lutheranism - and between theology and philosophy.

It is most interesting to see what kind of attitude the theologians adopted especially towards *natural philosophy*. The philosophical school, which most occupied theologians' thoughts in 17th-century Sweden was Cartesianism. At the Diet of 1664 Svenonius was already active in giving the clergy's official answer to the "Cartesian question". The clergy demanded a ban on all peregrinations, especially for those travels to "Cartesianism-infected" universities. Lecturing on Cartesianism in local universities should also be controlled, according to an extract from the minutes signed by Svenonius. Cartesianism was suspect, because it taught that only matters concerning religion had been revealed by the Holy Spirit in the Bible, while sayings dealing with nature and chronology were written only according to common opinion. At this time, one of the main concerns behind the clergy's polemics was the fear that Cartesian philosophy would smuggle the hated syncretism into the country.¹⁴⁴

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Cartesianism was attacked for other theological reasons too at Turku. Methodical doubt would lead to atheism as soon as it was extended so as to cover the Works of God also, theologians thought. All in all, Cartesianism was heresy.¹⁴⁵ It was not thus physical but primarily other philosophical and theological reasons which made the "new philosophy" unacceptable.¹⁴⁶ This was true in other European countries as well, e.g. the Netherlands.

It was largely due to Cartesianism that the theologians started to change their views on the role of philosophy and the Faculty of Arts in general. The Faculty of Theology now wanted to close itself off from philosophy, which - as it seemed - had sunk into a sea of heated disputes (although not yet at Turku). According to Salminen the strategy favoured by Svenonius was to make the Faculty of Arts a sort

¹⁴⁴ Lindborg 1965, p. 93-96. Göransson 1951. Salminen 1978, p. 350. It seems that Svenonius had changed his attitude towards physics since his earlier days, when he was not altogether negative towards it. In 1645, i.e. before he had studied under the guidance of Calovius in Wittenberg, Svenonius had written that the "*scopus & intentio*" of the Bible was other than the matters of nature. Therefore far from all problems of natural philosophy were dealt with in the Bible. This silence should not be taken to mean that scrutiny of nature was futile, but that it should be guided by nature itself and the general principles of right faith. Wexionius-Svenonius 1645, Th. I.

¹⁴⁵ Salminen 1981, p. 94-97.

¹⁴⁶ See also the chapter "Cartesianism and Natural Philosophy" of this work.

of bulwark for theology. This tendency reached its height in the 1680's. Cartesianism should be met on the philosophical front and killed there, so that unanimity in theological matters would not be endangered. Philosophers were also allowed to incorporate theological points of view in their positions if only they argued for the Orthodox dogmas and not against them. At the same time theology distanced itself from all philosophy, including Aristotelianism. However theology and philosophy separated more radically only in the 1720's.¹⁴⁷

The anti-philosophical attitude became visible even in some nominations. In 1681 Laurbecchius applied for the professorship of theology, but his application was turned down. The reason for this was, as Svenonius put it, that Laurbecchius was too well-versed in Cartesianism - albeit in opposing it. Svenonius' own favourite candidate, professor of physics Anderas Petraeus had studied philosophy (i.e. logic and metaphysics) only very little. According to Svenonius this was a merit, because those well acquainted with philosophical subtleties would be more prone to heresies.¹⁴⁸ It seems also highly possible that Svenonius' arguments are just good pretexts for him wanting his own son-in-law to be nominated to a good position. Nevertheless it is significant that even in that case Svenonius used Petraeus' inexpertness in philosophy as the main argument for him.

The apparent differentiation of theology and philosophy by no means meant more liberty and independence to the latter. Instead of being indifferent to what was written in philosophical dissertations, theologians kept an even keener eye on the propriety of discussion in philosophical theses. As long as there was no obvious deviation from accepted philosophical and theological dogmas, theologians did not interfere with philosophers' doings. Undoubtedly philosophers benefitted from this arrangement: because they had fully accepted the pro-orthodox line themselves, they could live and work in peace. Indeed, it has been claimed that just as theologians were ready to skip away from Aristotelian philosophy, the philosophers still stuck desperately to it.¹⁴⁹

¹⁴⁷ Salminen 1981, p. 98-99 and 1983, p. 63. However, Salminen has not satisfactorily shown whether this caused a change in theological argument, too. On the 18th-century developments see Salminen 1983, p. 82-84.

¹⁴⁸ Salminen 1981, p. 98.

¹⁴⁹ Salminen 1981, p. 98.

Natural Philosophers on Their Own Status

According to most scholars at Turku, knowledge of natural things was a gift given by God. Adam was the first physicist, who gave names to all species on the Earth. Since the Fall only small parts of the knowledge had been preserved, and now men had to take great pains in gathering the scraps.¹⁵⁰ The best way to do this, it was thought, was to read the Book of Nature:

The world is like a Book: heaven, earth and water are its Leaves and its Letters are the inhabitants of its abodes... We do not want to understand here by contemplation of Nature that man should think only about the external forms of things, ...but should penetrate to the interior of things with his understanding and reason, and investigate their causes, principles, affections and other properties.¹⁵¹

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The fact that natural philosophy was a gift from God was of fundamental importance for the whole discipline. When the Wittenbergian theologian Abraham Calovius argued that there was no contradiction between philosophy and theology, he made exactly the same statement. Because natural philosophical knowledge came ultimately from God, it could not contradict his Word.¹⁵² This notion also asserted some degree of epistemological certainty for physical knowledge. If natural philosophy was a gift from God, it implied that the human mind had been created in such a way as to match the intelligibility of nature. Therefore positive knowledge of nature was possible.

In the previous subsection we have seen that at times theologians

¹⁵⁰ Alanus-Wassenius 1646, Th. II. Thuronius 1660, *De Philosophia in Genere*, p. 26-28. Thuronius-Sutthoff 1665, p. 6-7. Miltopaeus-Kiellin 1672, *Theorema Propaemticum*. Miltopaeus-Lithomannus 1668, Th. I. Flachsensius 1678, *De Philosophia in Genere*, p. 16-18, Appendix, p. 131-132. Hahn-Granbeck 1685b, Th. II. Hahn-Hasselqvis 1698, *Prooimion*. Hahn-Frolander 1692, p. 2-3, 7. Tålpo-Askbohm 1697, p. 2. This is one of the points raised by Calovius, Preus 1970, p. 131-133. Cf. Brooke 1991, p. 19.

¹⁵¹ Thuronius-Sutthoff 1665, p. 5-6. "Liber mundus est: Folia sunt coelum, terra, aqua: Literae sunt illorum domiciliorum incolae... Talem verò nos hic intellectam volumus Naturae contemplationem, non quā Homo externas tantum rerum formas oculis intuetur... Sed quā ad interiora rerum mente & ratione penetrat, earumquē causas & principia, affectionesque & proprietates subtiliter investigare satagit." See also Wexionius-Svenonius 1645.

¹⁵² Preus 1970, p. 132. See also Thuronius 1660, *De Philosophia in Genere*, p. 89-90.

made strong demands on philosophy to consent and to fight against philosophies potentially dangerous for theology. It should be noted that the gradual separation of philosophy and theology from the 1680's on did not necessarily mean that philosophy itself was regarded as invalid.¹⁵³ But how did the philosophers respond to the claims for control and to the exclusion of Aristotelianism from Theology? In natural philosophy, which most interests us, no direct responses to these challenges were made. The general attitudes of the philosophers can however be traced.

It seems that in the 17th century the majority of philosophers at Turku were ready to assert the old slogan: *philosophia est ancilla theologiae*.¹⁵⁴ But what did this subalternation mean in practice? In 1647 the professor of physics, Georgius Alanus started a "philosophical dissertation" with a thesis which claimed that philosophy was *not* subordinated to theology.¹⁵⁵ Alanus was working on the definition which was given by metaphysics for subordination. In order to be subordinated, two disciplines must have the same subjects of study, the same first principles and the same goals.¹⁵⁶ None of these three requirements were fulfilled. Theology studied supernatural things by the light of faith, in order to achieve the *summum bonum theologicum*, whereas philosophy was a rational enterprise dealing with natural matters. What Alanus means, actually, is that philosophy was not a sub-faculty of theology. Hence, philosophy was an autonomous, but certainly not an independent discipline.

Being the handmaiden of theology meant first and foremost respecting the principle of the unity of truth. This is what Calovius had also stressed when he argued for the compatibility of philosophy with

¹⁵³ The articles of Salminen referred to above seem to suggest that the theologians questioned the relevance of Aristotelian philosophy itself. He has not shown, however, whether this really was the case or whether theologians had lost confidence in philosophy only as an instrument for theology.

¹⁵⁴ See e.g. Justander-Westhius 1654, Th. VII. For a history of the *ancilla*-concept see Grant 1986, p. 50-54.

¹⁵⁵ Alanus-Ulstadius 1647, Th. I. "Philosophia non subordinatur Theologiae".

¹⁵⁶ For a slightly different criterion of subalternation see Thuronius 1660, De Philosophia in genere, p. 50. He claims to follow Suarez and Scheibler in his presentation, according to which a discipline is subalternated to another, 1. if the subject matter of the subalternating science includes the one of the subalternated, 2. if the subalternated discipline additionally discusses only accidental differences, which the subalternating discipline does not deal with, and 3. if the conclusions of the subalternating science produce the principles of the subalternated discipline.

theology.¹⁵⁷ In one of his first dissertations Alanus put it as follows: "The truth is only one - not double, not multiple. It is the voice of God irrespective of whether it talks to us through Nature or Scripture."¹⁵⁸ Truth in theology and in physics could not be contradictory, because both disciplines studied the works of God, only from different points of view. There were wrong philosophies which produced conclusions contrary to the word of God. All these heretical (but not necessarily pagan) views should be abandoned, because they were useless and pernicious (*non utilis & perniciosa*). Proponents of non-Lutheran confessions, especially the Calvinists, were accused of favouring double truth, which applied different criteria for natural knowledge and faith. Religious heresy and philosophical (especially metaphysical) dissidence were thus associated.¹⁵⁹

Yielding to the truth in theology was not only negative from the point of view of philosophers. This aspect received expression in other European countries too. For example in France many Cartesians and the founders of the *Académie des Sciences* were happy to point out that philosophers were not competent to make judgements about matters of theology, trying to keep away from theological controversies and secure their working peace.¹⁶⁰

As well as theologians, philosophers could themselves claim the usefulness of their discipline to theology, except that philosophy should be used in the right way.¹⁶¹ It was especially in combatting adversary religions that philosophy was regarded as most serviceable: "Anyone who does not have a fungus in the place of his brain sees that Philosophy is in some way necessary for refuting the contentions of adversaries and for repelling the insanities of the heretics."¹⁶² Once

¹⁵⁷ Preus 1970, p. 132.

¹⁵⁸ Alanus-Kempe 1646, Th. I. "Philosophiam S. Theologiae contrariari falsum est." "*Unica duntaxat est veritas, non duplex, non multiplex. Dei vox est, sive per Naturam sive Scripturam ad nos fiat.*"

¹⁵⁹ Alanus-Kempe 1646, Th. I. Miltopaeus-Lithomannus 1668, Th. I. Thuronium 1660, De Philosophia in Genere, p. 89-90. Hahn-Granbeck 1985b, Th. II. Tälpo-Steenbergius 1685, Th. I.

¹⁶⁰ Clarke 1989, p. 37-42, 224.

¹⁶¹ Justander-Westhüs 1654, Th. V-X. Wexionius-Jeronius 1656, Th. II-VII. Wexionius was a professor of history and politics, but his thesis discusses the use of every philosophical discipline in theology. He did not, however, represent the Wittenbergian school in his views. Salminen 1978, p. 231.

¹⁶² Thauvoniüs-Forstadius 1652, Th. I. "Philosophia est maximè utilis & Theologiae neutiquam contraria." "Ad strophas adversariorum refutandas & haeticorum quisquillas evertendas quam sit utilis imo quodammodo necessaria Philosophia,

again this was one of the arguments expressed by Calovius, too.¹⁶³ It is not unusual for a discipline to motivate and legitimate its own existence and methodology by referring to those values which are considered most important in that particular community at a certain time. In the 17th century one of the most respected academic values was theological utility. Despite this rhetoric, philosophy was not pursued entirely for the aid it could provide for theology, but as Alanus claimed, physics had a *finis* of its own; to know the causes of natural bodies. This more independent trend marks a difference from certain early medieval meanings of the *ancilla*-concept, which implied that philosophy was not to be studied for its own sake at all. The study of the visible world was encouraged by God only because man would find the way to contemplating the invisible world and thereby honour Him. The study of nature as proposed in the quadrivium would also give man means for gaining the God-ordained dominion over the world.¹⁶⁴

In this context "philosophy" referred mainly to metaphysic and logic. All in all however, the Bible and religious tradition were thought legitimate sources of knowledge in natural philosophical enquiry also. In fact, they were the recognized authorities for settling the truth in obscure cases. During the 17th century the single theory which most threatened this alliance was the Copernican world-system. It questioned the idea of the unity of truth because accepting Copernicanism would have meant giving up the fundamental exegetical principle of orthodox Lutheranism, i.e. the literal reading of the Bible. For this reason Copernicanism became very much a matter of faith.¹⁶⁵

One of the few physicists who openly turned against the Copernican non-literal reading of the Bible was Achrelius. In his *Contemplationes mundi* he accused the Copernicans of saying that the Bible was composed partly in accordance with our understanding and partly according to vulgar opinions. Achrelius seems to have been at least vaguely

videt qui non fungum pro cerebro habet." See also Miltopaeus-Lithomannus 1668, Th. I. Thuronius 1660, *De Philosophia in Genere*, p. 90, also mentions other uses for philosophy in theology, such as sharpening the reason, explicating concepts and interpreting the Bible accurately.

¹⁶³ Preus 1970, p. 133.

¹⁶⁴ Grant 1986, p. 50. Grant mentions Philo Judaeus from the first century A.D., St. Augustine (354-430), Peter Damian (1007-1072), Hugh of Saint-Victor (d. 1141) and St. Bonaventure (1221-1274) as proponents of this view.

¹⁶⁵ Ratschow 1964, p. 82-116. See also Svenonius 1664, p. 14-15.

aware of another group which opposed literal reading of the Bible in matters concerning nature. He states that in criticizing the authority of the Bible the Copernicans move to the party of the Pre-Adamites. All suspicions against the word of the Bible Achrelius repels by citing the Psalm 104.¹⁶⁶

The Cartesian natural philosophy progressed at Turku during the 1690's. The reason this philosophy had caused so much dispute elsewhere was that it approached the Bible from a different point of view and no longer automatically accepted it as an authority in physical matters. At Turku, however, scholars were careful not to make any direct statements questioning of the relationship between theology and (natural) philosophy. For example the thesis by Magnus Ståålhöös in 1697 seems to promote only a slightly more independent status for philosophy.

It is not up to the Scriptures to name or explain everything which occurs in nature, but to show the way and to give philosophy the ability to judge things in the right way; which and what kind of things do exist, and in what way they are congruent with the highest Entity.¹⁶⁷

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Thus, according to Ståålhöös, while the Bible could not produce answers to all questions concerning nature, it should direct the inquiry. In another passage from Ståålhöös the drifting apart of theology from philosophy is beginning to show.

Although the statements and utterances of GOD are not norms by which to judge philosophical controversies, nevertheless all inductions and conclusions in Philosophy must be formulated and posed

¹⁶⁶ Achrelius 1682, p. 196 "Existimantes multa ibi tribui rebus, partim secundum nostrum concipiendi modum, partim secundum vulgi opinionem.", 201 "At *Scripturarum auctoritatem dum vellicant*, Pleno gradu vadunt in castra *Prae-Adamitarum*. Enimvero Spiritus Sanctus cum de rebus loquitur, non secundum apparentiam vel ex hominum sensu, sed juxta ipsam veritatem easdem proponit, ut docet Psalmus CIV."

¹⁶⁷ Hahn-Ståålhöös 1697, p. 13. "Non equidem scripturae est, omnia quae in rerum natura occurrunt, nominare vel explicare: est tamen ejus, viam sternere, atque asum dare philosophiae, rite dijudicandi res; quae & qvales sint, & qvomodo cum Ente summo convenient."

so as to really consent not only with nature itself but also with the Divine mind, whose contents they consist of.¹⁶⁸

The physical theories should thus be in accordance with the word of God. Ståålhöös had in mind the so-called metaphysical truth, which differed from ethical and logical forms of truth.¹⁶⁹ Because God was the creator of the world, the truth about nature was therefore in accordance with the ideas in his mind.

Ståålhöös' point of view is closely connected to the context where he expresses these ideas. He is arguing that we should not assume that there is a sphere of fire below the moon since the Bible makes no mention of it. In doing this he is trying to discard the way of arguing which stems from rejecting the so-called topos of negative authority. It says that the non-existence of something cannot be argued from silence in the Bible. The course of ratiocination which Ståålhöös opposes runs in the following way: the Bible does not mention the existence of X. Rejecting the topos of negative authority, it becomes possible to state that this does not *deny* its existence and thus, it is *possible* for X to exist. Ståålhöös does not mention any authors, who would really have argued in this way, but since the condemnations of 1277 it had become usual to argue for the possibility of the existence of certain things by saying that the Bible did not deny its existence. Stating otherwise would have been regarded as an attempt to limit the power of God.¹⁷⁰ Arguing for the possibility of existence comes very close to jumping to the conclusion that certain entities actually *do* exist if their existence is even a possibility, which is not rejected in the Bible. In my reading Ståålhöös is arguing against something which he considers as misuse of the rejection of the topos of negative authority. Another important point to take notice of is the express statement that there are occasions in which the Bible is useless for physical

¹⁶⁸ Hahn-Ståålhöös 1697, p. 12-13. "Qvamvis igitur oracula & elogia DEI, non sint norma controversiarum philosophicarum dijudicandarum, interim tamen omnes, in Philosophia, inductiones & conclusiones, sic formari ac dirigi debent, ut non tantum cum ipsa natura, quin & cum mente Divina, in cuius conformatione omnia consistunt ac sita sunt, revera consentiant."

¹⁶⁹ Thuronius 1660, Tractatus Prooemialis, p. 20. "Metaphysicam [veritatem], in congruentia rei cum intellectu potissimum Divino consistentem, quae dici quoque solet transcendentalis, objectiva, Entitativa & veritas in essendo." Ethical truth was "consent of the heart and the speech" whereas the logical truth had to do with e.g. the formal consistency of an argument.

¹⁷⁰ Moss 1993, p. 164, et passim.

argument and thus should not be used for that purpose.

Only a handful of statements can be found in which something is said about the role and status of natural philosophy (or philosophy in general) beside and below theology. In all these public statements philosophy seems glad to accommodate itself to the higher criteria of truth. Not even the emergence of Cartesianism changes these attitudes. Therefore, it is more interesting to see what kind of role theology actually plays in natural philosophical thinking.

4. THEOLOGY AS THEORIES IN NATURAL PHILOSOPHY

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In the previous subsections of this chapter I have tried to sketch an idea of the relationships between theology and philosophy both on the inter-institutional and intra-institutional levels. These relationships form a net of power relations and social factors, which on a grand scale influence all learning at the University. How is this influence mirrored at the level of physical theories, then? The pattern is made more complicated by the notion that logical and metaphysical dogmas were also in many ways involved in natural philosophical thinking. In a way, metaphysics was a transmitter between the two disciplines, since physical theories had to be in accordance with metaphysical ideas, which in turn were reconciled with the theological dogmas. Logic, on the other hand, was essential for all these disciplines because it offered the rules and patterns needed for syllogistic reasoning. E.D. Sylla has very aptly compared the learning of logic in medieval universities to the place that mathematics holds in the modern university.¹⁷¹ Logic was the key to most other areas of knowledge, just as mathematics is considered to be today. On the other hand the truth of certain logical or metaphysical dogmas could be argued for by

¹⁷¹ Sylla 1975, p. 351.

physical arguments.¹⁷² All in all different disciplines form a network of knowledge where everything is interrelated with other disciplines.

We can discern three ways in natural philosophical thinking in which theology and natural philosophy crossed each other. First of all, arguments supporting physical theories could be based on the Bible, although other arguments could also be used. Slightly different from this were the cases in which the contents of a natural philosophical theory were fundamentally based on a theological dogma. Finally, sometimes physical explanations or descriptions were sought for Biblical events - even for miracles. Let us now turn our attention to those instances in which the first type of argument was utilised.

Arguments from the Bible

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Theological arguments could well be brought into natural philosophical discussion. The most well-known, and for a modern scientist also probably the most notorious examples of the influence of religion upon science are the cases where a natural philosophical factual claim was either rejected or verified by appealing to the authority of the Bible. The most famous, and for the 17th century admittedly also the most important case was that of heliocentrism. Although the physical reality of heliocentrism had already been denied during the 16th century, the Copernican theory did not arouse much opposition during that century. However, from 1600 on different churches all over Europe started to see it as a threat to the Biblical world-view.¹⁷³ If heliocentrism was asserted to be physical reality, as Galileo Galilei and some other scholars had done, it would mean that the Holy Spirit speaking through the Bible would either lie or err on the question of the Earth's location.¹⁷⁴ Both of these alternatives were thought intolerable, because the authority of the Bible was according to the Lutheran dogma bound

¹⁷² Flachsenius 1678, Collegium Logicum I, p. 288. According to Flachsenius the generation of a natural body, as is shown by physics, proves that there really are *four* causes.

¹⁷³ Among Lutheran scholars Melanchthon had already used the book of Job to repudiate the physical reality of the Copernican system. Elert 1962, p. 414-431. However, he did later on accept the so-called Wittenberg interpretation of the theory. Westman 1986, p. 83. Obviously it was not until the middle of the 17th century that the Lutheran theologians started to employ Biblical argument against heliocentrism on a larger scale. Preus 1972, p. 227-229. The Catholic Church declared Copernicanism heretical in 1616.

¹⁷⁴ Scholder 1966, p. 56-78.

to a literal reading of the Holy Book. A wide range of hermeneutical problems became involved in the question.¹⁷⁵ Thus not only was the good old world-view at stake but, what was more important, the authority of the Holy Scriptures and the authority of the church against mathematicians and philosophers to lay claim to its proper interpretation. Therefore innumerable natural philosophers and astronomers adopted the view which made the Bible the most forceful argument for geocentrism. On the other hand in Lutheran countries the so-called Wittenberg interpretation, according to which Copernicanism could be used in astronomical calculations but not accepted as physical reality, because this would contradict the literal reading of certain biblical passages, had also gained a strong foothold in the sixteenth century. Let us now see how this problematics was dealt with at Turku.

As a theory, Copernicanism was already known at the University of Turku by the time of its foundation. At this time, however, most arguments were physical and affirmative in nature: the immobility of the Earth was stated more often than the opposite view was rejected. At Alanus' time Copernicanism had not yet been attacked with a bundle of Biblical quotations. Religion did nevertheless play an important role in the reasoning. It was stated that the stars move and the Earth rests because God had created their natures to be such. The ultimate guarantee of the traditional world-view was in the order of the cosmos as ordained by God.¹⁷⁶

Since Thauvonius, Thuronius and Petraeus did not much deal with matters concerning the structure of the universe, there is about three decades' pause in arguments on heliocentrism in physics theses. The one who really introduced Biblical arguments into discussion of heliocentrism was Petrus Laurbecchius in his 1661 mathematical thesis "*...adversus Copernicum redivivum*".¹⁷⁷ Laurbecchius' work was the first at Turku to discuss the Copernican system in detail. Although Laurbecchius elaborately introduced over two pages of Biblical quotations in support of the geocentric system, these were certainly not the only arguments he found against Copernicanism. What is important, though, is the status given to the Biblical arguments; because reason alone could not provide the crucial argument one had to rely

¹⁷⁵ Westman 1986. Moss 1993, p. 129-147, et passim. See also Svenonius 1664, p. 14-16.

¹⁷⁶ Alanus-Moderus 1645, Th. XVII-XXI. Alanus-Lacmannus 1648, Th. XXII-XXIII.

¹⁷⁷ Kexlerus-Laurbecchius 1661, Cap. III, 2. See also Salminen 1983, p. 60.

on the word of God. I would like to describe this kind of approach as "dogma-determined reasoning". It can be asked whether both the qualitative and quantitative importance of Biblical arguments in theses discussing Copernicanism continued on the line opened by Laurbeckchius.

Discussion of the different world-systems became fashionable from the end of the 1670's on - before that date neither physicists nor mathematicians troubled themselves much on the subject. The space and emphasis given to Biblical argument seems to vary in theses, although it was at least in principle always given a primary epistemological status. The majority of authors did not present such an extensive quantity of Biblical quotations as Laurbeckchius had done.¹⁷⁸ Some of them more often presented physical arguments, but it was nevertheless common to guarantee the Bible a crucial role in deciding the matter.¹⁷⁹

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One of the most thorough studies on the different world-systems was written by the professor of mathematics Johan Flachsenius in 1679. This ardent apology for geocentrism has been noted as an expression of arch-conservatism at the University of Turku - to a great extent because of its reliance on the Bible.¹⁸⁰ Curiously enough the importance placed upon the authority of the Bible in it is out of all proportion to the few lines in which *Scriptura Sacra* is referred to.

...because what is thought to be right is often utterly false, it seems that Christian people can hardly respect the revered testimonials of the Holy Scripture enough. One divine manifestation of such works of God is more valid than the wit of all human minds...¹⁸¹

¹⁷⁸ Flachsenius-Forsman 1678, Th. II. Flachsenius-Grimsteen 1679, Membrum Tertium. Tålpo-Rhydelius 1682, Th. VI, XVI, XX-XXI. Flachsenius-Bergius 1682, Th. VIII. Hahn-Granbeck 1685a, Th. XI. Hahn-Alm 1688, p. 18-21. Hahn-Tålpo 1699, p. 16-19, 26ff. Hahn-Flodin 1707, p. 10-21. Tammelin-Nidelström 1706, p. 15-18.

¹⁷⁹ Especially Flachsenius-Forsman 1678, Th. II. Flachsenius-Grimsteen 1679, Membrum Tertium. Hahn-Wijsing 1685, § V. Hahn-Flodin 1707, p. 10-21, emphasised the qualitative power of Biblical arguments.

¹⁸⁰ Myrberg 1950, p. 8-9. Sandblad 1944, p. 185-186. Slotte 1898, p. 26-27. Lehti 1979, p. 48-49.

¹⁸¹ Flachsenius-Grimsteen 1679, Memb. III, Th. 1. "...cum non rarò falsissimum sit quod verius esse putatur, hominibus Christianis divinis scripturae Sacrae testimonijs firmatis haud satis digna habenda videtur: De talibus enim Dei operibus una divina manifestatio pluris est, quam omnis humanarum mentium sagacitas..."

And somewhat later Flachsenius writes, confirming the overwhelming authority of the Bible:

The passages of the Scriptures which establish the Thesis which attributes rest to the Earth and movement to the Sun, are clear to us. The testimony of the Holy Spirit, the creator of all nature, is so excellent that it exceeds a thousand times all certitude of the human mind...¹⁸²

A more cautious but nevertheless equally determined position was taken by Samuel Flodin in a thesis published in 1707 under the guidance of professor Hahn. According to him we should stick to the Bible until some necessity requires us to believe otherwise. It can be read between the lines that this "necessity" was unlikely to come.

We regard it as wiser not to stick to [those] opinions, at which so many Fathers, Theologians and Philosophers laugh. Especially because no necessity urges us it would be rash to relinquish those passages of the Holy Scriptures which ascribe rest to the Earth and continuous movement to the stars.¹⁸³

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Those authors who made more frequent use of the Bible concentrated mainly on proving two things by it. Firstly it was stated that the Earth was created as immobile. This argument can be found even in the earliest theses at Turku. Secondly the miracle explained in the book of Joshua was thought to imply that the Sun would have to revolve in order to stand still.¹⁸⁴ Both mathematicians and physicists as well seem to have been equally attracted to using theological argument. It might be asked, though, to what degree *their* interest was to save the authority of the Bible and how much they strove to save

¹⁸² Flachsenius-Grimsteen 1679, Th. 10, Qvaest. I. "Nos verò cum clara sint scripturae loca, quae Thesin de Terrae quiete Solisque motu stabiliunt, tantumque sit unicum Spiritus Sancti totius naturae authoris testimonium, ut omnem humanae mentis certitudinem mille transcendat..."

¹⁸³ Hahn-Flodin 1707, p. 14. "Consultius autem ducimus non [?] sententiae adhaerere, quae tot Patrum, Theologorum, & Philosophorum adridet palato, praecipue nulla urgente necessitate, temerarium foret, recedere ab istis Scripturae Sacrae locis, quae Telluri quietem, sideribus motus perpetuos addunt." "?" indicates a damaged spot in the text.

¹⁸⁴ Achrelius 1682, p. 197-198. Hahn-Wijsing 1685, § V. Hahn-Weckelman 1694, p. 8-20.

the geocentric world-view. Probably these motives cannot be separated from each other, although in mathematical and physical theses the main emphasis naturally was on their respective subject-matters. Moreover, the Bible was not expected to provide answers to all questions. In 1685 a thesis was published in which the essential prerequisites of physical knowledge were studied. It argues that neither reason nor experience nor the Bible alone were enough to acquire knowledge, but the three had to be combined in the proper relation. The restrictions of the Biblical argument were stated as follows: "He who sticks only to the Scriptures will remain ignorant of things which are most evident, and will come to incomplete and deficient knowledge of nature, for it is not the first intention of the Bible to explain the natural world."¹⁸⁵

Although the Bible certainly gave the ultimate answer in a dispute which human reason was considered incapable of settling, it was far from being the only argument used. Thus it seems that we have to be cautious in our views concerning the importance and frequency of theological argument in this matter, since while it played an important role in dealing with cosmological or other natural philosophical questions, the fact remains that most authors did not cite the Bible excessively and exclusively to support their views.

There were questions in natural philosophy in which the authority of the Bible did not play such a crucial role as it did in the question of the proper world-system. In most cases, the Bible produced just another argument among others, albeit often the most powerful one. What kind of issues were argued for with the help of the Bible or theological dogma? For example, in 1650 Thauvonius and Warelus wrote that the fiery element does not exist exclusively in the sphere below the moon, but all over the elementary world. This was not only because fire would have been of no use to man if it was situated unreachably high, but also because the Holy Scripture did not mention its existence.¹⁸⁶ They thus have direct recourse to the topos of negative argumentation. Another important dogma to argue for was the existence of souls. Although it was evident even from physics that certain actions could not be caused otherwise than by a soul, and most "sane"

¹⁸⁵ Hahn-Govinius 1685, Quaest. V. "Scripturae qui adhaerebit tantum, quae evidentissima sunt, nesciet, & mancam & mutilam dabit scientiam naturalem. Non enim prima hujus est intentio, explicare mundum."

¹⁸⁶ Thauvonius-Warelus 1650, Th. XXXI, see also Th. XXVIII.

philosophers agreed with the claim, the best evidence came from the Bible.¹⁸⁷

There were, indeed, many things which could be argued for on the authority of the Bible. Support was found both for the sphericity of the Earth and the innumerability of the stars and for the existence of giants.¹⁸⁸ It was common to all these cases that the Bible was not the only ground for the statement. These questions could be answered and answers proved already by referring to physical causes. Nevertheless, support from other (profane and clerical) authorities was willingly adduced in addition. It was also typical to refer almost exclusively to the Old Testament. Sometimes it seems that the quotations were selected quite indifferently, without much concern for their proper context or the intentions of the author.¹⁸⁹ This kind of use of texts, which allowed quotations to be taken out of their context, was legitimised by the literal reading of the Bible. If all of the text was literally true, it would not change its true meaning to present only excerpts from it. Usually the content of the verses named or quoted was not further analysed, the right interpretation being thought self-evident.

Formally this kind of argument fell into the area of dialectical reasoning. Dialectical, or probable reasoning differed from the purely scientific reasoning because its premises or basic principles were less certain and not necessary. Thus, the premises relied on "opinions" on what was commonly thought to be the rule, or on what was regarded as true generally or for the most part. The more authoritative the opinion was on which the reasoning was based on, the more secure the result of the reasoning was considered to be.¹⁹⁰ Although in principle dialectic could produce only probable conclusions, the special divine status of Biblical authority made it totally certain.

¹⁸⁷ Thauvonius-Rosander 1652, Th. II. Hahn-Háf 1685, p. 3-4. Hahn-Hornaeus 1690, p. 3.

¹⁸⁸ Thauvonius-Miltopaeus 1653, Th. XXII. Thauvonius-Gyllenius 1655, Th. XXIII. Petraeus-Westman 1674b, Th. XII. See also Thauvonius-Forsenius 1650, Th. XXVI-XXVII.

¹⁸⁹ An example of this might be Achrelius' claim that the Bible speaks the truth and not only according to human understanding. (Cited above in subsection "Natural Philosophers on Their Own Status, note 69). He cites Psalm 104 for support, which describes the works of God in nature extensively and presents him as the cause of all the processes of nature: "He causeth the grass to grow for the cattle, and herb for the service of man...".

¹⁹⁰ Moss 1993, p. 3-9.

Theories Entirely Based on Theological Dogmas

100 In Lutheranism there was no attempt to entirely "theologize" physics, as was the case for example in the Calvinist tradition. However, there were fundamental concepts and theories in natural philosophy, which could not be formed on the basis of philosophical reasoning, but had to be grounded on theological ideas. For example, it was self-evident for all scholars at Turku that the world had been created by God. This assumption could be expressed in terms of Aristotelian philosophy by saying that God was the efficient cause of the world. This aspect was hardly ever passed over unnoticed in dissertations: whatever entity the question was about in a thesis, God was mentioned as its prime universal efficient cause.¹⁹¹ More immediate causes of things were always searched out as well, and regarded as vital, but in questions of cosmology especially God was reserved a major role. For instance, it was argued that because the heavenly bodies did not generate, their existence could be explained only by creation. In this sense natural philosophy also could produce evidence for the existence of the Creator.¹⁹² God was not only the primary efficient cause of the world, but he was also the final cause of everything, because all entities in the world were created for the glory of God.¹⁹³

Being the originator of the world it was no wonder that God was thought to play a significant role in many processes of nature. The theological basis for the ideas about God's action in nature can be found from the dogmas about providence and omnipresence. God's providence was a concept which was always bound up with creation in Lutheran theology. Providence was seen as a personal act of God and not just as a force which had been set in motion and which then

¹⁹¹ See e.g. Alanus-Ketarenus 1644, Th. XII. Alanus-Kempe 1647, Th. 6. Alanus-Lacman 1648, Th. VII. Thauvonius-Sundius 1656, Th. XI. Tälpo-Rhydelius 1682, Th. IX. Achrelius-Rungius 1686, p. 7. Hahn-Granbeck 1685a, Th. VII. Hahn-Alm 1688, p. 7. On division of the efficient cause into primary and secondary, universal and particular, etc., Thuronius 1660, *Institutiones logicae* I, p. 155-172. Flachsenius 1678, *Collegium Logicum* I, p. 301-325.

¹⁹² Flachsenius 1678, *De Philosophia in Genere*, p. 18. "Discere debuissent isti audaculi, quod philosophia sit partim *cognitio Dei*, quantum hic ex operibus creationis lumine naturae cognosci potest, partim *cognitio creaturarum ac operum à Deo conditorum*."

¹⁹³ Thuronius 1660, *Institutionum logicum* I, p. 187-199. Flachsenius 1678, *Collegium Logicum* I, p. 319-320, 347ff.

operated in accordance with predetermined laws.¹⁹⁴ The purpose of providence was to maintain the existence of creation together with its life and movement (*conservatio*). But it was also supposed to organise and direct the course of both natural processes and human activities (*gubernatio*). During the 17th century a three-level system of providence was largely accepted in the Lutheran world. The first level was God's general or universal providence, whereby he sustains and upholds all things, such as the orderly movements of heavenly bodies, regular rainfall or growth. This sort of providence was called *creatio continuata* by some Lutheran theologians. The second and third level of providence were for more individual concerns of men and their moral acts.¹⁹⁵

Providence was viewed as God's ongoing activity in nature. For Calvinists God's omnipresence was in fact His *actus providentiae*. This theory obviously had certain important implications for nature. All natural bodies were inherently inert and immovable, and therefore God had to play an active role in all nature's processes.¹⁹⁶ The Lutheran scholars of the 17th century could not accept the Calvinist view of predetermination, which they regarded as too strong. Nevertheless it was claimed that God had a direct influence on the causes and effects of created things. This was because all secondary causes were created by God and thus dependent on Him and their causality was subordinated to the primary cause as well. An excessive interpretation of this statement was regarded as problematic, though. If God were the sole cause of everything, there would be no free will in man, the inborn abilities for action would have been created in vain in natural things, and what is most serious, God would have been the cause of the evil acts of men as well. The metaphysical theses published at Turku concentrated on solving this theological-philosophical dilemma, and the mode of action of God in the world was considered to be grounded in the hierarchy of the causes itself.¹⁹⁷

In physics, however, the intentions of the authors were different. It was thought that God had empowered the secondary causes in na-

¹⁹⁴ This question became especially acute when Descartes and the Occasionalists based their explanations of nature on this kind of *deus ex machina*. Ratschow 1966, p. 231.

¹⁹⁵ Preus 1972, p. 193-203. Elert 1962, p. 442-443. Ratschow 1966, p. 208-247. Svenonius 1664, p. 33-40. Flachsenius 1690, p. 57-58.

¹⁹⁶ Deason 1986.

¹⁹⁷ Tålpo-Jung 1690. Juslenius-Limnander 1706.

ture. In other words He was the efficient cause of all secondary causes, the ultimate cause which cut short the infinite regress of causes. Hence, although physics was mainly concerned with explanation by secondary causes, it needed not exclude ultimate reference to a primary cause.¹⁹⁸ Despite the actual omnipresence of God and his continuous action as the primary efficient cause there was plenty of room left for the secondary causes which were the proper subject of study for physics. In fact, this action of the divine providence assured that we could rely on the orderly performance of nature and acquire knowledge about it.¹⁹⁹

The ability of God to perform miracles by voluntary acts was naturally never disputed. The omnipotent God could by his mere will hinder, alter, mitigate and overcome secondary causes.²⁰⁰ At Turku, however, we find an emphasis on the view that God would never operate against nature, but only *above* it.²⁰¹ It was not up to physical theses to discuss the nature of miracles more closely, and therefore what Thauvoniuss actually means by this also remains somewhat obscure. In my view it only stresses the supernatural character of genuine miracles to say that they were not violations of nature's laws, but a surpassing of them. God would not act against his own creation, but he could certainly act altogether independently of it.

Whereas providence was an act which secured the normal course of nature, on special occasions God could manifest himself as certain unusual phenomena, which nevertheless were not miracles. Comets, for example, were thought to be divine signs for mankind which told people to rue their sins and to perform penitence. Even here the difference between creation (a miraculous act of God) and generation (natural reproduction) was made clear. Turku scholars emphasised that God did not *create* portentous phenomena, i.e. produce them from non-existent matter. This was because the Bible said that God had finished his creation on the sixth day. He would rather operate on the laws of nature and existing matter when producing something like a comet.²⁰²

¹⁹⁸ For a discussion on the *causa procreans* and *causa conservans* as effective causes see Flachsenius 1678, Collegium Logicum I, p. 310-315.

¹⁹⁹ Preus 1972, p. 196. It is notable that the imputation theory, which originally was a concept used in kinematics has here been applied to theological use. On imputation theory in the Middle Ages see Maier 1951, p. 113-314.

²⁰⁰ Preus 1972, p. 203.

²⁰¹ Thauvoniuss-Warelius 1652, Sect. I Membr. II Artic. IV Ax. 1.

In the case of the theory of comets it was both theology and physics which benefitted from the interpretation. Theologians had in this theory a weapon spectacular enough to appeal to the masses in the fight against sin. In physics recourse to a theological dogma also served the conservative physicists' aims well. The idea of the non-elementary nature of celestial matter and its incorruptibility was still central to natural philosophy at Turku.²⁰³ However, the existence of comets and "new stars" could no longer be denied, especially because Tycho Brahe, the revered authority in astronomy, had been one of the discoverers of "new stars". Claiming that comets were supernatural products solved the problem, because it did not presuppose giving up the theory of the incorruptibility of the heavens.

Though the origin of comets was regarded as supernatural, it was still thought possible to study these phenomena physically and mathematically. The movements of comets could be seen and their speed and orbit calculated. The case was different in regard to some other natural entities, the existence of which could not be sensed but was only guaranteed by the Bible. *Aquae supracelestae* are a classic example of this. They were invisible and therefore their existence was known only because the Bible said so.²⁰⁴ In 1711 Michael Polviander described human ignorance as follows:

Nothing is more hidden to the reason than both the existence and location and order of these [supracelestial waters] in their place which was decreed in the first Creation. It is no wonder, because they are located hidden in the most remote place, to which neither the sharpness of our eyes can penetrate nor any other function of the senses can reach. They escape our senses and mind. Only the Holy Scripture informs us of this miraculous divine work. If it [the Bible] were silent about them, they could not be known and studied with any sharpness of man's ingenuity nor with any scrutiny of the reason but would stay enfolded in darkness of ignorance for ever.²⁰⁵

²⁰² Alanus-Moderus 1645, Th. XXXII. Alanus-Lacmannus 1648, Th. XLV. Hahn-Ekedahl 1695, p. 24-26.

²⁰³ See chapter "The Structure of the Cosmos" of this work.

²⁰⁴ Thauvonius-Warelius 1652, Sectio II, Artic. II. Thuronius-Pryss 1664, Th. IV. Miltopaeus-Lithomannus 1668, Th. IV. Hahn-Govinius 1685, Quæst. V. Tälpo-Bachster 1686, passim. Hahn-Löngreen 1709, Th. IV. Hahn-Polviander 1711. Tammelín-Tammelín 1711, p. 4-5.

²⁰⁵ Hahn-Polviander 1711, p. 4. "Nil rationi magis absconditum quam harum tum

The existence of *aquae supracoelestae* was generally acknowledged to be proved by the Bible, because there could be no other evidence for it. Only seldom something was assured on theological grounds, but contrary to all sense perceptions and ratiocination. In 1702 Carolus Erling raised a question about the source of moonlight. Philosophy and theology held different opinions in the matter, and this is how Erling responded:

And although none of the sane Philosophers consider all this light, whatever it is, to belong to the Moon as a peculiar or inherent quality, because of its waxing and waning, and alternation of its Phases which make it appear sometimes full, sometimes half and sometimes crescent. We, however, trusting and following Theologians, dare to attribute to it some innate light, and we base this assertion on documents... provided by the Holy Scripture...²⁰⁶

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Erling's views were not common at the University of Turku. They show, however, how high a point confidence in the Biblical evidence could reach.

When we talk about physical theories grounded on Biblical arguments, the examples where the very existence of a physical entity was made dependent on the Bible were certainly the most extreme. There were also instances, when there were several equal answers produced to a problem by Aristotelian natural philosophy. The right answer was then decided by criteria derived from orthodox Lutheran dogma. These cases are analogous to the problem of Copernicanism in as far as the ultimate answers are given by the Bible. The type of argument we are talking about now is, however, slightly different in manner. In

existentia, tum situs & ordinatio in istum suum locum in primordio creationis facta. Nec mirum, cum in occulto nobis remotissimoque lateant loco, quo nec oculorum nostrorum acies penetrare, neque ullius sensus operatio pervenire potest. nostros istae ludunt & sensus & mentem. sola sacra scriptura est, quæ de hoc operis divini mirabili nos informat opificio, quæ si tacuisset nullo sagacitatis humanæ acumine rationisque indagine cognosci ac investigari potuisset: sed perpetus ignorantiae tenebris involutum latuisset."

²⁰⁶ Hahn-Erling 1702, p. 16-17. "Et licet nemo saniorum Philosophorum sit, qui totum hoc lumen, quantumcunque est, Lunae tanquam proprium & congenitum adscribat, propter ejus incrementum & decrementum, Phasiumque vicissitudine, quâ modo plena, modo dimidiata, modo falcata, apparet, nos tamen, niti, Theologoru secuti, aliquid lucis innatae ipsi tribuere audemus, stabiliendo hanc assertionem documentis... ex S. Scriptura...".

question of "dogma-determined theories" (like anti-Copernicanism) theological argument comes only at a dead end, where philosophical and mathematical reasoning cannot (or is not allowed to) lead to a conclusion. On the other hand in "dogma-impregnated theories" theological aspects are involved at all levels of the reasoning which make the theory construct.

The dogma that God had created the world and all species in it had some consequences for physical theories. One of the most significant ideas in this respect was that the number of species in the cosmos was thought to be constant. New species would not evolve neither could any of them become extinct. In this context the word *species* did not refer to living organisms only, but to all entities or substances on earth including the lifeless ones. Man-made artefacts were not new species properly speaking, because they were always made of already existing materials.

It was known that living organisms especially were subject to change, alteration and finally to death. Therefore the conservation of the species must have been arranged somehow. The primary means for this was, of course, generation. All generation was caused by form, which had the potential to start and guide the process of generation. Matter was unable to generate by itself because it was passive by nature. Because generation was first and foremost generation of the form, it was important that the physical theories were in accordance with metaphysical dogmas on the propagation of form. The views held in metaphysics were on the other hand dependent on theology. And why were the concepts concerning generation so important for the theologians? Mainly because the answers given to the question of generation also had certain implications for views on man's soul.

Since the apple scandal the descendants of Adam and Eve were burdened not only by worsened living conditions but also by an indelible spiritual stigma, original sin.²⁰⁷ Painted with dark colours, the Lutheran dogma emphasized the despicable sinfulness of man's very nature. In this context original sin was seen as something very real,

²⁰⁷ Flachsennius 1690, p. 60. "*Peccatum originale est intima atque habitualis totius naturae humanae, iustitia originali per lapsum primorum parentum privatae, corruptio, in omnes omnino homines naturaliter ex Adamo descendentes, per carnalem generationem propagata, eosdemque reos faciens irae Dei, & aeternae damnationis.*" Svenonius 1664, p. 49-63. S. regards original sin as consisting of two aspects: the privation of the original status of man as the image of God, and of "the most sordid type of lusts".

almost touchable. However, the substance as such was unknowable for man but could be understood only through its accidents. Original sin was thus an essential accident in man, belonging to all individuals among this species. Now this sin needed a channel for its propagation, because its metaphysical status was that of an accident. According to the logical rules an accident could neither exist nor form new a substance by itself.²⁰⁸ Therefore, also the hereditary mechanism of original sin had to be physically explained. The solution to this problem was provided by a theory called *propagatio per traductionem*. A new form/soul was excited by the souls of the parents; this incident was often described by an analogy with one fire arising from two sparks.²⁰⁹ This *traductio* was also the channel through which original sin was propagated from soul to soul, from generation to generation.

It was essential from the point of view of theology that metaphysics and physics follow its accepted dogmas. This was important not only for the dogmatic coherence's sake but most of all because of the needs of theology. Because philosophical concepts were essential for theological theoretisation, their purity was the more important. It has been said that it was the dogma of angels especially, which was dependent on the right description of substantial forms.²¹⁰ In physics, however, substantial forms were not defended on these grounds. This was because the dogma of angels was a part of theology and thus outside of the area of competence of physicists.

Physical Explanations of Biblical Events

The impact of religion upon natural philosophy is visible also in the third type of argument, which concentrates on explaining events in the Bible on physical grounds. The roots of this tradition go back to the medieval times, where e.g. Peter Lombard's widely used textbook

²⁰⁸ Achrelius 1682, p. 349-350. Hahn-Ljungdahl 1704, p. 43. "...quia peccatum quod est accidens, non potest per se absque subjecto proprio, nempe anima, subsistere." Thuronius 1660, *Institutionum Logicum Tractatus Prooemiale*, p. 57-69. Flachsenius 1678, *Collegium Logicum Prooemiale*, p. 135-147.

²⁰⁹ Alanus-Jurvelius 1647, Th. XLVII. Thauvonius-Laurbecchius 1653, Sect. I. Thauvonius-Helsingius 1658, Th. 1-4. Thuronius-Mathesius 1665, Th. 2. Hahn-Ulholm 1689, p. 103-104. Miltopaeus-Enebergh 1667, Th. XIII-XX. Hahn-Collander 1699, p. 6-7. Hahn-Hornaeus 1690, p. 10-13. On "traducianism" at Turku see Leikola 1983a, p. 238-240.

²¹⁰ Salminen 1981, pp. 99-100.

of theology, *Sentences* (written around 1150), was full of natural philosophical material. Not only did several medieval authors apply physical knowledge to the exegesis of the creation and other important events in the Bible, but they also developed a special genre of hypothetical problems.²¹¹ Despite these long traditions this was not an overwhelmingly usual practice in dissertations written at Turku. This may be due to the tendency of the Lutheran church, which M. Büttner has pointed out, to omit directly Biblical explanations. Geography for example aimed at demonstrating how the world created by God functioned, and for this purpose we had to study the facts of this world in order to understand God.²¹² This kind of argument was not, however, entirely unknown at Turku either. Usually it was integrated in one or two *quaestios* or *corollaries* in the final part of the thesis. Nevertheless, this type of argumentation also deserves to be looked at more closely.

When approaching this kind of practice the question of its motivation arises. As against Büttner's description of Melanchthonian physics, the seventeenth-century Lutherans were occasionally also interested in explaining the way God had ruled the world in the past.²¹³ Why were events in the Bible reduced to physical terms? What function did this kind of approach serve? The intention was certainly not to strip God's works and miracles of their divine aura. Secularization was totally out of question. There seems to be no single motive for handling these problems. The following examples illustrate the way biblical themes were treated in physics and at the same time how they clarify their function.

The creation of the world and its species was a subject which was studied repeatedly.²¹⁴ The order of different acts of God in creation was a matter of physical explanation. The fact that only the Bible could tell us about these matters was not disturbing, because the Bible was considered as an authoritative source for physical knowledge. Of course, dogmatic questions greatly influenced the way in which the details of creation were interpreted. For example, definitions of the

²¹¹ Grant 1986, p. 59-86.

²¹² Büttner 1979.

²¹³ Büttner 1979, p. 163.

²¹⁴ Thauvonius-Lilius 1656, Th. 15-18. Hahn-Ulholm 1689, p. 2-5. Hahn-Weckelman 1694, p. 42-50. Hahn-Wijsing 1685, § III. Hahn-Helinus 1694, p. 10-11. Hahn-Amnelius 1688, p. 10-11. Hahn-Melliin 1687, p. 16. See also Svenonius 1664, p. 25-30.

nature of the nothingness from which the world was created were given.²¹⁵ Creation was one of the most central doctrines in Lutheranism, and its exegesis could be aided by introducing certain physical terms into the discussion. The events in the Bible were thought to be literally true and this may have given impetus to human curiosity. The beginning of the world has always fascinated man, and the exact date of the creation was subject to speculation for a long time. There was some disagreement as to which day the creation of the world actually took place, and theologians were sceptical about the possibility of determining the date.²¹⁶ However, physical facts spoke for the autumn:

Thus there is no doubt that the world was created in autumn, especially because after the establishment of the world at the very beginning, trees were created heavy and burdened with apples, which are product of autumn.²¹⁷

On the other hand one reason to explain phenomena described in the Bible was to make them sound more easily believable. The first man, Adam, had all knowledge of nature. His mastery over nature was confirmed, when he gave names to all the species of animals.²¹⁸ How this actually took place was considered problematic: how could Adam catch all the fishes, especially big marine fishes and give them names? Paradise was not situated on a shore, anyway, but in the Middle East. A "rational" and "believable" explanation was possible in physical terms:

An extremely vast river, which was divided into four branches, originated in Eden (these are Moses' words) in order to irrigate Paradise which was located in Mesopotamia. Eden was a region in Mesopotamia which was located outside Paradise. ...Now it certain-

²¹⁵ Hahn-Ulholm 1689, p. 2. "...massam chaoticam primo devolvimus, quam Deus miro modo creavit, non de sua substantia, nec alia sibi coaeterna... sed de nihilo, & quidem negativo non privativo, quia omnis privatio praesupponit subjectum..."

²¹⁶ Svenonius 1664, p. 32. Svenonius 1662, p. 303. "An creatio mundi in tempore rationibus philosophicis certo demonstrari possit? Nos N. Calv. A."

²¹⁷ Thauvionius-Lilius 1656, p. 15-18. "Dubium igitur non est, praesertim cum mundi conditi initio arbores pomis gravidae & onustae creatae sint, quales autumnus profert, ipso autumnus tempore mundum creatum esse."

²¹⁸ Alanus-Wassenius 1646, Th. II. Achrelius-Hwal 1683, p. 12-15.

ly becomes credible that [God] could convoke those immense inhabitants of seas before Adam. And who would deny that the gathering together of Whales could have happened through such a deep river.²¹⁹

It seems that Achrelius and Hwal assume that Biblical geography was the same before the Flood as it was in their times. Because of the analogies with their own era the location of Paradise could at least in principle be determined, and the name-giving act be explained by referring to existing rivers.

Elisaeus Hwal's (=Whale) thesis also contains other aspects in which the world-view of the Bible is made to sound physically more reasonable. Hwal states that no whales nor any other fish were brought into Noah's Ark during the Deluge, because no fish could have lived long on dry land, but that there was plenty of space for the fish during the Flood.²²⁰ In the same partly critical, partly explanatory manner Hwal deals with the question of whether it really was a whale which swallowed Jonah. The Biblical story is thoroughly described, but the possibility that the big fish in question was a whale is denied. Hwal does not refute the validity of the story itself, but maintains that the fish must have been of some species other than a whale.²²¹ At this time whales were usually regarded as dangerous beasts, but Hwal has physiological knowledge which makes him think otherwise:

Although *Valaena*, *Pristis* and *Physeter* are vast and immense marine animals, their throats nevertheless consist of such a narrow meatus that they could not swallow a whole man, as is also testified by many authors cited above.²²²

²¹⁹ Achrelius-Hwal 1683, p. 14-19, 22. "Ex Eden (Mosis verba sunt) egrediebatur ad irrigandum Paradisum in Mesopotamia situm vastissimus fluvius in quatuor brachia divisus. Eden namque erat regio in Mesopotamia extra Paradisum sita. ...Dum convocasse ingentes illos maris incolas ad Adamum, credibile certe foret, nec quis negaret, mediante tantae altitudinis fluvio, congregatio Cetorum quin posset fieri."

²²⁰ Achrelius-Hwal 1683, p. 43-44.

²²¹ Achrelius-Hwal 1683, p. 91-103.

²²² Achrelius-Hwal 1683, p. 92. "Quia *Valaena*, *Pristis* aut *Physeter*, utut sint *Belluae marinae vastissimae atque permagnae*, cum tamen *gulae meatus habeant angustiores*, solidum hominem transglutire non possunt, sicut id etiam perplurimi testantur scriptores prius citati."



§. XVI.

Notissima est, quæ in *Sacris nostris* (†) de Columba Noæ habetur historia. Quæ de, cum Columbæ nunciæ mentio fiat, paucis disquiremus. Noachus, cum quousque decrevisset aquæ diluvii, ex Corvo non didicisset, Columbam quoque, avem docilem, ἐκ τῶν πιστολογῶν, seu quæ libenter humi pascitur, homini amicam, procul diuque volantem, & ad nidum, unde quaque, etiam e locis remotissimis redeuntem, ter emisit. *Quæ, cum, in terra, λιμναζομένη* adhuc רגלה - לפה - מצאה מנוח לא - non invenisset requiem planta pedis sui, mox ותשב אליו אל - התברך reberfa est ad eum in arcam. At septiduo post, rursus emisit, venit ad eum sub vespertam. vel quia quies in arborum ramis non visa est satis commoda, vel inopia ciborum, vel desiderio conjugis, & pullorum, si quos habuit, vel denique, DEO sic providente, ut anxium Noachi animum suo reditu recrearet, & eum excitaret in spem proximæ liberationis וזהו הנהגתו עליה - וצוה טרף בפרה - ecce (†) *Gen. 8, v. 8, 9, 10, 11, & 12.* foli-

Sometimes the subject of a natural philosophical study could be motivated by biblical themes. Johannes Helin, who wrote this thesis under the guidance of Petrus Hahn in 1694 claims that he got the inspiration to study doves from the Bible. The Holy Book mentions the bird several times; for example it was a dove who brought Noah evidence that the Deluge had stopped. The dove was also praised for its chastity and it was said to have as many virtues as it had feathers.

The biblical story thus offered a matrix in which to discuss a certain physical characteristic of whales.

Arguments explaining certain events in the Bible were very often derived from verses of the Bible itself, which referred to the physical environment. It was noticed, however, that the Bible did not mention all possible facts concerning nature. What kind of effect did this have on the status of theories and facts about which the Bible kept silent? For example, Moses did not mention the creation of the four elements, or the three Paracelsian principles. Instead of doubting the existence of these natural things it was claimed that Moses talked in simple and general terms.²²³ Remarkably enough, the same interpretation of the Bible had been fiercely rebuffed when it was used to defend heliocentrism!

There are two dissertations which discuss the question of whether there were rainbows in the world before the Deluge.²²⁴ The problem was caused by the assumption that the rainbow was a sign of the covenant between God and men and also served as a portent. Was there need for such a sign before the Deluge? The answer could thus clarify our picture of natural conditions at the very beginning of the world. It was stated that all conditions necessary for producing a rainbow already existed in the world before Noah's Ark. If the natural causes were present, and nothing impeded it, the result would occur automatically, so that Abraham Melliin could conclude in his thesis that the *res* itself had existed before Deluge, but its *officium* did not.²²⁵

The scholastic mode of writing theses sometimes left its marks on their contents. One can only conclude that questions like "Did Adam get another rib from the God?" were primarily meant to be discussed and disputed. Similarly studies about where the dove of Noah found the twig of an olive-tree exist to indicate that the flood was receding. We are also given the physical reasons why Lot's wife was transformed into a pillar of salt rather than into some other stone. Pondering this kind of question was probably more or less just practice for developing arguments, defending and opposing them.²²⁶

²²³ Hahn-Imbergh 1704, p. 6-7.

²²⁴ Hahn-Melliin 1686, p. 37-40. Hahn-Pryss 1691, p. 19-20.

²²⁵ Hahn-Melliin 1686, p. 40.

²²⁶ Hahn-Govinius 1685, Quaest. VII. Adam got a new rib from God after the creation of Eve. The argument for this goes as follows: If Adam had an extra rib ready when he was created, he would have been monstrous, which was an impious statement. On the other hand, if one of his ribs had simply been taken away, he

The purpose and function of this kind of argument is not always easy to determine. However, in the 17th century these problems were considered as relevant as any other natural philosophical problem. The fact that this kind of question was put indicates a change in comparison with the sixteenth-century Melanchthonian tradition. The study of Creation and ancient times had been typical of the Catholic and Calvinist traditions from which Lutheran science had tried to differentiate itself in the sixteenth century.²²⁷ Now the emphasis had changed. The Bible represented for orthodox Lutherans the same reality as could be found in the authors' own environment. These studies may have been inspired by varying and unarticulated motives, and they may have been carried out only seldom in practice. Sometimes these kinds of research problems were merely a by-product of more general research schemes. The fact that they were dealt with at all tells us, however, much about the various ways in which religious thought and natural philosophy were intermingled.

I have in this chapter described the academic context in which natural philosophical learning found itself in 17th-century Turku. I have argued that the ideology behind the foundation of the Academy influenced its preferred functions and contributed to the shaping of the hierarchical order of the disciplines. The disciplinary boundaries were at the same time epistemological ones, which was also reflected in the form and methodology of natural philosophical inquiry as presented in academic dissertations. Since theology was the dominant science of the day and all other disciplines had to accommodate themselves to the framework it produced, the relationships between it and natural philosophy are also important to understand. I have pictured these relationships on three levels: between the institutions state, church and university, between the faculties of the University and finally at the level of theories. I have argued that it is necessary to see both theology and natural philosophy as historical entities to which our present standards for their proper role and boundaries cannot be applied. According to physicists, natural philosophy was the *scientia* of the causes of natural bodies. In the next chapter I shall offer a view of the natural philosophical theories embraced at the University of Turku.

would have been disfigured all the same. Thus God must have given him a new rib. See also Hahn-Helinus 1694, p. 22-24. Hahn-Hahn 1702, p. 43-44.

²²⁷ Büttner 1979.

The Body of Knowledge: Physical Theories at the University of Turku

1. THE COMPOSITION OF A SUBSTANCE

When Aristotle formed his theory of substance it was one of his primary tasks to explain the play of variety and uniformity of natural things. The theory of substance would be the apparatus with which the continuous process of change - generation, growth and decay - could be explained reasonably. The existence of individual as well as specific characteristics in natural bodies could also be analysed into form and matter, the two constituent parts of a substance.

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All theorizing in Aristotelian natural philosophy was based on the concept of substance which Aristotle formulated in his metaphysics.¹ Aristotelian philosophy itself went through several dogmatic transformations during its florescence among Arab and Western philosophers. In the Middle Ages and Renaissance the birth of various modifications was often motivated by the various preferences of different Christian sects. The ambiguities in translations and not least in Aristotle's texts themselves contributed to this variety of interpretations. Being one of the most fundamental concepts in Aristotelian philosophy, it is not surprising that by the 17th century numerous versions of the theory of substance had been developed.² Whatever interpretations of it were favoured on religious or other grounds, the choice was certainly not insignificant from the point of view of natural philosophical theory formation either.

¹ For a general account of the role of substance in Aristotelian metaphysics see Lear 1988, p. 247-293.

² E.g. Wallace 1988, p. 201-231.

The subject of study in physics was the finite substance, in particular as identified with a *corpus naturalis*, a natural thing or body. In order to be a real substance a thing was presumed to have a self-sufficient existence, or as the Aristotelian terminology put it, a substance ought to be able to *esse per se*. Every substance was, however, ultimately dependent on a benevolent act of God (creator) as the primary efficient cause of its existence.³ But how was this condition of self-sufficiency fulfilled? The ontological status of a substance gained its meaning through the distinction made between substance and accident.

In Aristotelian tradition the concept "accidence" was used in various senses. An accident could be specified generally as a predicate - either necessary or contingent - among other predicates such as *property*, *genus* or *differentia*. On the other hand an accident could refer to something which might or might not belong to an individual, e.g. paleness or being seated. For example in term *rational animal*, "rational" could be classified as a *differentia* (a characteristic peculiar to the species of man only) and thus it could not be an accident. However, it could be understood as a quality as well, and all categories other than that of substance could be collectively classified as "accidents".⁴ The latter reading was usual in physics theses at Turku, although ambiguities are not avoided altogether.⁵ In physical theses the *differentia* of a substance consisted of causes and *affections*, which were all dependent on the substance and were thus accidents. For example Thuronius in his metaphysics counts quantity, quality, relation, action, passion, duration, location, disposition of parts and state as accidents. On the other hand the metaphysical concept *affectio* referred to certain general concepts used of an entity which nevertheless were not accidents.⁶

From the physical point of view the scholars at Turku maintained that there was a real distinction (*distinctio realis*) between a substance

³ Thuronius 1664, p. 334-337, et passim. Flachsenius 1678, Collegium Logicum Prooemiale, p. 131-148, et passim.

⁴ Henry 1982, p. 128-131.

⁵ See e.g. Flachsenius 1678, Collegium Logicum Prooemiale, p. 137-138.

⁶ Thuronius 1664, p. 343-352. "Summa Accidentium genera juxta Aristotelem recensentur novem: Quantitas, Qualitas, Relatio, Actio, Passio, Quando, Ubi, Situs & Habitus." (p. 345) On affections Thuronius 1664, p. 75-87, et passim. Thuronius counts as affections perfection, unity, goodness, duration, necessity and contingency, finiteness and infinity, and causation.



This table published by Jakob Flachsenius in his *Collegium Logicum* of 1678 presents the structure of reality. In his own words this diagram shows "the series of the predicaments of substances through genera, species and differences all the way to individuals". Every finite substance in this world has a place in this scheme. For example, a sparrow is a bird (volatile), which was an irrational sensitive mixed material body. The four elements were material bodies as well, but were "absolutely simple", not mixed. The diagram is possibly based on a model by Bartholomeus Keckermann.

and its accidents. This meant that they belonged to different ontological categories.⁷ Accidents were unable to form a substance by themselves, because a substance was more than the mere sum of its constituent parts.⁸ Correspondingly no accident could exist free without belonging to a substance:

Contradictory things cannot be true simultaneously. Now to inhere in substance belongs to the definition of an accident; to be an accident and not be in a substance is a contradiction. But it pertains to the definition of a substance not to be in a substance but to exist by itself and have its Being in itself.⁹

Nevertheless, accidents were not unimportant, because only they enabled men to gain knowledge of a substance. No substance could be known by itself, but only through its accidents.

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A substance was a so-called composite whole consisting of form and matter. In physics the subject was most often approached by studying the constituent parts of a substance separately. Form and matter were also considered to be the *principles* of a substance - they were called principles because they were not derived from anything else, but rather everything else was derived from them. When it comes to the composition of a substance, it was stressed that a substance could not be formed without the presence of both principles, the form *and* the matter.¹⁰ Only occasionally could either form or matter be referred to as "substance", but then always as "incomplete substances", which would not have real existence in nature.¹¹ In other words there would be as many substances in the world in a physical sense as there were composite wholes.

⁷ Thuronius 1664, p. 260-261.

⁸ Hahn-Bolhemius 1688, p. 2-4. "Patet sic nullum accidens posse constituere substantiam ut causam per se & solitariam, adeoque Affectiones corporis, ejus causae non sunt dicendae." See also Thuronius 1664, p. 334-352.

⁹ Hahn-Herkepæus 1703, p. 1-2. "Nec enim contradictoria simul possunt esse vera. Jam ad definitionem accidentis pertinet tò in esse substantiae: esse vero accidens, & non esse in substantia, contradictionem implicat. Ad substantiae vero definitionem pertinet, non esse in substantia, sed per se existere & Essentiam suam habere in se." see also Hahn-Florinus 1693, p. 14-15. Hahn-Bolhemius 1688, p. 20-21.

¹⁰ Petraeus-Wallenius 1674, Th. VI, VIII.

¹¹ See e.g. Thuronius-Waghner 1664, Th. I.

Actuality and potentiality, and their derivatives activity and passivity were characteristics which were included essentially in form and matter. In classical Aristotelianism they were of crucial importance in explaining various processes in nature. The basic arrangement of things was still valid at Turku too, the form was the active part of the pair, whereas matter was the passive one. However, they seem not to have played as important an explanatory role in natural philosophy at Turku as they had done in some earlier versions of Aristotelianism.

Privation, for Aristotle as well as for many of his followers even in the 17th century, had been the third principle of substance besides form and matter. It played an important role in generation, because generation was considered to be "movement" or change from non-being (*privatio*) to being. To put it differently, a privation was the absence of a definite form. In 17th-century literature a difference was often made between privation as an absence of form and as pure negation.¹² Thuronius makes this same distinction in his *Metaphysics* as well. He means by negation the absolute absence of an essence (e.g. not-man), and by privation he means "negation of an Essence in a subject which is capable of it" (e.g. blindness).¹³ Thuronius also discerns various aspects of privation, and among other things he distinguishes physical from logical privation. Most physical authors at the Academy of Turku do not mention privation at all, and those few who do deny its existence. In this they are talking about the *privatio physica*, which in Thuronius' definition was the absolute absence of a generating form.¹⁴ Privation in this sense was labeled an absurdity of the "Peripatetics" or a "foetus of idle little minds" (*vanorum cerebellorum foetus*), which thus ought not to be accepted as an explanation of any kind of generation.

Privation is not a principle of generation. It would be and not be simultaneously; it would be when it would function and not be

¹² Wolter 1965, p. 136-137. Reif 1962, p. 78-84, 131-132. On the differences of privation and negation and their connection with the discussion on the existence of vacuum see Grant 1981, p. 9-14.

¹³ Thuronius 1664, p. 29-30. "*Ens negativum est, quod essentiam destruit & tollit. Estque purè negativum, quod omnimodam essentiae absentiam, vel negationem Entitatis absolutè notat, diciturque nihil negativum, ut non homo, non visus: vel privativum, quod negat Essentiam in subjecto capaci, diciturque nihil privativum, ut caecitas.*"

¹⁴ Thuronius 1664, p. 31.

because it would never exist. It is absurd to claim that in the instant of mutation *terminus à quo* would unite with *terminus ad quem*. Hence it would be and not be simultaneously. ...I ask when would privation be? Not in generation, because then there is a form. Not before generation because then there should not be any form, and thus no privation either. Before generation there is only remote potency present, but privation demands immediate potency, which is considered as act.¹⁵

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In other words Tålpo is here disputing the existence of privation in the Aristotelian sense, which he takes as the absolute negation of an entity (cf. Thuronius' definition). Privation can exist only relatively, i.e. as the absence of something which already exists and is capable of being something. The concept "privation" was actually used sometimes in physics, but then always in a relative sense.¹⁶ As nothing could actually exist without a form, the existence of privation as negation or non-being was excluded by definition. Privation was thus accidental in the same sense as form and matter were accidental, i.e. as far as they were compounds of a substance. We do not get a very clear picture of the nature of privation from physical dissertations. There seems to have been no urgent need to discuss the status of this Aristotelian principle, because generation simply was no longer regarded as a change from non-being to being.

The Form Defines the Characteristics of a Natural Body

The form was regarded as the subject matter of physical inquiry only as far as it was considered to be a constituent of a *corpus naturalis*, i.e. in its state of being connected with matter.¹⁷ To put it in the

¹⁵ Tålpo-Höök 1690, p. 10. "Privationem non esse generationis principium. Nam simul esset & non esset, esset cum operaretur, non esset cum nunquam existeret. In instanti mutationis concurrere terminum à quo, & terminum ad quem, absurdum est statuere. Sic enim idem simul erit & non erit. ...Qvaero quando datur privatio? non in generatione, quia in hac forma datur, non ante generationem, quia tunc forma adesse non debet, ergo nec privatio. Ante generationem non nisi remota adest potentia, at privatio connotat proximam, proxima potentia habetur pro actu." Cf. Sperling 1662, p. 13.

¹⁶ See chapter "On the Structure of the Cosmos", the discussion on light and darkness.

¹⁷ Flachsenius-Lund 1681, Th. IV. According to Reif 1962, p. 97 in most early 17th

Aristotelian terms of the four causes, form was defined as one of the two internal causes of a substance, matter being the other. Forms were whole and indivisible. The indivisibility was mainly due to the fact that forms lack extension and thereby quantity.¹⁸ The lack of extension guaranteed form the ability to penetrate a whole body and still be whole in every part of the body (*toto esse in quolibet parte totius*). The existence of a spirit or any other intermediate between form and body was denied; angels and demons represented the only species of "spirits". These creatures were actually pure form, but they could also be called spirits, because unlike ordinary forms they were not perishable.¹⁹

A form was, as a respondent put it, the "...disposition of a natural body, through which it is what it is."²⁰ A form was the principle which gave an entity its specific and individual characteristics, which distinguished it from other natural bodies.²¹ Two closely interrelated problems are connected to the question about the function of form. Firstly, all individual substances (i.e. composite wholes consisting of matter and form) belonged to a wider class of beings, which was called the *species*. Thomas Aquinas for example thought that although universals had no separate existence in the real world, there had to be some universal element, which places objects in their species. For Aquinas the form was the bearer of universality.²² This leads us to the second aspect in relation to the question of the function of form. If form was the carrier of specific characteristics, what then differentiated individuals *within* the species?

According to the thomist view the primary principle of individuation was so-called *materia signata quantitate*. The complicated de-

century physics textbooks far less space was taken in propounding arguments for substantial form than for matter.

¹⁸ An interesting discussion of the indivisibility of material form (= form conjoined to matter) exists in Thuronius-Pryss 1664, Th. I. Reif 1962, p. 95. On form see also Thuronius 1660, Institutiones Logicae I, p. 179 ff. Flachsenius 1678, Collegium Logicum I, p.328-347.

¹⁹ Thauvonius-Forsenius 1653, Ax. IV. Thuronius-Pryss 1664, Th. I. Petraeus-Wallenius 1674, Th. XIII.

²⁰ Petraeus-Wallenius 1674, Th. XVI. "...dispositio Rei Naturalis, per quam est id quod est."

²¹ Thauvonius-Forsenius 1650, Th. VIII. Thauvonius-Warelius 1652, Sectio I Membr. II Artic. III Ax.I. "Forma est causa interna, per quam C.N. constituitur." Petraeus-Wallenius 1674, Th. XXVI-XXXIII.

²² Copleston 1985, II, p. 326-327.

tails of Aquinas' view need not concern us here, but the important point to remember is that matter was for him the basic cause of individuation. Other medieval philosophers had different answers to the problem of individuation. St. Bonaventure for example regarded the actual union of form and matter as the primary source of individuation. Further interpretations were put forward by some of the leading scholastics of the 17th century, such as Francisco Suárez, who had a considerable influence on Protestant metaphysics. He differentiated between a material substance considered experientially, and considered in itself. Because our knowledge of the substance was based on accidental notions such as quantity, etc., matter could be considered as the principle of individuation. However, if material substance is examined in itself, its individuality must be ascribed to its form.²³ Where do the authors at Turku stand amongst these traditions?

This question is not easy to answer because the question was not put as clearly as this at Turku. Although the discussions which took place there are related to the problem of individuation, no difference was clearly made between specifying the species and individuation of the individual within a given species. It was at least partially the problem of individuation which led the scholars at Turku to accept some remarkable divisions concerning the form. I have claimed above that indivisibility was thought to be an essential property of a form. Indeed, this was held to be true when it came to the actual existence of things. Nevertheless, at the conceptual level some important distinctions were introduced.

First of all, a form could be considered either *essentialiter* or *formaliter*. Form *essentialiter* could be called a substance, although not properly speaking in the physical sense. It was conceptually different from its matter. A form considered formally was then the form in actual connection with the matter thereby constituting the species.²⁴ Obviously this distinction could also be seen as the basis of the distinction which was made between the generic and the specific part of the form.²⁵ Specific form (*forma specifica*) was the proper form of a

²³ Lewalter 1967. Copleston 1985, II, p. 272-173. Copleston 1985, III p. 360-361. Trentman 1982, p. 822-824.

²⁴ Thuronius-Waghner 1664, Th. I. "*Absoluto uno* seu Entitativo, quo omnis forma in se actu est & substantia, (licet incompleta), à materiâ in qua, tanquam domicilio, habitat diversissima. *Respectivo altero* seu formali, quem juxta non quamlibet, sed aptam informat materiam, eamque actuat ac perficit, ut cum eâ elaboratâ certam constituent speciem."

thing, giving the substance its specific characteristics and holding the substance together, so to speak.²⁶ However, because of its dominant position the specific form also accounted for the characteristics of an individual. Although the differences between individual substances, which we could discern with our senses, were produced by the generic form, it was incapable of acting without the specific form.²⁷ Specific forms were always perishable, only excepting the form of man, or the rational soul.

"Generic [form] is what more inheres in matter rather than form, and does not constitute the species."²⁸ Generic form was thus "the visible form" of things, and was responsible for producing the qualities which could be referred to the material component of the substance. However, it clearly had the ontological status of a form. If the generic form - though subservient to the specific form - thus was the principle of individuation within the species, we cannot assign the interpretation accepted at Turku to any of the traditions described above. To be fair, the question of individuation was not openly asked at Turku, but questions of the *function* of form in the composite whole and the relation between different parts of the form could not avoid dealing with similar problems.

Generic forms could further be divided into partial, subordinated and accidental forms. Subordinated forms were thought to be latent in a body, and could only exercise their proper functions if freed from the dominance of the more general form. For example, the forms of the four elements were subordinated in mixed bodies. Considered from a different point of view it could also be said that the forms of elements existed both *essentialiter* and *formaliter* in elements, but only

²⁵ Thauvonius-Forsenius 1650, Th. XIII. "Dividitur Forma Physica, in Genericam & Specificam. Fundamentum hujus divisionis est ipsa natura, quae formas non unius conditionis esse voluit, sed unam propriam, plures improprias, unam operantem adeoque imperantem, plures quiescentes adeoque obedientes mistis voluit largiri. Nam Forma potest alicubi esse Essentialiter tantum, alicubi etiam Formaliter. Essentialiter est ubicunque est formaliter v. in ea materia quam proximè informat, ita ut informando speciem constituat. Ita formae Elementorum in Elementis sunt & essentialiter & formaliter, in homine v. tantum essentialiter habentes se ad modum materiae, quia anima humana ibidem est formaliter."

²⁶ Thauvonius-Forsenius 1650, Th. XXI. Thuronius-Waghner 1664, Th. XI.

²⁷ E.g. Thuronius-Waghner 1664, Th. VII says of accidental forms that they "in mistis corporibus sine lege sine ordine stabulantur, imperioque formae specificaе subsunt."

²⁸ Thauvonius-Forsenius 1650, Th. XIV. "[Forma] Generica est quae magis materiae quam formae rationem habens, speciem non constituit."

essentialiter in the body of man, in which the rational soul was the form *formaliter*.²⁹ Accidental forms like fatness or baldness existed only temporarily. This hierarchy of forms helped to explain how an individual substance could remain a continuous unity despite transformations during a longer time span. Although Socrates grew bald and old, we would nevertheless have grounds to call him Socrates, because these transmutations were only accidental and thus did not threaten the integrity of his substance. Finally, it was the partial forms which enabled every organ of a body - e.g. heart, nerves, stomach - to function in a specialized manner.³⁰ Although the divisions displayed here were only conceptual, they nevertheless played an important role in explaining nature's processes.

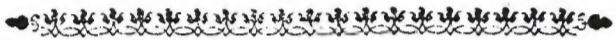
A classical question in scholastic philosophy had been how new individuals were born, i.e. where did new forms come from. The topic was subject to a wide-ranging discussion among 17th-century Aristotelians too. Interestingly enough Aristotle himself regarded the generation of form as an absurdity.³¹ For the scholars at Turku this was an important question, because it was intimately related to metaphysical and theological dogmas. Several answers to the question of the origin of form had been given in the course of the centuries. It could be stated, for example, that the souls of men were directly created by God, whereas other forms were educed when virtual forms (*rationes seminales*) residing in matter became activated. This explanation was considered good by St. Bonaventure, whereas some other medieval authors denied the existence of any "hidden" forms in matter, because forms were always actual. They regarded matter only as having a "potency and natural aptitude" (*potentia et aptitudo naturalis*) to receive certain kinds of forms. The idea of *rationes seminales* was linked especially with the Augustinian tradition, while some other scholars preferred the creation of forms.³² Theories like this were often dealt with in dissertations written at Turku, although

²⁹ Thauvonius-Forsenius 1650, Th. XIII.

³⁰ Thauvonius-Forsenius 1650, Th. XIII-XXII. Thuronius-Pryss 1664, Th. II-III. Thuronius-Waghner 1664, Th. V-XII.

³¹ Reif 1962, p. 140-141. Gill 1989, *passim*. This was because Aristotle regarded form as a principle and thus not derivable from anything else.

³² Copleston 1985, II p. 75-77, 223, 275-276, 328. Steneck 1976, p. 34-35. Wolter 1965, p. 142-144.


 DISPUTATIO PHYSIOLOGICA
 De
GENERATIONIBUS
ET CORRUPTIONIBUS COR-
PORUM NATURALIUM.

Magnifico ^{Quam} Rectore,
Admod. Reverendo & Praclarissimo Viro,
DN. M. SVENONE VIGELIO
 S.S.Theol.Prof.P.per celebri & Past.in Sagis fideliss:

Spectabiliq; Decano
Reverendo & Excellentissimo Viro,
DN. M. SIMONE KEXLERO,
 Mathematicum Profess. solertissimo.

SUB PRÆSIDIO
Reverendi Excellentiss. & Clariss. Viri,
DN. M. GEORGII C. ALANI
 Physf. & Botan. Profess. Celeberrimi,
Consentiente Ampliss. Fac. Phil. in nova Reg. Acad. Aboensf
 Pro summi Philosophici honoris puncto ferendo placidæ
 Philosophantium censuræ committit.

PETRUS S. LIDENIUS SMOLANDUS.

In Audit. Majori horis antemerid. die 12. Apr. An. 1643.

A B O G I Æ

Typis Exscribent Petrus Wald Acad. Typographus,
 ANNO 1643.

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Petrus Lidenius from Småland in Sweden contended about nothing less than the generation and corruption of natural bodies. Generation and corruption were always functions of the form. The thesis was one of the first ones published in physics - the year was 1643. Lidenius reveres the rector Vigelius, the dean Kexlerus and professor Alanus by naming them all on the title-page of the thesis. "Physiological disputation" means the same as a physical thesis.

their proponents were hardly ever named.³³ The importance of the doctrine becomes evident from the way many authors use strong language against the supporters of these other views. (They were often called such names as dreamers and hallucinators.)

But competing theories on the origin of forms were also rejected at Turku on various other grounds. It was said, for instance, that forms could not be created, because this would have presupposed a continuous act of creation by God. (But according to the Bible the work of creation had been finished on the sixth day.) The astronomical influence of the stars or the warmth of the sun would not do either, because it supposed the ultimate source of activity (the efficient cause) to be extrinsic to the form itself. A relatively tenacious emphasis was placed on the point that forms could not "be deduced from the potency of matter" (*educi è potentia materiae*). This view was generally held among Catholic scholars, and a slightly different interpretation of it was favoured by some Dutch Aristotelians.³⁴ Passivity belongs to the essence of matter, it was stressed, and consequently it could not act independently. The elicitation of forms from the potentiality of matter was also objected to because in that case an accident would bring forth a substance. This alternative was rejected as logically and metaphysically absurd.³⁵

A proper theory of the origin of forms had to cover two different aspects. First of all there was the ultimate origin of forms, explained by God's creation: He had created a form for every species at the beginning of the world. He had also given these created forms a power to multiply by generation. This explanation accounted for the "normal" propagation of forms. A new form was produced by two forms or souls *per traducem*, as two different fires brought about a new single flame by a spark from both of them. Semen would function as a

³³ An exception to this is the foreword in Alanus-Lidenius 1643, who also uses strong language. He connects "wrong" opinions with opposition to theologians or religious groups, such as the Jesuits. "Hinc prostant illa somnia de immissione formarum è coelo, quod est Fernelij de educatione formarum è potentia materiae, qui error cum Thoma Aquinate est Toleti, Picolominei, Ruvionis Rhodensis, Conimv. Complut. Pererij, Zanardi, Morisani, aliorumque praecipue Iesuitarum sociennorum. De origine formarum ex qualitatibus contemperatis quod Magirus somniat. Et quae sunt hujus furfuris alia."

³⁴ Reif 1962, p. 140-141. Lindroth 1939, p. 162-164.

³⁵ Thauvonius-Forsenius 1650, Th. XXVI. Thauvonius-Warelius 1652, Sectio I Membr. II Artic. III Ax 2. Petraeus-Wallenius 1674, Th. XIX-XX. Thuronius-Waghner 1664, Th. XIV-XVI.

vehicle for the form/soul in animated creatures, including man. The scholars at Turku did not rely solely on the Bible in this, but thought that the truth of traducianism was satisfactorily confirmed by reason and experience as well. How else could it be explained, it was said, that humans gave birth to humans, and asses to asses, but not asses to humans?³⁶

At least as important as the question of the origin of forms was the theory of their destruction, an issue far less discussed at Turku. It was stated that when the conjunction of form and matter dissolved, the form became a complete nothing.³⁷ The nature of this nothingness was not, however, philosophically more closely defined. The question "What is a form and how is a new form produced?" seems to have occupied professors' minds especially during the first decades of the existence of the University. Entire theses were dedicated to the subject at Turku, and the "correct" theory of the propagation of form was frequently referred to in dissertations on other subjects of physics too. After the 1680's the same ideas were still accepted in dissertations written by Petrus Hahn. However, the mode in which they were presented had changed. They seem not to have been matters of great urgency any more and were asserted only occasionally and then as statements of facts. This indicates, first of all, that the theory had been well established, and was by no means decreasing in importance. On the other hand the latter part of the 17th century posed different kinds of challenges to the theory of substance in the form of Cartesianism. Defending the theory of the *propagation* of forms was not so essential when the whole concept of forms was being attacked.

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Material Constituents of the World

All matter in the world was made of the four Aristotelian elements earth, water, air and fire. These elements and their forms were created by God from absolute nothingness (*ex nihilo*). The idea of *ex nihilo* creation was self-evident on a purely biblical basis, but on one oc-

³⁶ Alanus-Kempe 1646, Th. VIII. Alanus-Jurvelius 1647, Th. XII-XXV. Thauvonius-Forsenius 1650, Th. XXVII. Thauvonius-Warelius 1652, Sectio I Membrum II Artic. III Ax.1. Petraeus-Wallenius 1674, Th. XXI-XXV. Thuronius-Waghner 1664, Th. XVIII-XIX. Achrelius-Hwal 1683, p. 42, 52-53.

³⁷ Alanus-Lidenius 1643, Sectio II, Th. XXI. Thuronius-Mathesius 1665, Th. 7. According to Thuronius this can be stated on purely physical grounds, although nothing prevents God from annihilating a form if He so wishes.

casion we meet philosophical arguments which were presented in order to defend the claim that God actually *could* create matter *ex nihilo*. The judgement rested on the omnipotency of God. Precisely because the essence of God was independent and self-supporting, the mere act of His will was sufficient to bring forth an effect, unrestricted by any necessary preconditions.³⁸

The basic features of the Aristotelian theory of the elementary qualities are generally well-known, so that there is hardly any need to go over it in detail here. It is, however, advisable to represent a general survey of the subject as it was understood by the scholars at Turku. The four basic qualities hot, cold, wet and dry inhered in the four elements. In fact, it was these accidents which caused the elements to act in a manner specific to them. In addition to the classical hot-cold and wet-dry contraries several other qualities were introduced into discussion in the dissertations written at Turku.

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There could be two classes of qualities in general, manifest and occult. The former were clearly sensible qualities, which we know from our everyday lives, such as warmth, coldness, redness or softness. The latter, however, derived their name from the fact that they could not be sensed in any way. Their existence could only be inferred from certain effects and manifestations which they produced, such as the magnet's power to attract iron or a drug's power to purge ill blood. All qualities, including the occult ones, were produced by the specific form.³⁹

Christian Aristotelians had not always been ready to accept the intelligibility of the occult qualities. (Indeed, even their existence was sometimes questioned.) According to the mainstream of medieval tradition there could be no *scientific* knowledge, i.e. knowledge of the causes, of insensible and irregularly behaving things.⁴⁰ The new mechanistic philosophies of the 17th century did not reject the class of occult qualities as such, but rather attacked the boundary line separating the occult and manifest qualities. For mechanical philosophers such as Descartes and Walter Charleton all qualities became in

³⁸ Hahn-Justander 1707, p. 11-14. "Ergo etiam naturaliter notum esse debet, DEUM ad agendum per se sufficere, nec indigere ulla materia, ex qua operetur."

³⁹ Alanus-Muntehlius 1645, Th. I, XXV-XXXV seems to attribute at least some of the causes of occult qualities to subordinate forms. Th. XXXV: "...Rhabarbrum cum purgat, vis purgandi non à specifica, sed subordinata fluit forma." Achrelius-Hagert 1689, p. 2. Hahn-Æimelæus 1698.

⁴⁰ Hutchison 1982, p. 233-242.

a sense "occult", because even the apparently sensible qualities of bodies were generated by insensible mechanisms.⁴¹ The position accepted at Turku is an intermediate one between the two and relies very much on Daniel Sennert. Sennert was one of the philosophers to reshape the ideas concerning the sensibility - and thus intelligibility - of "occult qualities". According to him we should not deny the existence of what is manifest by experience, although we might not always know their causes.⁴² The causes of occult processes could thus be studied in physics as far as something could be judged by its effects.

However, qualities could be classified in innumerable other ways too; e.g. divisions into active, passive, and sometimes intentional qualities were introduced. (The nature of the intentional qualities was not specified, and they were discussed only seldom anyway. Light was usually mentioned as an intentional quality, because it could "operate at a distance".)⁴³ The partition into primary and secondary qualities followed the aforementioned division. In traditional Aristotelianism the primary qualities of the elements would consist of a combination of the contrary pairs hot-cold and dry-wet. The Aristotelian criteria for the priority of these four qualities was their activity, or ability to affect other bodies - a hot stone in a tub could make the water warm, but it could not transfer its hardness to it.⁴⁴ Hot, cold, wet and dry were also all tangible qualities.

At Turku the division into primary and secondary qualities was sometimes expressly denied. However, the criterion of primacy proposed here was different from that mentioned above. According to the view criticised primary qualities would arise from the form, whereas secondary ones would be brought about by the matter. This idea is disputed, because *all* qualities were thought to stem ultimately from the form.⁴⁵ Other, and often even more tangible qualities than the four classical ones were introduced. We learn, thus, that earth was "most coarse, most firm and heaviest, cold and dry"⁴⁶ and fire "subtlest, ligh-

⁴¹ Hutchison 1982, p. 242-253. On Descartes' views on qualities see e.g. Garber 1992, p. 292-297. Wilson 1993.

⁴² Hutchison 1982, p. 134, 242.

⁴³ Alanus-Munthelius 1645, Th. XVII-XXI.

⁴⁴ Maier 1952, p. 9-10.

⁴⁵ Petraeus-Schepherus 1668, Th. XXII. This is not to say that the division into primary and secondary qualities was not known or that it would have been repelled on every occasion, see e.g. Achrelius 1682, p. 6.

⁴⁶ Tälpo-Rhydelius 1682, Th. VI, XIV-XVIII. Hahn-Alm 1688, p. 12-16. *crassissi-*

test, hottest and driest".⁴⁷ As even the use of language implies here, the relative amounts of each quality in each element could be weighed. This was because two elements could include the same qualities, but they might be present in different degrees. These qualities were just a part of the general characteristics, so called *affectiones*, of the elements. Other affections common to the class (*genus*) of elements were e.g. number, quantity, impurity, round figure, movement and indivisibility.⁴⁸ These affections were essential to the nature of the elementary world in general.

The four elements could not, however, be responsible for all the sensible qualities found in nature. The three Paracelsian principles salt, sulphur and mercury therefore played an important role in physics. Paracelsus had himself considered these three principles the basic material elements of the world. The Wittenbergian doctor, Daniel Sennert, had criticised Paracelsus for undervaluing the elements, and he could not approve of the position reserved for them by the Paracelsian system. The Sennertian reading of the Paracelsian dogma was followed at Turku too: salt, sulphur and mercury would be composed of the elements earth, air, water and fire.⁴⁹

It was often stated that ordinary salt, sulphur and mercury should not be seen as the three principles. The spiritual power of the principles would lie in real salt, mercury and sulphur only analogically and, so to speak, make its powers visible through them.⁵⁰

And this differs from common salt especially in respect of its purity and subtility, because this [i.e. common salt] contains in addition to this bitter chemical fluid, which is nearest to the nature of salt, also sulphur or oil, and mercury, which is a certain kind of spirituous liquid.⁵¹

mum, firmissimum, & gravissimum, frigidum & siccum.

⁴⁷ Thauvonius-Warelius 1650, Th. XXVIII. subtilissimum, levissimum, calidissimum & siccissimum. See also Th. XVI, XX, XXV. Alanus-Kollanus 1642. Thauvonius-Warelius 1652, Sectio II Artic. III De Elementis in Genere & Specie.

⁴⁸ Alanus-Ketarenus 1644, Th. XVIII-XXII. Thauvonius-Warelius 1650, Th. VIII-XII. Thauvonius-Sundius 1656.

⁴⁹ Thauvonius-Bergius 1656, Th. I, 3. Hahn-Florus 1693, p. 18, 29, et passim. Lindroth 1943, p. 263-264, 267. Pagel 1958, p. 339-341. Partington 1961, p. 271-276.

⁵⁰ Achrelius 1682, p. 50. Hahn-Florus 1693, p. 10. Hahn-Weckelman 1694, p. 6-7.

⁵¹ Hahn-Hahn 1702, p. 8. "Et differt hoc à sale communi praesertim ratione puritatis

Salt was on one hand a principle of solidity, but on the other hand of solubility, and was the primary cause of all savours. Sulphur was fatty, flammable and the cause of odours and colours. Mercury was liquid, spiritual and the cause of all inconsistency in bodies. It also was partially responsible for the production of colours, savours and odours. Salt, sulphur and mercury were omnipresent in nature, but they could in particular be seen as a sort of vapour or *effluvium* evaporating from bodies.⁵²

Along with the question of the essence of matter the problem of *prima materia* arose. The nature of prime matter was widely discussed from the Middle Ages on until the seventeenth century. Because Aristotle's original meaning in this question was (and still is) under discussion, several interpretations of the dogma of prime matter were given.⁵³ Most usually the term had the meaning either of pure potentiality or unformed matter of which the four elements were made. The task which most preoccupied philosophers concerning the prime matter was to determine the nature of the matter which underly all generation. This prime matter would thus be the substrate which persisted through the transformations of the elements into each other. Unless there was something pre-existing in such things as fire, which changed into air, the air would come into being from nothing (*ex nihilo*) and the fire would be reduced to nothingness. This was regarded as an untenable conclusion, because outside God's creative act *ex nihilo nihil fit*.⁵⁴

At Turku the notion of prime matter was either accepted or rejected, depending on the meaning the term was given. The existence of prime matter could not, however, be accepted "as far as it is understood to be matter for generation, in which all generations occur and which is not generated itself."⁵⁵ The notion of prime matter which had been of

atque subtilitatis, cum hoc praeter acrem succum istum chymicum, salis naturae propinquissimum, etiam sulphur seu oleum, & mercurium seu liquorem qvendam spirituosum in se continet."

⁵² Thauvonius-Warelius 1652, Sectio II Membr. II, Artic II. Thauvonius-Bergius 1656. Hahn-Florinus 1693. Hahn-Bjurbeck 1697, p. 1, 4. Achrelus 1682, p. 30-36, 49-50, et passim.

⁵³ According to some recent studies Aristotle never committed himself on the question of the actual existence of prime matter. According to this reading of Aristotle the four elements are the simplest existing matter. Gill 1989.

⁵⁴ Reif 1962, 85-87, 90-93, 107, et passim. Weisheipl 1965, esp. p. 147-156. Wallace 1987, p. 99-100.

⁵⁵ Thauvonius-Warelius 1652, Sectio I Membr. II Artic II Ax. 1. "*qvatenus illam*

crucial importance for earlier Aristotelians was thus rejected. This was because the problem itself had become irrelevant. The transmutation of pure elements into each other was denied at Turku, so there was consequently no need to presuppose any pre-existing matter underlying them. In this context the old conception of prime matter came to be understood as a source or reservoir of potential things. This was again thought to be an absurd notion, because it was impossible for passive matter to generate things without the impact of a form: things (forms) would not arise from the potentiality of matter. The view expressed in the quotation at the beginning of this paragraph is supported by another argument, which was promoted by professor Tålpo and his student Laibec. According to them "the Aristotelians" made a mistake when they called the chaos which God first created *prima materia* because of its homogeneousness. In Tålpo's and Laibec's opinion the primordial chaos was not homogeneous, because it already contained the four elements, even though they were not yet structured into more developed species of things.⁵⁶ There was thus a fixed order underlying all reality in our material world.

The existence of prime matter could thus be accepted in another sense of the word. In his *Fasciculus Physicae* Petrus Warelius asserts that *prima materia* exists as far as the question is about the ultimate components of matter.⁵⁷ The same line of thought can be found in the metaphysical dissertation by Tålpo and Laibec, who write:

I cannot see that anything else can be understood by the first subject of a natural body, except the first or most remote material principle of natural bodies, or the matter of what natural bodies consist of and are produced from. ...if we have matter which is composed of something already existing it is necessary that there also be the matter of which it is primarily produced. Otherwise there would be regress to infinity, which nature abhors.⁵⁸

dicunt esse subjectum generationis in quo omnes generationes fiant & quod non generetur." See also Miltopaeus-Thuronius 1679, Th. XIII. Thauvonius-Sundius 1656, Th. XII.

⁵⁶ Tålpo-Laibec 1680, Th. XII-XV. See also Achrelius 1682, p. 4. Petraeus 1668, Th. XII.

⁵⁷ Thauvonius-Warelius 1652, Sectio I Membr. II Artic II Ax. 1.

⁵⁸ Tålpo-Laibec 1680, Th. XI. "Per primum enim subjectum cuiusque rei naturalis, non video aliud posse intelligi, quam primum vel remotissimum corporum naturalium principium materiale, seu materiam ex qua corpora naturalia & constant

Although the prime or first matter was not observable by the senses,⁵⁹ its existence could be proved by appealing to the philosophical principle according to which infinite regress was against the natural order of things. It can be concluded, thus, that for the authors at Turku the matter of the four elements, of which everything is made and into which everything resolves, was the prime matter proper. True enough, the elements could be divided into matter and form, but this division could be made only conceptually. Elementary matter without elementary form could not exist.⁶⁰

The notion of the four elements as the prime matter leads us quite naturally to the discussion about the theory of atoms. When talking about Aristotelian influenced "atomistic" theories we cannot avoid talking about *minima naturalia* either. This doctrine had been a classical part of the Aristotelian natural philosophy, having been presented in different forms in the course of the centuries, and its importance as an explanatory principle in physics also varied. There is no single meaning for the term *minima naturalia*. Although Albertus Magnus had in the 13th century identified them with the Democritean atoms, in their most usual meaning they were understood as the smallest possible part of a substance. Every substantial form, especially living beings, would have certain maximum and minimum limits for existence.⁶¹ Hence, the *minima* of the element earth was a particle, anything smaller than which would lose its identity as earth. The same applied of course to mixed bodies. In the 16th century the Averroist tradition of *minima* and Lucretian corpuscularism brought about a new and intense interest in corpuscular theories. In the early parts of the 17th century Daniel Sennert finally reconciled the Aristotelian *minima* theory with Democritean atomism.⁶² The theories which were held at Turku accepted two different views on the "microstructure" of matter.

The doctrine of the maximum and minimum quantity of a physical substance was not openly discussed at Turku. Other views on the finitude of the physical world were used as arguments though. The world according to the Aristotelians was finite in magnitude: "...it has

& producuntur; ...data enim materia aliunde producta, necessum est dari eam ex qua primo producitur, alias progressus fieret in infinitum, unde abhorret natura."

⁵⁹ For a discussion on the nature of prime matter and its unknowability see Wolter 1965. Reif 1962, p. 92-94.

⁶⁰ See e.g. Thauvonius-Warelius 1650, Th. XII.

⁶¹ Maier 1949, p. 179-196. Wallace 1988, p. 214-215.

⁶² Wallace 1988, p. 215. Nielsen 1988, p. 299.

already been stated that there exists in nature a body of maximal magnitude (i.e. the supercelestial waters). Therefore it is necessary, that the smallest possible particle exists as well."⁶³ One of the fundamental presuppositions in physics was that nature was not capable of infinity (*natura non est capax infiniti*). Therefore, it was certain on metaphysical grounds that atoms of some kind existed, although they would escape our sight because of their extreme smallness.⁶⁴ The problem of *minima* in the scholastic tradition was usually connected with problems of divisibility and continuum in time and place, but this was not the case at Turku. The physical world needed the smallest possible indivisible parts.

Christopher Meinel has in his article on atomism categorized three types of arguments used for the existence of atoms in early 17th century.⁶⁵ Of these arguments those based on *divisibility*, such as the one cited above, were ranked among the most effective at Turku. Secondly, traces of arguments based on *experience* and "experiments" can also be found in our dissertations. The sight of dust particles floating in a ray of light was according to Meinel a typical argument based on experience. However, it was often stated at Turku that the particles of dust were far too big to be real atoms. But there were other proofs. A tiny amount of a smelling substance could suffuse large areas. Golden rings could be worn out and wet clothes dry without our noticing any transposition of matter. Thirdly, it was said that we have learnt from chemistry that all compositions could be resolved into their constituent parts. These processes could not be explained unless atoms existed.⁶⁶ This kind of experience-based argument was common and circulated widely in 17th-century physical literature.⁶⁷

The existence of atoms (the word was regularly used in dissertations written at Turku) was thus proved. But what were these atoms like, then? There was a tendency in 17th-century Aristotelian atomism to

⁶³ Hahn-Langelius 1688, p. 3. "...dato jam corpore maximo in natura (puta aquas supra coelestes) utique corpus quoque minimum dari omnino necessum erit".

⁶⁴ Thauvonius-Warelius 1652, Sectio II Membr. II Artic. II, Ax.2. "Dantur revera atomi". Thauvonius-Eurenus 1655, Th. III. Miltopaeus-Blanck 1667, Th. III. Hahn-Langelius 1688, p. 2-3. Hahn-Herkepæus 1703, p. 2-3. Hahn-Bolhemius 1688, p. 11-13.

⁶⁵ Meinel 1988.

⁶⁶ Thauvonius-Warelius 1652, Sectio II Membr. II Artic. II, Ax.2. Miltopaeus-Blanck 1667, Th. III, et passim. Hahn-Langelius 1688, p. 3-9, 25-30.

⁶⁷ Meinel 1988.

fuse together the doctrines of atoms and elements.⁶⁸ At Turku the indivisible atoms were on one hand equated with elements.⁶⁹ The elements were, after all, the ultimate constituents of matter. On the other hand it was stressed that elements could never exist in pure form in nature, although in some discussions the elements are treated as if they did actually exist.⁷⁰ They had the potentiality to achieve an actual existence in a pure state, but in the present state of the world they were more or less just theoretical abstractions. Therefore, the smallest possible *actually* existing particle of every composite body was called an atom as well. These *atomi mixti* included the essential properties of the substances they were parts of.⁷¹ We are not told in what sense the mixed atoms were the very smallest parts of composite bodies, but it seems possible that the concept of mixed atoms got close to traditional readings of the *minima naturalia* theory. This double sense of the concept of atom thus meant that only one type of atom existed in actuality, which were at least qualitatively, possibly even quantitatively different from each other. The doctrine of the *atomi mixti* gains meaning and importance in explaining some of the more complicated processes in nature.

Atoms performed many "visible" functions in nature, but in addition the doctrine offered a physical explanation, or proof, for an important principle. "Nature abhors a vacuum" was as much a physical as it was a metaphysical statement, and no explanations of natural phenomena could be allowed to violate this principle. Conversely the same statement could be used as a proof of the existence of atoms, because the only way that nature could be saved from the vacuum was the movements of atoms.⁷² The brevity of the statements where vacuum is dealt with at Turku does not allow us to draw any far-reaching conclusions about its nature and other characteristics. In any case, the cosmological plenum was achieved by the movement of

⁶⁸ Meinel 1988, p. 73.

⁶⁹ Thauvoniuss-Warelius 1650, Th. XII. "[Elementa ...] INDIVISIBILIA vero ea propter dicuntur, quod non possint dividi in partes speciei & essentiae differentes, simplicia enim sunt, sic & homogenea..."

⁷⁰ Alanus-Kollanus 1642, Th. VIII. Alanus-Ketarenius 1644, Th. I, IX, XX. Thauvoniuss-Sundius 1656, Th. VIII, IX, XXI. Petraeus-Schepherus 1668, Th. X, XIX. Achrelius 1682, 5-6, 10-11. Hahn-Weckelman 1694, p. 2-8. Tälpo-Rhydelius 1682, Th. VI, VIII, X, et passim. Hahn-Alm 1688, p. 6, et passim.

⁷¹ Miltopaeus-Blanck 1667, Th. XV-XXII. Hahn-Langelius 1688, p. 17-25.

⁷² Cf. Nielsen 1988, p. 318-319.

atoms: "[The element of air] is invisible and can permeate all things. It joins with and separates from other bodies quickly, and it is capable of filling in every place which is not occupied with any other body, even through the smallest gap, so that there would be no vacuum in nature."⁷³ The permeability of air seems to imply that all materials were porous to some degree, and they were thus capable of condensation and rarefaction too. The dimension of a body and the place it occupied were equal, because there could be no *penetratio dimensionum* in the natural world.⁷⁴

The Problem of Mixtures

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Whereas an element was a *corpus simplex*, consisting only of form and matter, all other material things were their mixtures. Even the visible substances of earth, water, air and fire were always mixed bodies. Elements could thus never be sensed, and they only existed more or less as abstractations. How to explain the birth of a mixed body from the elements was, however, a serious problem for Aristotelian natural philosophy. If several forms could not occupy the same body, and if the substantial forms could not change without losing their identity, how was a mixture to arise? Closely related to this was the problem of how the transformations which undeniably occurred in nature were to be explained in terms of the Aristotelian philosophy. Every time food, let us say, turned into blood and muscles, it took a new form in the human body. But how and when was the old form abandoned, where did it go and how was the new form produced? These problems were often discussed by studying the paradigmatic, and at the same time the simplest possible case of mixtures - the mixing up of elements.

However, the word mixture could refer to many different kinds of things. There was not just one sort of mixture, but they could be either natural or artificial, and not all of them were linked with the same kinds of problems. Hahn and Æimelæus discern three kinds of mix-

⁷³ Alanus-Kollanus 1642, Th. XVI. "[Elementum aëris...] Quod sit invisibilis, & per cuncta rerum permeabilis. Cito enim accedit & recedit omnemque locum nullo alio corpore repletum, etiam per minimam foramen, ne detur vacuum in rerum natura, complere aptus natus est." See also Hahn-Langelius 1688, p. 20. Milto-paeus-Blanck 1667, Th. XVII. Achrelius 1682, p. 4.

⁷⁴ On conceptions of void see Grant 1981.

tures in their *De Mixtione*. First of all there was a mixture in which the surfaces of the mixed bodies remained unbroken, like grains of oats and barley in the same vessel. This type of mixture did not cause any problems, because a new kind of an entity was not born. Secondly there was the mixture in which two or several components formed a homogenous compound. A mixture of wine and water, for instance, did look continuous, but the forms of both water and wine could nevertheless be discerned - at least conceptually. The third type of mixture according to Hahn and Æimelæus was the mixture proper. It occurred "whenever a plurality of miscibles are mixed up with each other in a way that they give birth to a third substance, the nature of which differs from the natures of the components."⁷⁵ It was due to this type of mixing up that the four elements were capable of being matter for such a variety of substances from the human body to minerals and plants. Salt, sulphur and mercury were the *prima mista* of this type.

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The difficulties arose from the concept of substance itself. Qualities of a body were principally determined by the form. Even so they were only accidents, and the presence of any specific accident in a substance was not logically necessary.⁷⁶ In other words, in principle any accident either could or could not belong to a certain substance. The problem was to determine how many qualities could change without endangering the integrity of the form. What was the step beyond which we could no longer talk of the same substance as before?

There were a few basic models of explanation for how a mixture could come into being. In one early dissertation Alanus and Tobetius report some of them. According to the Averroistic interpretation of the Aristotelian theory of mixture both the forms of the mixing bodies and their accidents remained *in actu* in a mixture. The forms could, however, stretch or intensify so that they could include all the new qualities and thus form a new body. In Avicenna's version of the

⁷⁵ Hahn-Æimelæus 1698, p. 4. "quando miscibilia plura ita commiscentur, ut tertium quoddam gignant à natura componentium diversum". See also Maier 1952, p. 19. "Unter mixtio proprie dicta dagegen ist lediglich eine Mischung aus den vier Elementen zu verstehen, die so geartet ist, dass eine einheitliche homogene Substanz entsteht, und kein Gemisch aus mehreren Substanzen."

⁷⁶ In this case no difference was made between accidents which would necessarily inhere in a certain substance, and "accidental" accidents. Thuronius 1664, p. 343. "Inhaerentia est modus inexistendi in alio, accidenti proprius. Accidens est Ens substantiae inhaerens: vel Accidens est Ens extrinsece substantiam afficiens."

theory the forms remained whole, but the qualities were broken and so could communicate with each other. According to Duns Scotus all forms were destroyed, but a new form came into being, which in turn inherited qualities from the previous forms.⁷⁷ Although Alanus' and Tobetius' description of these theories contain some inaccuracies, it shows that they had some kind of idea about the traditional explanation models. These theories were carefully considered, but the arguments were weighed in the balance and found wanting. In fact, these theories were presented as characteristic examples of fallacious argument.⁷⁸

Averroes' and Avicenna's views on the *mistio* theory were rejected because the scholars at Turku could not accept any changes happening to the form, if it was to be presumed that the substance itself did not change. Therefore any transmutation of the elements - once a cornerstone of Aristotelian physics - was strictly denied as well.⁷⁹ The integrity of forms was almost a sacrosanct matter; not even any altering or "stretching" was allowed to the substantial forms, a view supported by the following philosophical argument:

Because the Elements differ from each other having opposite forms, even common sense suggests that they cannot easily transmute into one another. This is so although the Peripatetics jointly claim that the water becomes air, the air fire, and that all the elements transmute into each other - not totally, however, but at least partially, as they assume. Because this opinion causes two absurdities, it cannot be tolerated at all: it introduces vacuum into nature, and claims a place to be smaller than the thing located there. ...if all other things which are contrary to each other, also transmuted into each other in respect to their substances, the snake would transmute into man, a hawk into a dove and a wolf into a sheep.⁸⁰

⁷⁷ Alanus-Tobetius 1647, Th. XIII-XIV. The description of Duns Scotus' stand more resembles the so-called thomistic interpretation than Scotus' own account. A detailed survey of medieval solutions to the *mistio* problem can be found in Maier 1952, p. 3-140.

⁷⁸ Alanus-Tobetius 1647, Th. XIII-XIV. Hahn-Æimelæus 1698, p. 9-15.

⁷⁹ Alanus-Ketarenus 1644, Th. XXVIII. Thauvonius-Warelius 1650, Th. X. Petraeus-Schepherus 1668, Th. XX. On Aristotle's view on the transmutation of elements see Gill 1989.

⁸⁰ Thauvonius-Sundius 1656, Th. XVI. "Quemadmodum Elementa differunt oppositis formis, ita non facile inter se transmutari ipsa ratio dicitur, quamvis Peripatetici communiter ex aqua fieri aërem. ex aëre ignem, cunctaque Elementa

Rejecting the possibility of the transmutation of pure elements led to certain conclusions concerning the cosmos. It was implied that if the elements could not transmute or alter, they could not disappear either. The amount of matter in the universe was constant - it had neither increased nor decreased since the Creation. "Thus elements can neither transmute, alter nor generate, but they exist in the same quantity today as they were in the prime creation and will remain so ever after."⁸¹ The idea of ungenerability and incorruptibility of matter was itself explicitly already held by Plato and Aristotle, and the scholastic philosophers during the Middle Ages also thought that the amount of matter in the world was stable. In fact, maintaining this idea underly many of the difficulties in theories on generation and corruption.⁸² The particular justification of the doctrine at Turku was, as we have seen, different from previous views.

If the transmutation and alteration of elements were excluded as alternatives, how could the origin of a mixture be explained, then? According to the originally Sennertian definition, cited from J. Sperling, "Mixture is a union of miscibles, divided into their minimal parts, made by a specific form."⁸³ This implied that only the smallest possible corpuscles could be united in a new way to form a mixture, because "elements cannot unite in major particles because their qualities are mutually contrary."⁸⁴ The fight between the contraries was weak enough only in atoms (i.e. in single elementary or mixed particles) to allow the forms of the *miscibilia* to unite under a new form of a higher rank. "Lower" forms did not disappear, but were transformed into subordinated ones. It was the uniting form that had the activity to bring forth a mixture.⁸⁵ It still remains unexplained, however,

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inter se transmutari, non totaliter quidem sed partialiter autument. Quae opinio cum duo infert absurda, vacuum in naturam introducitur & locum locato minorem arguit, minimè toleranda est. ...si enim omnia contraria substantialiter in se invicem transmutari debent, etiam serpens mutabitur in hominem, accipiter in columbam & lupus in ovem."

⁸¹ Miltopaeus-Thuronius 1679, Th. XVII. "Elementa igitur non transmutari nec alterari aut generari possunt, sed in tantâ mole in prima creatione facta sunt quanta protempore dantur & posthac manebunt." See also Thauvonius-Sundius 1656, Th. XVI.

⁸² Weisheipl 1965, p. 147-148.

⁸³ Hahn-Æimelæus 1698, p. 4. "*Mixtio est miscibilium, in minima divisorum unio, à forma specifica facta*". See also Alanus-Tobetus 1647, Th. IX.

⁸⁴ Hahn-Æimelæus 1698, p. 15. "elementa ratione qualitatum sibi contraria, in majoribus particulis uniri non possint".

⁸⁵ Hahn-Æimelæus 1698, p. 18. Alanus-Tobetus 1647, Th. XXII-XXVII, XXXII-XXXIII.

how this "uniting form" originated.

Nature consisted materially of the four elements. The diversity which was characteristic of it was produced by an endless chain of mixtures. The less mixed matter was, the more imperfect it was. The ladder of nature led substances gradually (*natura non facit saltum*) from less perfect mixtures to the most perfect one - the matter of the human body.⁸⁶

2. THE STRUCTURE OF THE COSMOS

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Unravelling the structure and origins of the universe seems always to have fascinated man. The 17th century especially was a time of rival world-systems. Cosmological themes were not unusual in physical dissertations written at the University of Turku either. Cosmological and astronomical themes were naturally discussed in mathematics as well. Although the physicists and mathematicians looked at the subject from different points of view, and posed different kinds of questions in their studies, they both shared similar views on fundamental issues such as the structure of the universe. In the following I shall pay attention to the difference between mathematics and physics only on those occasions when it has some particular significance for the theories supported.

The Age and General Structure of the Universe

In accordance with the Christian doctrine it was, of course, self-evident that the world had a beginning and an end.⁸⁷ The certainty of these facts was derived from the Bible. It has been stated in some studies in history of science that there was a generally pessimistic feeling in 17th-century scholastic natural philosophy. According to this view the world was ageing and would soon come to an end. The

⁸⁶ Hahn-Æimelæus 1698, p. 17. Alanus-Tobetius 1647, Th. XXXVI.

⁸⁷ Thauvonius-Lilius 1656, Th. 15-18, 20. Flachsenius-Lund 1679, Positio II. Kexlerus-Herlicus 1643, Th. XXXIII. Thuronius-Norman 1661, Th. XXXVIII-XLIII. Gezelius 1672, p. 243.

new natural science would then have been the one to bring new optimistic attitudes into human life.⁸⁸

It seems that the matter cannot be generalized that simply though, at least as it concerns the academics at Turku. True enough, serious concern was felt because of the hardness of the times and - as it seemed - the increasingly deteriorating morals of mankind. The annihilation of the world would, however, happen suddenly and supernaturally.

Indeed, as truly as this world's machinery did not come into being by physical generation, as little will it cease from being by physical corruption so that its internal and natural principles would be covered by another natural form. But it will be resolved beyond nature's laws by God when it pleases his wisdom to do so.⁸⁹

Because of the supernatural character of the destruction, there was no reason to interpret phenomena like floods or crop failures as indicating degeneration or aging of the Earth. Only after the Fall of Adam had there been a sudden falling-off in the living conditions provided by nature for man, but this, of course, also had a supernatural cause. In every other respect the Earth and the species inhabiting it remained in the state they had been at the time of the creation.⁹⁰ Thus there was no quest for the kind of optimism aroused by the new science, which was to improve the conditions of life in this world. No scientific or other human efforts in this world could dispel the fear (or hope) of doomsday.

The world had a temporal existence, but what exactly was time thought to be? Only a few authors were interested enough in the nature of time to write about it. Time was said to be a "real essence" which existed independently, without being thought of by man. So-called particular time was an affection of every natural body, and it determined the temporal limits of its earthly existence. Universal time was however some sort of meta-time, common to the entire world. It was

⁸⁸ Frängsmyr 1981, p. 20. See also Erikson 1969b, p. 139ff.

⁸⁹ Thuronius-Norman 1661, Th. XLI. "Verum ut nulla generatione Physica coepit haec mundi machina: Ita nec corruptione physica ex interno & naturali principio superinducta nimirum alia forma naturali, esse desinet: Sed à Deo cum ipsius sapientiae visum fuerit, supra extraque naturae leges solvantur."

⁹⁰ Flachsenius-Forsman 1678, Th.V. "Naturam senio deficere atque langvescere absonum est." Frängsmyr 1981, p. 22, 33-34, also refers to similar views held e.g. by Hakewill.

this universal time which could be measured by clocks or by the movements of planets. In fact, the movements of planets actually produced universal time. From the meagre discussion we can see that the conceptions of time at Turku followed standard Aristotelian ideas, according to which time and change were closely bound to each other. Everything in the real physical world happened in successive duration - only spiritual beings were capable of instantaneous actions. The only exception to this was generation, which was regarded as an instantaneous act.⁹¹

The question of the plurality of worlds was a theme which had been speculated upon since the Middle Ages, and in the 17th century the discussion intensified. This happened not least because of the spreading acceptance of Copernicanism, which produced a physical framework within which the existence of other earth-like worlds became possible.⁹² However, at Turku the question did not attract much attention. The unity of the world was simply stated as a matter of fact, relying on the old notion of the perfection of the cosmos. "Universe" was by definition something which included everything, the cosmos was thus perfect and complete and nothing was left to make another world of.

Most evident reasons persuade us that there is only one world. If yet another world existed, it would contain bodies either the same as this world, or diverse from them. If diverse, universe would not be universe, because it would not include everything in itself. ...Therefore, we firmly draw the conclusion that there is only one world which contains everything.⁹³

This one integer world was divided in a traditional way into two essentially different regions: the sublunar elementary world and the

⁹¹ Alanus-Neostadius 1646. Tålpo-Rodde 1682, Questions: "An tempus sit duratio successiva? Aff. Dist." and "Differtne duratio ab essentia Realiter? Neg.", Tålpo-Höök 1690. On Scholastic understanding of time see e.g. Davies 1993, p. 105-109. Knuuttila 1981. Maier 1955, p. 47-64. Normore 1982, p. 367.

⁹² Dick 1980, 1982.

⁹³ Thauvonius-Lilius 1656, Th. 25. "Unum tantum esse mundum rationes evidentissimae nobis persvadent. Etenim si adhuc aliud esset mundus, ille corpora contineret, aut eadem cum his, aut ab his diversa: Si diversa, universum non erit universum, quia non complectetur omnia. ...ergo unum tantum esse mundum, qui omnia comprehendit, firmiter concludimus." See also Thuronius-Norman 1661, Art. IV Q. 3.

supralunar heavens devoid of any processes of generation and corruption.⁹⁴ In Aristotelian philosophy the matter of the heavens has usually been called the fifth element or the ether. According to the favoured interpretation of this phrase at Turku the heaven could indeed be said to consist of some kind of a fifth essence, if understood as an essence different from the elements and thus not subject to mutation.⁹⁵

Some other authors at Turku claimed that we would always remain ignorant of the nature of the matter of which the heavens was made (excluding the matter of the stars and planets, which was known). It was certain, in any case, that the heavens *were* material. This was because it possessed both figure and magnitude - affections which were characteristic of matter.⁹⁶ On some occasions we are told that heaven is made of liquid matter, in which the planets swim like fish in water. Yet for Lutheran scholars such as Melanchthon and the astronomer Reinhold, in whose opinion it would have been impossible to explain the regular movements of the planets unless they were carried along certain spheres this view was unacceptable. The liquid theory adopted at Turku is then derived from later authors, mainly from Tycho Brahe.⁹⁷ Physicists and mathematicians at Turku shared the same view concerning planetary spheres. The non-existence of any solid spheres was presupposed - they were thought to be mathematical constructions devoid of any physical reality, built only for helping the human imagination.⁹⁸

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There are no traces of this official view changing during the period concerned in this study. There was, however, one proponent of a radically different conception. The professor of eloquence, Daniel Achrelius, argued in his *Contemplationes mundi* for the idea that celestial matter did not differ from the sublunar. If, Achrelius claimed, the

⁹⁴ Alanus-Ketarenus 1644, Th. I. Kexlerus-Herlicus 1643, Th. IV, XIV. Gezelius 1672, p. 251.

⁹⁵ Alanus-Terserus 1648, Th. 16. Kexlerus-Krook 1664, Th. XI. On medieval understanding of the *quinta essentia* see e.g. Grant 1978, p. 286-289.

⁹⁶ Alanus-Terserus 1648, Th. 15. Hahn-Granbeck 1685, Th. VIII.

⁹⁷ Achrelius 1682, p. 61-62. Gezelius 1672, p. 244-245. Gezelius stresses that the matter of the heavens is liquid, tenuous and pure, has light and the power to penetrate other bodies. Aiton 1981, p. 98-102. Donahue 1975, p. 256, et passim.

⁹⁸ Kexlerus-Naezenius 1663, Th. VII. Achrelius 1682, p. 61-62. Flachsenius-Bergius 1682, Th. I. Flachsenius-Tälpo 1675, Th. V. Tammelin-Gjöslung 1704, p. 2-3. Tammelin-Odelin 1712, p. 1, 5, et passim. On the question of the solidity of spheres in 16th and 17th-century astronomy see Aiton 1981. Donahue 1975. Jardine 1982.

world was created from a chaos of the four elements, both the Earth and the heavens would be made of the same matter. The influence of stars and planets on the Earth was essential in Achrelius' magnetical natural philosophy. According to him the heavenly bodies would not be able to produce the effects they indubitably did on the Earth unless they consisted of an essentially similar kind of matter.⁹⁹

Achrelius also noticed that celestial bodies were proved to be subject to change and therefore had to consist of the four elements.¹⁰⁰ The immutability of the heavens had been a traditional argument proving the greater nobility of the heavens in comparison with the Earth. Achrelius, however, questions the whole idea of simplicity as a criterion for a greater nobility. For him, perfection was variation and multitude:

The absolute perfection of the world consists of the variety and plurality of things, and I doubt strongly whether simplicity adds any pre-eminence and some kind of dignity to the Celestial bodies. Certainly nobody doubts that the machinery of the human body is composed of the four elements, and yet it would be absurd to deny that it is the most perfect among the created substances.¹⁰¹

Achrelius' view was not without European predecessors. There was in fact no universal agreement during the 17th century about the idea that the heaven and the earth should be so radically separated. The distinction had begun to weaken in the latter part of the 16th century, when J.C. Scaliger for example rejected the dichotomy between these two areas in his *Exercitationum exotericarum*. This work was well-known at Turku too. On the other hand the Reformation tended to place new authority in physical matters also on the Bible which could be interpreted to mean that the heavens and the earth were similar in matter but different in form only.¹⁰² Even older roots for the idea can

⁹⁹ Achrelius 1682, p. 13, 11. "Si corpora Coelestia à sublunaribus differrent, illa haud dubiè, in inferiora Elementa, à quibus in totum discrepant, agere non possent." On Achrelius' natural philosophy see Kallinen 1991a.

¹⁰⁰ Achrelius 1682, p. 13-14.

¹⁰¹ Achrelius 1682, p. 14. "Atque in hac varietate & pluralitate rerum mundi consistit absoluta perfectio. At vero an simplicitas illa Dignitatem aliquam ac præeminentiam corporibus Coelestibus addat vehementer dubito. Certè corporis humani fabricam ex 4. Elementis compositam nemo dubitat, & tamen velle negare quin non inter omnes creatas substantias præstantissima sit, absurdum foret."

¹⁰² Donahue 1975, p. 246-248.

be found. William Ockham had already proposed that there was no reason to postulate two different matters because phenomena could also be explained by reference to one kind of matter only.¹⁰³ However, only the adoption of new physical concepts in the 17th century could make a wider range of scholars take this suggestion seriously. One of the most prominent proponents of the homogeneity of the world was Descartes, who also rejected the four elements. Compared with Descartes, Achrelius' view, (derived from the writings of a jesuit scholar Athanasius Kircher), was still very traditional. Nevertheless it was radical enough to arouse a heated discussion in the Senate, and the imprimatur for further parts of the book was almost cancelled.¹⁰⁴

In traditional Aristotelian natural philosophy the four elements were thought to inhabit certain concentric spheres. The Earth was placed in the middle, followed by water and air, while the highest place below the moon was reserved for the sphere of fire. This view was generally maintained in most dissertations, nobody suspecting that the element/globe of earth would not lie immobile in the centre of the world.¹⁰⁵ In some aspects, however, the traditional view had started to collapse at Turku.

Because no element could exist in nature in a pure state, it was also unreasonable to expect any strictly defineable spheres of the elements to exist. The visible earth, water, air and fire were not elements proper. Neither did the qualities gravity and levity, which were traditionally seen as the causes of elementary movements downwards and upwards, have any absolute value but a relative one only. Even the light air, it was stated, could be found in underground caves and conversely, particles of earth (dust) could levitate in the air. The existence of a separate sphere for fire below the moon was especially criticised in the latter part of the 17th century, this being for a very anthropocentric reason.

Although it is true that the fire ascends, nevertheless it is not in accordance with truth that it would strive for a predetermined place

¹⁰³ Wolter 1965, p. 144-146.

¹⁰⁴ Consistorium Academicum 5.12.1678, CAAP IV, p. 476-477. See also chapter "The 1680's: Sharpening Critics and the First Proponents".

¹⁰⁵ Alanus-Kollanus 1642, Th. V, XIII, XVII. Alanus-Ketarenius 1644, Th. XXIII-XXIV. Thauvonius-Warelius 1650, Th. I, IV, XIV, XX, XXV. Thauvonius-Sundius 1656, Th. IV, X. Gezelius 1672, p. 151-152. Hahn-Alm 1688, p. 14.

under the sphere of moon ...because there it is of no use to man. ...but we conclude it to be justified to judge that it occupies its place under and above the earth.¹⁰⁶

The treatment of earth and water as a single body was begun in the fourteenth century by Albert of Saxony and Pierre d'Ailly. However, it was not until the early sixteenth century that this aggregate was conceived as a single sphere. In this respect Copernicus was one of the pioneers. By the 17th century the concept "terraquaeus sphere" finally found its way even into the more traditional scholastic textbooks.¹⁰⁷ This development also finds expression at Turku, where *terraquaeus globus* is probably the most common nomination for the earth.

On Stars and Planets

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The structure of the elementary spheres was thus no longer the traditional one we meet in most standard descriptions of a Medieval and Renaissance Aristotelian universe. Let us now turn our attention to the statements concerning the structure of the supralunar heavens.

The universe was assumed to hang in a complete nothingness. Farthest up, there were the *aquae supracoelestae*. It was an invisible body, but its existence could be assured by appealing to the Bible, where it says that "And God made the firmament in the midst of the waters, and divided the waters which were under the firmament from the waters which were above the firmament: and it was so."¹⁰⁸ *Aquae supracoelestae* were made of simple, non-elementary matter, because otherwise they would have resided in a place unnatural to a heavy body like ordinary water. Although these things could not be observed by the senses nor understood by the reason, the word of the Bible was enough to make the nature and existence of *aquae supracoelestae*

¹⁰⁶ Thauvonius-Warelius 1650, Th. XXXI. "Quamvis hoc sit verum quod ignis ascendat; tamen locum determinatum sub concavo lunae appetere veritati non est constaneum; ...Quia nulli usui ibi homini est. ...sed infra & supra terram, sedem suam occupare concludere fas esse judicamus." See also Thuronium-Miltopaeus 1679, Th. IX. Hahn-Ståålhöös 1694. Hahn-Flodin 1707, p. 9.

¹⁰⁷ Grant 1984, p. 22-23, 27-29.

¹⁰⁸ The Bible (Genesis 1:6-7.) as quoted by Thuronium-Pryss 1664, Th. IV. "Et fecit Deus expansum in medio aquarum, divisitque aquas quae erant sub expanso, ab aquis quae erant super expanso & fuit ita." See also Thauvonius-Warelius 1652, Sectio II, Artic. II. Hahn-Govinius 1685, Quæst. IV. Hahn-Polviander 1711. Miltopaeus-Lithomannus 1668, Th. IV. Tammelin-Tammelin 1711, p. 4-5.

a subject of physical inquiry.¹⁰⁹ Whereas the authors at Turku seem to be very sure about the proper composition of the "waters" above the firmament, Thomas Aquinas for instance took a more agnostic stance. According to him there were several opinions about the matter, which were all compatible with the scriptural text, and he saw neither need nor any way to choose between them.¹¹⁰

Unlike in the most common versions of Aristotelian cosmology and astronomy,¹¹¹ no *primum movens* was supposed to exist above the *aquae supracoelestae*. The existence of the prime mover was very seldom discussed in physics, and the same applies to other principles of kinematics and dynamics as well. Since natural movement of the simple bodies would always be caused by an internal principle of motion, the form, no extraneous mover was needed for simple bodies such as stars and planets - nor could an extraneous agent of motion have caused a continuous natural motion, only a violent temporary one.¹¹² This view is in clear contrast with the views of the Calvinists, who regarded all natural bodies as inherently passive and dependent on an impetus from God for all their actions.¹¹³ But, as has been stated in chapter "Theology as Theories in Natural Philosophy", for Lutherans explanation by physical causes did not exclude an ultimate reference to God's power. However, this was not a matter for the physicists to discuss.

The sphere of the fixed stars was located immediately below the *aquae supracoelestae*. They were called "fixed" because they always kept the same distance in relation to each other and to the Earth. A more dynamic picture of the subject was offered by Achrelius, who stated that not all fixed stars were situated at the same distance from the Earth. The deepness of the skies would hide innumerable stars, which no man could ever see and count. Gezelius also mentions this possibility in passing.¹¹⁴ Planets, on the other hand, were often also

¹⁰⁹ Hahn-Govinius 1685, Quæst. V. Tälpo-Bachster 1686, p. 14, 21-22, et passim.

¹¹⁰ Grant 1986, p. 64.

¹¹¹ See e.g. Grant 1978, p. 280-284.

¹¹² Kexlerus-Laurbecchius 1661, Cap. III.6. (G2). "...neque enim astra, aut primo Mobili, aut vehiculo materiae caelestis raptantur, ut qui motus eorum necessariò tum foret violentus; sed vi insitâ, ab internòque principio, ipsa sese in alia aliâque loca promovent."

¹¹³ Deason 1986.

¹¹⁴ Alanus-Lacmannus 1648, Th. XXVIII. Gezelius 1672, p. 347. Achrelius 1682, p. 128-129.

called stars or "erratic stars" (*stellae erraticae*) because of the apparent irregularity of their movements in relation to the Earth. Planets could also be differentiated from the stars because of the latter's scintillation.¹¹⁵ The existence of "new stars" was discussed very seldom. Gezelius however regards them as real stars, because they could not be discerned to have any parallax and thus they had to be located in the same place as the ordinary stars. He concedes that they might be stars previously not seen, but finds it much more probable that they are temporary signs lit up by God.¹¹⁶

It was frequently stated that the most important final cause of the heavenly bodies was to generate time by distinguishing one moment from another by their movements. The actual measurement of the movements was a task left to the mathematicians, and they did, indeed, focus more on the movements of the stars and planets. Mathematicians and physicians generally shared the same basic assumptions about the structure of the universe. Another theme which was very popular among mathematicians in addition to the descriptions of planetary movements, was the causes and mechanics of solar and lunar eclipses.¹¹⁷ It strikes a modern reader that for mathematical dissertations these theses contain very little calculation and other mathematical reasoning, excluding some geometrical proofs. At Turku even these proofs seem to be relatively clumsy for 17th century-mathematics.

In physics, standard problems concerning stars and planets were quite different. Following the typical method of inquiry, the central themes which were dealt with were the form, matter, final causes, number, movements, quantity and other qualities of the celestial bodies.¹¹⁸ An example of this kind of scrutiny is that of Alanus, who

¹¹⁵ Alanus-Lacmannus 1648, Th. XXXII. Gezelius 1672, p. 324-343. Hahn-Erling 1702. Hahn-Wijsing 1685.

¹¹⁶ Gezelius 1672, p. 349-351. "Stellae igitur fuerunt, forte ob distantiam antea invisibiles, propius divina providentia accedentes aliquandiu conspiciendas se praebeant & denuo ad pristinas sedes abierunt."

¹¹⁷ Flachsenius-Petreibus 1672. Flachsenius-Woivalenius 1684, Quæst. IV. Flachsenius-Bergius 1682, Th. II-IV. Flachsenius-Tålpo 1675, Th. VI-XVII. Flachsenius-Forsman 1678. Tammelin-Frostman 1700. Tammelin-Nidelström 1706. On the measurement of time Kexlerus 1661. Kexlerus 1664. On eclipses also Tålpo-Laurbecchius 1698.

¹¹⁸ Alanus-Moderus 1645. Alanus-Lacmannus 1648. Thauvonius-Holstius 1656. Thauvonius-Thuronius 1651. Gezelius 1672, p. 343-344. Hahn-Amnelius 1688. On constellations and astrology see Achrelus 1682, p. 128. Hahn-Bruzeliu 1712. On the galaxy Hahn-Ljungdahl 1706.

describes the three furthest planets as follows:

XXXIV *Saturnus* emits leaden light, it is cold and dry, inimical to the life of animals, twenty two times bigger than the Earth.

XXV *Jupiter* is a very bright Planet, moderately warm and moist, friend of life, exceeds the magnitude of the Earth fourteen times.

XXVI *Mars* is a Planet which has a shade of red like a flame, it is warm and dry, thirteen times smaller than the bulk of Earth...¹¹⁹

In 17th-century Turku, dissertations on this kind of subjects formed the major part of the astronomical discussion in physics, and only a part of the existing literature concentrated on discussing Copernicanism. I would like to claim that from the 17th-century point of view proving the centrality and immobility of the Earth was just one theme among others, albeit an important one.

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Kexlerus' "*Astronomia*"

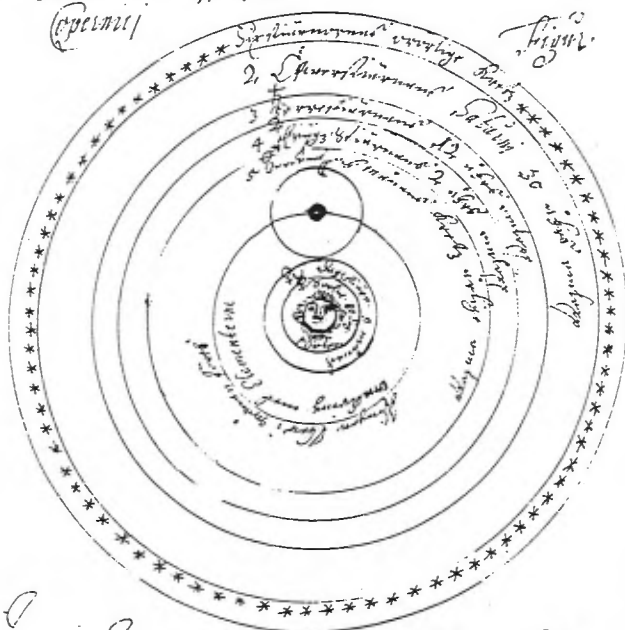
The most notable manuscript which has been preserved to us from the 17th century is a textbook of astronomy. This approximately 70 page treatise has become famous for two reasons. First of all it was written in Swedish. Although Sigfridus Aronus Forsius had written his (also unpublished) *Physica* in Swedish, it was still unusual to use the vernacular in an academic treatise. Latin was still the dominant language of learning in Europe, although such big names in 17th century natural philosophy as Bacon and Descartes had also written in the vernacular. This work has been accorded even more fame by historians of science because it is the earliest work in the whole of Sweden which states that the Earth revolves around its axis. Although the exceptional and even "advanced" character of this work has been acknowledged, the references to its contents are very short and partially misleading.¹²⁰ For these reasons it is helpful to have a closer look at this textbook. This discussion is not intended to be exhaustive, how-

¹¹⁹ Alanus-Lacmannus 1648. "XXXIV *Saturnus* Est planeta plumbæ lucis, frigidus & siccus, vitæ animalium contrarius, terræ vicies bis major. XXV *Jupiter* est Planeta maximè lucidus, temperatè calidus & humidus, vitæ amicus, terram magnitudine decies quater excedens. XXVI *Mars* est Planeta flammæ in modum rubens, calidus & siccus, terræ mole decies ter minor..."

¹²⁰ Sandblad 1944, p. 182-183. Salminen 1983, p. 60-61.

vordere in der Welt ist die Erde die erste die
 die Welt umgibt und die Welt ist die zweite die
 die Welt umgibt und die Welt ist die dritte die
 die Welt umgibt und die Welt ist die vierte die
 die Welt umgibt und die Welt ist die fünfte die
 die Welt umgibt und die Welt ist die sechste die
 die Welt umgibt und die Welt ist die siebte die
 die Welt umgibt und die Welt ist die achte die
 die Welt umgibt und die Welt ist die neunte die
 die Welt umgibt und die Welt ist die zehnte die

(Kopie)



Von der Erde ist die Welt die erste die
 die Welt umgibt und die Welt ist die zweite die
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 die Welt umgibt und die Welt ist die fünfte die
 die Welt umgibt und die Welt ist die sechste die
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The real author of the manuscript *Astronomia* undoubtedly was Simon Kexlerus, although he did not necessarily complete this exemplar which has been preserved to our time. The text is a fair copy having almost no corrections at all. This is how Kexlerus presented the Copernican planetary system. Outermost is the "unmoving sphere of fixed stars". He calls Jupiter "the lord's planet" (*herrestierna*) and Mars "the planet of the war" (*krigzstierna*). Although the Earth is located above Venus and Mercury, Kexlerus still expects the elementary sphere to reach up to the Moon.

ever. I shall restrict myself to an overall description of the contents of this work, with emphasis on the arguments for the revolution of the Earth. Closer scrutiny of its sources and the technical details of astronomy will be left for later studies. Because access to this manuscript is much more limited than to the printed and for the most part microfilmed dissertations, I shall quote it more extensively than usual.

This manuscript has previously been attributed to the professor of physics and botany, Andreas Thuronius. Indeed, the title-page of the work declares Thuronius to be the author. However, judging by the handwriting the title has probably been added to the manuscript afterwards, and thus cannot be relied on entirely. Contrary to the previous view Jaakko Lounela has produced convincing evidence in his fairly recent article that this work was written by the professor of mathematics, Simon Kexlerus.¹²¹

Lounela's most compelling argument are those based on information gleaned from the correspondence of Chancellor Brahe. It seems that Chancellor Brahe thought it important that someone at the Academy of Turku write a textbook on astronomy. He had charged Kexlerus with writing the book, and during the 1660's Kexlerus reported to Brahe that he was busy with the project.¹²² In his letter of 1663 Kexlerus complains about the many other responsibilities which retarded his progress in the work and he asks Brahe to liberate him from his office in the cathedral chapter. Moreover, he finds it hard to find equivalent Swedish expressions for astronomical terminology.¹²³ There are also other facts which strongly speak for Kexlerus' authorship. First of all the contents of the book is typical of mathematical astronomy; it would be strange if a professor of physics had written in quite that style, because the professors of physics did not generally

¹²¹ Lounela 1987.

¹²² Lounela 1987, p. 54, 57

¹²³ Kexlerus to Brahe 5.2.1663, PBB II:2, p. 8-10. "Wijidare hwadh belangar thet werck, som iagh lofwadt H.G. Excell. och nåde att förfärdiga, nemligen göra Astronomiam på Swenska språket, så haf[we]r iagh full thet under händer, men thet lijder intet mycket för migh. Ty först wardt iagh förhindrat genom rättgångs processer, både uthi den Kongl. rätten och uthi Consistorio Acad. man finner och beswärligen sdana Svenske ord som til samma konst tiena, och eliest hafwer iagh i medler tidh mäst warit opasslig, ...nu wille iagh medh all flijt samma werck fulborda, men iagh blifwer icke ringa förhindrat uthaff Consistorio Eccles. som titt och offta hålles: therföre är min tjenstlige och ödmiuke böön och begäran, ...at iagh kunne blifwa libererat ifrån samma consistorij arbete..."

"lower" themselves by writing astronomical works. (Not that most of them would have had the competence to so.) When Thuronius writes about astronomical matters, he does so consistently from the point of view of physical astronomy.¹²⁴ Secondly, the manuscript "*Astronomia*" shows such expertise in astronomy as we could expect Kexlerus to have. Kexlerus had studied in Leiden during the 1630's and was therefore well-informed on the latest developments.¹²⁵ In addition to this several other aspects, like the style of handwriting, settle the case of authorship in favour of Kexlerus.

Kexlerus' work was never published, not even finished. The manuscript ends at the title of the XIII chapter, and whatever might have been written after that has not been preserved.¹²⁶ The dating of this work remains somewhat open. We know that Kexlerus had been working on it around 1663, but possibly some parts of it had already been written during the 1650's; Brahe had given the task to Kexlerus sometime between 1648-1651.¹²⁷ The style of handwriting varies somewhat, which might indicate that the work had been written over a longer period, or that various clerks had been copying it. This would match with the fact that the manuscript is a fairly finished text which contains only few corrections. Therefore it hardly is an early draft of the work. The original manuscript lacks page numbering, although a later hand has numbered the openings. I prefer a more accurate page numbering than that, and for the sake of clarity I shall in the following refer to the pages as if they had been numbered normally from one onwards.

Kexlerus opens the discussion with the notion that all "*stiärnekonsten*" or "science of the stars" should be preceded by geometry. He therefore gives a short overview of the basic concepts of geometry, explaining what a straight or curved line, or a rectangle should be like. Having got to the structure of a sphere he feels ready to go on to astronomy itself.¹²⁸ According to Kexlerus astronomical knowledge is based on arithmetical and geometrical operations which deal with the observations made of the movements of heavenly bodies. Wise

¹²⁴ See e.g. Thuronius-Alanus 1664.

¹²⁵ Lounela 1987, p. 60. Kexlerus referred approvingly to Kepler's and Galilei's mathematics. Lehti 1983, 1984.

¹²⁶ Kexlerus A301, p. 68. "Thet XIII Cap. Om Wänttergatan och huru man alla stiärnesoopar him[m]elens lättelig kan igenfinna".

¹²⁷ Lounela 1987, p. 54.

¹²⁸ Kexlerus A301, p. 1-7.

men use "instruments and tools" to aid observation. These computations give rise to hypotheses which display and show the different orbits of stars and planets. This leads us to the final cause of astronomy, which is to measure time and to foretell future events on the Earth. Kexlerus discerns thus two parts in astronomy: the computation of movements and astrology. Both are based on knowledge of natural events, but the former is sufficient (*subjectum adequatum*) for proper astronomical knowledge. Because computational astronomy is thus "an adequate subject matter" of astronomy, Kexlerus prefers to concentrate his work on it. Kexlerus seems to grant some legitimacy to astrology, although he is not prepared to go into it himself. The status of astrology was by no means unambiguous, for both the church and the humanist tradition had for centuries criticised astrological practice.¹²⁹

The movements of all heavenly bodies can according to Kexlerus be divided into daily movements which are said to be common to all "stars". The other type of movement is the *motus proprius* of stars, which is peculiar to each of them. In a typical 17th-century manner Kexlerus calls both planets and fixed stars "stars". He first declares his doctrines on the "erratic stars" or planets, and goes on to describe the "erraticness" of their movements.¹³⁰ Kexlerus then tackles the problem of the reality of the heavenly spheres. This topic had been discussed in Uppsala while Kexlerus was studying there.¹³¹ Kexlerus' opinion does not differ from these in its main points: the heaven does not consist of hard concentric spheres "like an onion" (*lijska som uthi en löök then ene krettzen omfattas then andra*), the heavenly circles

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¹²⁹ Kexlerus A301, p. 7-8. "Thet aldräförste skiäl, Prima principia, på hwilcke dhenne himmelske wetskapen i sanning sig grundtager, aff Räkne- och måterikonsten, Arithmet[hik] och Geometria, hwar till lyda dhe synnerlige händelsers observationer och achttagningar förmede[...] begwämlige och aff wijse man dertill upfinder instrumenter och Redskap. Effter desse utdrager nog wisse och nödwändig wilckor Hypotheses, genom hwilcka stjärnornes lopps åtskilligheet i mörghfallige krettsar och ringar klarligen framställe och gryndelig bewijsas, så att dhe som denne konsten hafe giordt sig kunnig, kunna icke allenast sielfe förståå stjärnornas rörelser och lägenhet utan ock dher om andra nöijackteligen underwijsa. Fördhenskuld är stjärnekonsten Endeorsak, causa Finalis, och hwarför man dhen lära skall; Nembl. att weta till alle framfarne och närwarende, som tillkomande tijder stjärnornes rätta rum och gestalt i Himelen upleeta och betycka. Ther effter man sedan kan åtskillia tijderna och tillkommande händelser på Iordens afshsee och förespåå." (p. 8) On criticism of astrology see e.g. Barker 1993, p. 5. Garin 1983.

¹³⁰ Kexlerus A301, p. 8-11.

¹³¹ Sandblad 1644, p. 165-166.

being just abstractions. Kexlerus describes some of the opinions about the number and order of these spheres which the ancient authors had put. At the same time it was of course a question of the order of planets. None of the opinions of the "old authors" pleases Kexlerus.¹³² Therefore he turns to the more modern authors, Tycho Brahe's and Nicolaus Copernicus' planetary systems being discussed in considerable detail.¹³³

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Kexlerus finds it very positive in both Copernicus and Brahe that they do not expect the planetary spheres to be hard and material bodies.¹³⁴ He explains carefully the three motions which Copernicus had attributed to the Earth. This was certainly not the first time that Kexlerus wrote about Copernicanism in detail. His thesis *De Sole* which had been published at the University of Uppsala in 1632 under Martinus Gestrinius' supervision was the first work in Sweden in which the Copernican system was thoroughly discussed.¹³⁵ In the manuscript, both systems were illustrated with appropriate drawings. According to Kexlerus the old authors had erred in so many issues that both Copernicus' and Brahe's opinions were progress in comparison with them.¹³⁶ However, since Kexlerus cannot accept either of these systems outright, he develops a compromise view. We shall come back to Kexlerus' arguments somewhat later.

Having finished his profound discussion on the proper world-system Kexlerus goes into more practical matters, such as the astronomical principles of cartography. Thus in the fifth chapter of his book he explains what kind of circles there are in celestial and ordinary maps, and what they mean from the astronomical point of view. Concepts such as the poles, equator, ascension and declination circles and the order of signs on the zodiac are explained. We know that the Academy of Turku had access to some astronomical maps and "instruments"

¹³² Kexlerus A301, p. 12-16.

¹³³ Kexlerus A301, p. 17-20.

¹³⁴ Kexlerus A301, p. 17. "The 2 förnemblice och uthi stjärnekonsten widt förfarne män, Nicolaus Copernicg och S[ah]l[i]ge Tycho Brahe gjøre bägge ett taal på kretzar i him[m]elen, men uthi theras ordning kom[m]a the inte öfreens. Och behålla desse kretzar ichke som dhe wore hårde och stadige kroppar i himmelen, som skulle stiernornes kringföra, effter then gambles meening; men allenast till att betäckna stjärnornes ordning i him[m]elen, och genom sådana welckor theste bättre uppleeta theres lopp och rörelsser." On Copernicus' views on the reality of orbs see Jardine 1982. See also Aiton 1981. Donahue 1975.

¹³⁵ Sandblad 1944, p. 161-162. Nordenmark 1959, p. 34.

¹³⁶ Kexlerus A301, p. 20.

and Kexlerus also explains their use.¹³⁷

The rest of the book concentrates on the fixed stars. First of all he discusses their number, magnitude and height. The uncertainty of our knowledge is obvious, because various authors have come to different conclusions concerning the number of the fixed stars. Kexlerus remarks that the different results can partly be explained by the fact that the observations had been made on geographically different places on the Earth. However, the final number of stars was known only to God.¹³⁸ Probably for this reason Kexlerus has no established opinion about which of the numbers is right. He divides fixed stars into six classes according to their magnitude, which is measured in relation to the magnitude of the Earth. For example the biggest stars (*stellae prima magnitudinis*) are therefore in the relation 6852:64 to the Earth.¹³⁹ The rest of the manuscript consists of lists of variously classified star constellations and their descriptions. Kexlerus seems reluctant to take definite stands on matters such as magnitudes, numbers and distances, but he likes to confront Tycho Brahe's opinions with those of Landsbergius. He also occasionally refers to other, mainly modern authorities.¹⁴⁰

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But let us now get back to the claims which Kexlerus makes concerning the proper world-system. After having introduced and described the two modern planetary systems Kexlerus proceeds to give his judgement about them in the fourth chapter called "On the first movement in general, which happens from East to West".¹⁴¹ First of all he states that Tycho Brahe's system has been accepted by most scholars. It is in its favour that it agrees both with daily experience and

¹³⁷ Kexlerus A301, p. 30-49. The catalogue of the University Library mentions the following "**Instrumenta Mathematica**": several exemplars of *Globus Terrestris* and *Globus Coelestis*, *Sphoera Ptolomaica*, *Sphoera Copernicaea*, *Sphoera itidem Copernicaea, quā triplex terrae motus demonstratur*, *Globus Terrestris* and *Globus Coelestis in minori formā*, *Sphoera Armillaris*. See Wallerius 1682.

¹³⁸ Kexlerus A301, p. 49-50.

¹³⁹ Kexlerus A301, p. 50-54 (about the biggest stars p. 50-51).

¹⁴⁰ Kexlerus A301, p. 54-68 on p. 62 for instance he reports that Galileo has found several new stars in Taurus. "Galilaeus, en förfaren konstnär, bekänner sigh medh sine instrumenter hafwa i then [?] hoopen, forutan the 6 allomkunnige öfwer 40 stjärnor sedt och observeradt."

¹⁴¹ Kexlerus A301, p. 21 "Thet 4de Capitel. Om then första Rörelssen i gemen som ähr ifrån Öster till Väster. ...Så weele wij the 2 nye meningar med theres skiäl, Nembl[igen] S[ah]l[ige] Tycho Brahes och Copernicij kortteligen öfläggia och iämpnföra med hwar annan, på thet then gunstige läsaren må kunna see, hwilckendera sanninge[n] lijckare ähr, och ther wad han sig hålla skall."

the word of God.¹⁴² In Copernicus' system there are more things to be refuted. Kexlerus regards the claims that the Sun is the centre of the world and that the Earth would accomplish a yearly journey as absurd, because they would demand the world to be almost infinitely large and they are against the Holy Scripture.¹⁴³ The daily motion of the Earth instead seems far more acceptable to him.

What Copernicus understands by the daily movement, with which the Earth rotates around its axis every day from west to east, is not so despicable if one understands it so that the Earth is not therefore less in the centre of the world like its centerpoint.¹⁴⁴

Thus, Kexlerus concludes that the third opinion (i.e. in addition to Brahe's and Copernicus') is the best one, for nature as well. One should say in accordance with Brahe that the Earth is the "most central element" and the centre of the world. On the other hand, we could accept the daily rotation of the Earth and still retain its central position.¹⁴⁵ Kexlerus goes on explaining in detail, how the rising and setting of the Sun can be understood if the rotation of the Earth is accepted. Kexlerus' main physical argument for this semi-Tychonic (K. does not himself use this term) system is the argument from the ease

¹⁴² Kexlerus A301, p. 22. "[?]elängande Sl. Tycho Brahes meening, så ähr then hoos mesteparten dhe lärde i Academier antagen, alldenstund then kom[m]er öfreens icke alleenast med dagelig förfarenheet, utan och med Gudz ord."

¹⁴³ Kexlerus A301, p. 22-23. "Men hwad Copernici mening wedkom[m]er så bör ther uti utan att twifel ogillas och förkastas thet hen gör solen medlest i werlden, som ther skulle ståå stilla och orörlig och Iorden i then stoore åhrlige omlopps-kretzen under förmörckelse linien förrätta thet åhrlige loppet ifrå wäster till öster. Ty om det wora sandt, så wore thenne wärldenes stoorlek och widd nästan oändelig, och wij fördes tillijka med Iorden i him[m]elen, ther dock then H. Skriffthetta nedriga ifrå thet öfan till ähr och him[m]elen klarligen åtskillier."

¹⁴⁴ Kexlerus A301, p. 23. "Thet Copernico förehåller om then dagelige rörelssen, ther med Iorden wijd sin axel ifrå wäster till öster i hwart och ett dygn wändes omkring, om en wille thet förståå sålunda, att iorden icke bliff theste mindre stadigt och obeweekeligen mitt i wärlden såsom en medelprick, wore thet icke platt föracktandes."

¹⁴⁵ Kexlerus A301, p. 23. "Then altså af desse mootsträfige meeningar en 3de med natursens altsomstörste fördeel och behändig utdragas och om man säger 1. Med Tycho Brahe, att Iorden ...ähr det medleste Element och kropp, och lijka som en medelprick i heele wärlden... 2. Med Copernico, att Iorden på sam[m]a sitt aff gudi förordnat ställe, wijd sin stadige axel och orörlige medelpunct wardar ifrå wäster till öster dagelig på 24 tjemars förlopp omvänd och omwältrad hwaremot heele him[m]elen tyckes gåå ifrå öster till wäster, och the dagelige loppet fullborda..." See also p. 25.

or simplicity: "As nature in all its works always chooses the easiest and most convenient way, so it is true that she does not underrate such a thing in grounding the system of the world either."¹⁴⁶ This system would be especially convenient for the sphere of the fixed stars, because the speed of its rotation could be diminished considerably.¹⁴⁷ According to Kexlerus the whole cosmos was in a homogenous motion from West to East, both the stars and the Earth as well. The movement of the tides and seas, the speed of wind on high mountains and many other things were evidence of the Earth's rotation.¹⁴⁸ But how could all this be reconciled with the word of the Bible?

The solution which Kexlerus offers for this problem appears more than questionable, considering the emphasis which orthodox Lutheranism placed on the literal reading of the Bible.

A1. When the Bible talks of the immobility of the Earth, it is understood that the Earth does not altogether change places but stays where God has placed it. B2. Whatever the Bible says about the movement of the Sun and the stars does not refer to the first, but to the second movement from West to East. C3. The Bible talks about the Sun and the Moon standing still in accordance with people's opinion. Thus it means nothing else but that the daily movement of the Earth was prevented. D4. The claim that the shadow of the Sun retarded 20 steps could happen if the Earth turned its course backwards.¹⁴⁹

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The third argument especially, which claimed that the Bible would speak in accordance with people's understanding, was often fiercely refuted in debates about Copernicanism. This so called *topos* of ac-

¹⁴⁶ Kexlerus A301, p. 25. "Såsom naturen uthi alla som wärck alltijd utwällier the som behändigast och lättast ähr, så ähr sanningen likt, att hoon och i wärldens lopps förrättande sådant icke underlåter."

¹⁴⁷ Kexlerus A301, p. 26-27.

¹⁴⁸ Kexlerus A301, p. 27.

¹⁴⁹ Kexlerus A301, p. 27-28. "A1. När skriffen talar om iordens orörligheet, förståår hen ther medh, att iordhen heel och hållen icke wardar förd ifrå det ena stället till den andra utan stadigt blifwer ther gud henne satt har. B2. Thet skriffen seger om solenes och stiärmornes lopp förståås icke om then förste, utan om then andre rörelse[n] ifrån wäster till öster. C3. Om solenes och månens stillastående i himelen talar skriffen effter meniskiors meeningh, och förståår ther medh intet annat ähn then dagelige rörelsens förhindrande, then wij meena i solen förrätta. D.4. Att solens skugga gick 20 streck tillbaka, thet kunde wäl skee igenom iordens tillbakawändningh."

commodation had been presented in some form or other by several early 17th-century authors, although its most famous proponent was of course Galileo.¹⁵⁰ Kexlerus does not however refer to any author in expressing this view. The same argument was put by Kexlerus in print, in his *Cosmographiae Compendiosa* published in 1666. In this work Kexlerus also refutes the possibility of the annual motion for the Earth, but he seems to be more optimistic about matching the scriptural evidence with the idea of daily motion. However, in this publication Kexlerus does not actually commit himself to the daily rotation of the Earth.¹⁵¹ The central location of the Earth is more important for Kexlerus than its immobility. He can accept the daily movement but not the annual movement, because it would endanger the central position.

In the manuscript Kexlerus refutes two physical objections made by Tycho Brahe to the daily rotation of the Earth, in addition to the theological arguments. Both of Tycho's arguments turn on the point that no direct movements, either horizontal or vertical, would be possible if the Earth was in motion. Kexlerus develops a detailed geometrical proof to show that a stone dropped from a tower falls at its foot. His main argument is, however, based on the metaphysical assumption that because everything in the cosmos is revolving from West to East, even the direct movements are carried along; thus we cannot tell the difference.¹⁵²

There hardly is anything new and spectacular in Kexlerus' views if one looks at the matter from an all-European viewpoint. However, from the viewpoint of Turku, and Sweden in general, Kexlerus' ideas remain a unique peculiarity at this time. Moreover, it is evident that these views had no wider effect on the public discussions which took place at Turku on astronomy and on cosmology.

¹⁵⁰ Johannes Kepler, Paolo Foscarini, Tommaso Campanella, Giordano Bruno and Galileo Galilei all advocated some form of the topos of accommodation. Moss 1993, p. 129-211.

¹⁵¹ Kexlerus 1666, Liber I, Cap. I, IV. "Immobilitas globi terreni in medio mundi, qua nullo modo terra ad praeditas laterales partes moveri, aut unquam centri locum mutare queat. Job. 26:7. psal.24:2. psal. 104:4. quod non prohibet terram ab occasu ad ortum in eodem Axe revolvi singulis diebus una pene revolutione Philosophica haec sunt, quae sine salutis aeternae jactura possunt & recipi & rejici ad lubitum. Certum est quoq;, Spiritum S. extra fidei articulos sese accom[m]odare ad captum nostru[m], ut à nobis possit intelligi." See also Lehti 1984, p. 224.

¹⁵² Kexlerus A301, p. 28-30.

Ptolemy, Copernicus and Brahe

Whereas dissertations representing the general structure and "affections" of the universe/heaven were published regularly in physics, dissertations concentrating on the question of the competing world-systems are relatively rare, and appear mostly in mathematics. The pros and cons of the different world systems were discussed more profoundly by Simon Kexlerus/Petrus Laurbecchius in 1661, Johannes Gezelius in 1672, Johannes Flachsenius in 1679, Daniel Achrelius in 1682, and by Magnus Steen in two theses in 1694 and 1697. All of these authors were professors of mathematics, except Gezelius, who was Bishop and Vice-Chancellor and Achrelius, who had chair in Latin literature. (Laurbecchius became an assistant professor of mathematics in 1666.¹⁵³) We shall examine more closely only those occasions when more grave opinions *pro* or *contra* were expressed. At the same time we will see, whether any change in the astronomical thought of the period really happened.

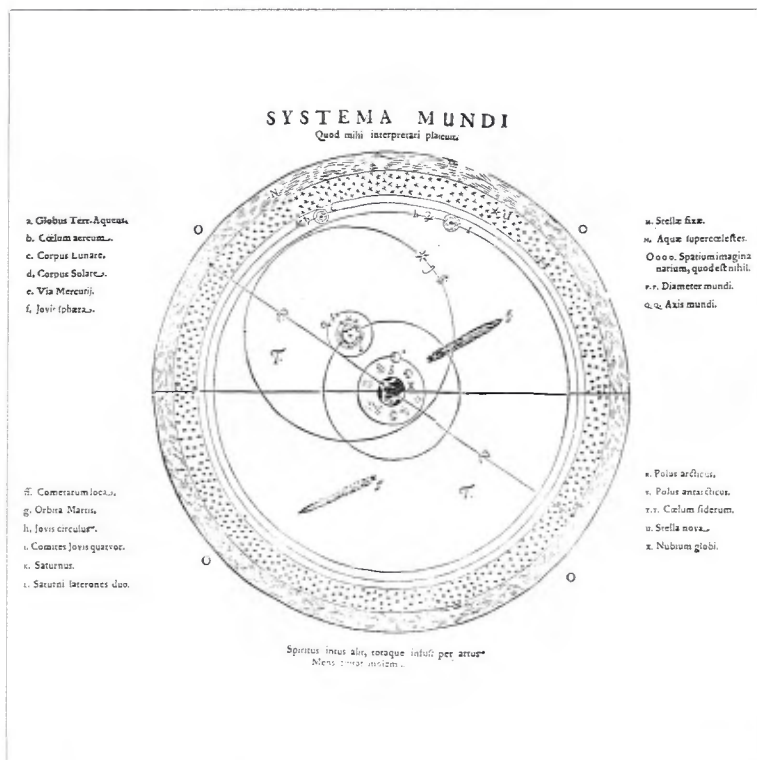
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It could be claimed that the reason why there was so little discussion about the real world-system might at least partially be discursive tactics; nobody wanted to endanger breaking the highly respected academic peace by making a fuss about a physically and theologically delicate matter, or perhaps keeping a low profile in matters of heliocentrism was a calculated strategy to decrease the risk of students gaining enough knowledge of the new system to believe in it. This interpretation does not, however, seem very plausible because the subject was nevertheless regularly, if not always extensively discussed. Moreover, the 1626 statutes of the University of Uppsala had already decreed that Copernican theory should be lectured upon.¹⁵⁴ Thus in my opinion it is more probable that the scholars at Turku did usually not feel an overwhelmingly strong need to defend the geocentric system, because nearly everybody believed in it. It was probably known that in European universities the "Copernican pestilence" was spreading alarmingly, but in the relatively secluded life of Turku, Copernicanism aroused no more opposition than some other "absurdities" approved by adversary philosophers.

In the competition between geocentric world-systems (those of Ptolemy, Brahe and Riccioli) and heliocentric ones (those of Copernicus,

¹⁵³ Slotte 1898, p. 18.

¹⁵⁴ Annerstedt 1877, p. 277.



Achrelus provides a lively picture of the cosmos in his *Contemplationes mundi* (1682). Achrelus favours the Jesuit Riccioli's planetary system in which the Moon, the Sun, Jupiter and Saturn orbit the Earth, whereas Mercury, Venus and Mars make their orbit around the Sun. In addition to the speedy comets, Achrelus also represented the four moons of Jupiter and two "lanterns" of Saturn. Harmony of the cosmos was an important theme for Achrelus and he describes how the planetary system moderates the various influences of planets. The sentence at the bottom of the page was usual in mystical literature of the age. It means that "The spirit, spread throughout the limbs (parts), enlivens from inside. The mind agitates the body."

Galileo, Kepler and Newton), three main issues were at stake. First of all, there were the notions of a) an essential difference between celestial and mundane matter, and the consequences of this division for the physics of moving bodies; b) the incorruptibility and immutability of the heavens and; c) the immobility and central position of the Earth. We shall see how these questions were approached at Turku.

One of the fundamental constituents of the Aristotelian world-view was the idea of the immutability of the heavens. This notion was closely but not necessarily related to the idea of the incorruptibility of the heavens. We have seen that at Turku all except Achrelius and possibly Magnus Steen conceived the heavenly matter to be something different from the elements and devoid of all generation and corruption. (Steen does not actually specify his view on this, for he only speaks of the heavenly matter as "ether".¹⁵⁵) Bearing in mind Achrelius' idea of the homogeneity of the universe, it is no wonder to see him generally describing the roughness of the moon, the sunspots, comets and new stars. Achrelius gets enthusiastic about the irregularities on the surface of the moon, seeing seas, mountains, valleys and forests there. Perhaps there were even living beings there!¹⁵⁶ But how did the more traditional Aristotelians explain the observed mutations in the celestial region, then?

Most authors refrained from more extensive comments about comets and new stars. The idea of the simplicity of heavenly matter could be saved only by appealing to the supernatural character of these phenomena. "New stars are a certain kind of supernatural phenomenon and signs produced by God in the celestial region. They presage destruction of the world and other imminent deplorable events."¹⁵⁷ If the cause of new stars and comets was supernatural, there was no reason to deny their existence on the supralunar area, as some Aristotelian scholars still claimed at the beginning of the 17th century.

¹⁵⁵ Steen-Petrejus 1697, p. 10, 20.

¹⁵⁶ Achrelius 1682, p. 61 "Enimvero apparuisse saepius in firmamento novas stellas, astronomorum observationes docent.", 100-101, 118, et passim. In 1656 Thauvonius mentions the *maculae lunae*, saying that they are caused by variation of density on the moon's surface. Thauvonius-Holstius 1656, Qvaest. 13. On theories on comets see Yeomans 1991.

¹⁵⁷ Alanus-Moderus 1645, Th. XXXII. "Stellae novae sunt quaedam supra naturae ordinem ab ipso Deo in coelesti regione producta *phainomena* & ostenta, mundi ruinam aliosque tristes eventus minantia & portentia." See also Alanus-Lacmannus 1648, Th. XLV. Hahn-Ekedahl 1695, p. 24-26.

The same views about the supernatural origin of comets is revealed in the notes which Andreas Thuronius made about his comet observations in 1664. Thuronius had observed a comet appearing in Taurus during Christmas 1664 and early January 1665. Thuronius' manuscript describes the location of the comet in the sphere of the fixed stars. Most of the manuscript, however, concentrates on interpreting the meanings of this omen.¹⁵⁸ Although Thuronius' manuscript reflects the views commonly held at Turku, his observations had no effect on the treatment of the subject in academic dissertations. Generally it was thought that even though comets were produced by God, their movements, colours and place in the heavens could be physically scrutinized.¹⁵⁹ On the whole, the way the observations of new stars and comets was merged into the traditional framework of knowledge is a very good example of the flexibility of Aristotelian natural philosophy.

When talking about the immobility of the Earth a distinction was made between its supposed yearly movement around the Sun, and the daily revolution around its own centre - just as Kexlerus had done in his manuscript. However, both of these movements were rejected on very similar criteria. The immobility of the Earth was by no means just an astronomical question, but the matter could very well be dealt with in connection with the element earth too, with regard to the proper place (*locus*) of the element. Achrelius and Kexlerus, on the other hand, discussed the subject as a part of the so-called general geography, which studied the affections of the Earth: its figure, magnitude, place and movement - or in this case immobility.¹⁶⁰ Achrelius on the other hand based his discussion very much on the model of Varenius' famous *Geographia Generalis*.¹⁶¹

One of the most effective arguments ever for the immobility and centrality of the Earth was based on Aristotelian physics and was found among the essential qualities of the element earth. Because of its gravity, it tended towards the lowest possible place, i.e. the midpoint of the cosmos. Only there could the element/globe of earth be

¹⁵⁸ Thuronius 1665, HYK Ms/Mf 550.

¹⁵⁹ Hahn-Gråå 1691, p. 10-20. Hahn-Ekedahl 1695. Scholars in Turku were precise about God not *creating* comets, since He had stopped creating on the sixth day. Instead of creating, God only produced comets from already existing matter.

¹⁶⁰ See e.g. Kexlerus 1666, *Geographiae Liber Primus* Cap. I. Gezelius 1672, p. 255-256.

¹⁶¹ On Achrelius' connection with Varenius see Kallinen 1991a, p. 20, 47-48, 80-81.

in a natural state of rest; no violent motion could move the Earth continuously. This could be achieved only by a natural tendency to spherical motion.¹⁶² Everyday experience and the astronomical knowledge of the reader were sometimes called as witnesses for the case. Who had felt the Earth move? Would not dropped stones fly along with the movement of the Earth rather than fall straight to ground, if our globe revolved? Would not in that case stars and planets seem now to be closer and bigger, now smaller and farther away?¹⁶³ Most convincing of all arguments was, however, the authority of the Bible, which was interpreted as disproving Copernicanism.

The arguments proposed for the immobility of the Earth at Turku were by no means new or original - they were well-known in other Swedish Universities and in Central Europe as well.¹⁶⁴ Since discussions of Copernicanism at Turku have also been studied several times,¹⁶⁵ it is hardly necessary to go through it again in detail, but something might still be said of the most eminent theses in the field.

As Edward Grant has stated in his article, physical, astronomical and theological arguments were generally introduced in discussions of the centrality and immobility of the Earth. Of these three types, astronomical arguments were least often used.¹⁶⁶ This scheme is by and large true for the cosmological discussions at the University of Turku too. The usual types of argument against Copernicanism were theological, astronomical, natural philosophical (the gravity of the Earth), as well as those based on observation. Petrus Laurbecchius, a professor of poetry and theology to be, neglected none of these in the expansive dissertation which he published under the mathematics professor Simon Kexlerus in 1661.¹⁶⁷ In addition to themes like squaring a circle and measuring the dimensions of the Earth, this thesis surveyed Copernicanism at a length and profundity not seen before at Turku. Laurbecchius was moreover the first scholar at Turku to men-

¹⁶² Hahn-Alm 1688, p. 14 "Terra etiam gravissima est, ...posita est in loco infimo, ut illà non detur magis profundus locus.", 18-21. Hahn-Weckelman 1694, p. 9, 17. Hahn-Flodin 1707, p. 5-10, 13-21. Tålpo-Rhydelius 1682, Th. XVI, XX-XXI.

¹⁶³ Ibid., Kexlerus-Laurbecchius 1661, Cap. III. Achrelius 1682, p. 199.

¹⁶⁴ On Copernicanism in Sweden see Sandblad 1944-45. On the immobility and centrality arguments see Grant 1984.

¹⁶⁵ Slotte 1898, p. 5-34, et passim. Sandblad 1944, p. 181-186, Sandblad 1945, p. 117-123. Lehti 1979. Leikola 1987, p. 565-574. Markkanen 1970.

¹⁶⁶ Grant 1984.

¹⁶⁷ This thesis is very advanced both mathematically and astronomically and it is reasonable to presuppose that Kexlerus played a major role in writing it.

tion the failure to discern stellar parallax as a weak point in Copernican astronomy. In his thorough refutation of Copernicanism Laurbecchius even harnesses the ancient wisdom concealed in Hebrew on the side of the geocentrists' by appealing to etymology. But his main argument is based on epistemological grounds, which is not a very common procedure in our dissertations.

Laurbecchius' argument runs as follows: Cartesians assert heliocentrism by virtue of the geometrical method, which according to them is the most trustworthy method of all. There is, however, a difference between a *methodus inveniendi rei* and *methodus docendi*. According to Laurbecchius, the Cartesians have mixed up these two methods and thus claim that their geometrical method is suitable for *inveniendi*. However, geometrical principles can never be applied to physics (and from false principles a proper conclusion cannot be reached, says Laurbecchius). Only in teaching and demonstrating physical facts might geometry be of some help. Therefore, it was false to claim the validity of a mathematical hypothesis in physical reality.¹⁶⁸ It was not unusual to associate Copernicanism with Cartesianism.¹⁶⁹ Was there a rising danger for either of them, then? It seems that no greater campaign against Copernicanism was launched at that time, and no concern about the matter was expressed in the Senate of the Academy either.¹⁷⁰ The motifs arising from Cartesianism will be examined more closely in the next chapter. Here it suffices to say that in 1661 there hardly was any pressing reason to attack Cartesianism at Turku.

Eleven years after Laurbecchius' thesis Gezelius took up the question in his *Encyclopaedia Synoptica*. He describes the order of planets in the systems - or hypotheses as he calls them - of Ptolemy, Copernicus, "the Egyptians", Tycho Brahe and Riccioli. It is peculiar to Gezelius' work that he takes no stance among the systems, although it is clear from other places that he favours a geocentric system.¹⁷¹ A more thorough presentation of the subject was achieved by Achrelius and Flachsenius at the turn of the 1680's. Achrelius, faithful to his

¹⁶⁸ Kexlerus-Laurbecchius 1661, Cap. I, III.

¹⁶⁹ See also Hahn-Tålpo 1699, *passim*. Tammelin-Nidelström 1707, p. 13-18. For instance, in Tübingen the theologian J.A. Osiander added Copernicanism to the list of lines of the Cartesians. Lindborg 1965, p. 71-73.

¹⁷⁰ CAAP II.

¹⁷¹ Gezelius 1672, p. 324-328.

peculiar style preferred Riccioli's system to that of Brahe. It was the Brahean system which usually was favoured by those authors who ever named any system preferable.¹⁷² It was more usual to refute Copernicanism outright than to present a positive description of the "right" and preferred geocentric mechanism of the world. Flachsenius' thesis starts with discussion of the metaphysical foundations of astronomical knowledge presenting the three cosmologies with plenty of illustrations.¹⁷³ This anti-Copernican peak undoubtedly spread the knowledge of Copernicanism among students, although it certainly did not encourage adopting these views.

Magnus Steen was appointed professor of mathematics in 1692, when Flachsenius had moved upwards in the academic hierarchy to a professorship of theology. Steen was the first scholar at Turku who could be called a Copernican.¹⁷⁴ His attitude towards Copernicanism was so positive that one is tempted to believe that he really supported the system. Not even Steen, however, was ready to claim physical reality for Copernicanism openly. In fact he seemed more pleased to leave the decision to each reader's own judgement. We have his word for the fact that this reservation was made for theological reasons: "...the Ptolemaic system seems to agree more with the Holy Scriptures, the Copernican with nature and its phenomena..."¹⁷⁵ Steen presents detailed descriptions of the Ptolemaic, Tychonic, Copernican and semi-Tychonic systems in two theses. (The latter were systems in which only the daily rotation of the Earth was accepted, but not the annual movement.) Most of his arguments include nothing new. He bases his pro-Copernican tendencies on the idea of harmony in nature, and on the simplicity of the Copernican system.¹⁷⁶

¹⁷² Achrelus 1682, p. 14-15, 192-201. In Brahe's system only the Moon and the Sun orbited the Earth, and the other planets revolved around the Sun. Riccioli, however, had only Mercury, Venus and Mars orbiting the Sun, which orbited the Earth together with Jupiter and Saturn.

¹⁷³ Flachsenius-Grimsteen 1679.

¹⁷⁴ On Steen see Slotte 1898, p. 28-31. Sandblad 1945, p. 118-120. Leikola 1987, p. 569.

¹⁷⁵ Steen-Petrejus 1697, p. 17. "...Ptolemaica scilicet Scripturae Sacrae: Copernicana naturae & phaenomenis magis (ceu videtur) consentanea..." See also p. 21 and Steen-Heinricius 1694, Membr. III.

¹⁷⁶ Steen-Heinricius 1694, Steen-Petrejus 1697. A good description of these theses, especially of the former, can be found in Slotte 1898, p. 28-31. However, Slotte pays no attention to Cartesianism in Steen-Petrejus' thesis. Copernicus preferred his own system because of its simplicity compared with the Ptolemaic system. See Hatfield 1990, p. 106-108. Harmony and simplicity were essential features

Despite the fact that both geocentrics and heliocentrics agreed that the Copernican system was simpler than those of Ptolemy and Brahe, this did not settle the question. For Copernicans, simplicity was a convincing argument pro. Their adversaries, however, refused to see simplicity as a necessary feature of physical reality.

It cannot be denied that the calculation of all phenomena would become easier for the understanding if the Earth moved on the Ecliptic. ...However, it has been demonstrated above that the author of this world did not create all things so that they would be easier for our understanding.¹⁷⁷

164 An interesting feature in Steen's heliocentric tendencies is that for the first time in the history of learning at the Academy of Turku Copernicanism was dressed in a Cartesian mantle in a positive sense. At the University of Uppsala it had for a long time been normal to link Cartesian and Copernican ideas. Steen had never studied there, however. Indeed, Cartesianism was refuted at Turku partly because it was thought to be smuggling heliocentrism into the country. Steen describes the Sun as residing in the middle of a vortex, from where it makes the planetary system move by the power of its rays. Steen also seems to approve of the Cartesian explanation of the birth of comets. Convinced of the explanatory power of the vortex theory Steen wonders how could the Earth *not* be moving along with the ether-stream.¹⁷⁸

Cartesian cosmology influenced Steen's ideas on the size of the universe, too. Before Steen, only Daniel Achrelius in 1679 had expressed the idea that the area of the fixed stars might stretch further from the Earth than ever imagined. Moreover Achrelius assumed most fixed stars to be suns similar to our own.¹⁷⁹ Achrelius did not, however,

of the heliocentric system for Kepler too. Westman 1972, p. 248-261.

¹⁷⁷ Kexlerus-Laurbecchius 1661, Cap. III, 6. "Negari non posse, faciliorem intellectu fieri rationem omnium phainomenon, motu Terrae in Eclipticâ: ...Verùm, neque eò rebus creandis collineasse naturae auctorem, supra demonstratum est, quid nobis esset cognitu facilius."

¹⁷⁸ Steen-Peterejus 1697, p. 10-15, 20.

¹⁷⁹ Achrelius 1682, p. 128-129, 131. "Ego vero omnino existimo, in penitissimis aetheris latebris, adhuc novam stellarum scenam aperiri, quae nullo tubo ab oculis mortalium potest discerni; & eapropter revera statuo, non alium posse numerare tot myriades stellarum, praeter Solum Deum..." (p. 128)

go as far as to claim the universe to be of an indefinite magnitude. Steen's argument goes along Cartesian lines: because our mind can always imagine a bigger quantity or magnitude, there is no logical reason to deny the world an indefinite size. Like Descartes, Steen insists on the difference between indefiniteness and infinity:

Wherefrom it is concluded that the world is of indefinite size, which differs from the infinite. The latter has no positive limits as all, like GOD, but the former is only negatively so, which is that we cannot find the limits it has...¹⁸⁰

It is difficult to estimate how deeply Copernican ideas became rooted in students' minds during Steen's five-year long professorship.¹⁸¹ If there were converts to Copernicanism, they kept quiet about it. Steen's successor, Laurentius Tammelin turned the course sharply backwards to geocentric Tychonism,¹⁸² and the non-mathematical dissertations show no sign of anything else. The stand which had been adopted decades ago remained living; a physically wrong hypothesis could be accepted as a tool for calculations.¹⁸³

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The Status of Astronomical Hypotheses

At this point it would be wise to have a look at what was actually meant by *hypothesis*. On the whole, any discussion on the role of hypotheses in science was generally met only in astronomy at Turku, whereas elsewhere in Europe there was much discussion about the status of hypotheses in natural philosophy/science too.¹⁸⁴ Since early antiquity the main project of astronomers had been to build a geometrical system which would reduce the apparently irregular movements of planets to a coherent description of uniform and circular movements. They were thus supposed to "save the phenomena". It is not generally remembered, however, that even Ptolemy saw that the

¹⁸⁰ Steen-Petrejus 1697, p. 16. "Unde mundum indefinitum esse concluditur, quod contradistingvitur infinito, quatenus hoc positive nullos agnoscat terminos, ut DEUS, illud negative tantum, ut si quos habeat invenire â nobis non possunt..."

¹⁸¹ Steen died in 1697.

¹⁸² E.g. Tammelin-Nidelström 1707.

¹⁸³ Alanus-Moderus 1645, Th. XXI. Kexlerus-Laurbecchius 1661, Cap. III. Flachsenius-Grimsteen 1679, Th. 10.

¹⁸⁴ See e.g. Clarke 1989, p. 131-144. and several articles in Madden 1960.

geometrical hypothesis must match the empirical observations and describe them adequately. Geometrical hypotheses, and especially that of Ptolemy which came to involve several eccentric and epicyclic spheres, contradicted the Aristotelian cosmological views. In order to solve this dilemma several ancient, and later medieval scholars adopted the view that the mathematical models of planetary movements did not represent physical reality. They were pure fictions suitable for calculating the apparent motions.¹⁸⁵

Copernicus' claim for a new kind of status for the astronomical hypothesis only gradually found recognition. According to Copernicus and his followers a hypothesis which would with sufficient accuracy correspond to the observed phenomena, would really represent a physical truth. This stance, although very roughly put here, is usually known as the "realist" view as opposed to the "fictionalist" view, according to which astronomical models only serve as tools for calculation.¹⁸⁶ Faced with the challenge which the heliocentric theory posed to it, the epistemological status of the astronomical hypothesis became the subject of wide-ranging discussions in the latter part of the sixteenth century and the early seventeenth century.¹⁸⁷ The attitude adopted by certain scholars at Wittenberg, according to which "Wittenberg interpretation" the Copernican system could be accepted as a mathematical tool, but it could not be granted physical reality, became by and large the model which was applied at Turku too.¹⁸⁸ However, the Protestant camp did not stay unanimous for long. Tycho Brahe for example was not content with mere mathematical fictions, but aimed at building a planetary model, or a hypothesis, which would correspond to the real physical disposition and movements of the heavenly bodies. Similar demands for the physical reality of astronomical hypotheses were further promoted by astronomers such as Kepler and Galileo.¹⁸⁹

This is by and large the background for the concepts of hypothesis

¹⁸⁵ Blake 1960, p. 22-25. Duhem 1969. On Ptolemy's understanding of hypothesis see especially Taub 1993, p. 40-45.

¹⁸⁶ I have to emphasize here that this Duhemian division into "realist" and "fictionalist" approaches does little justice to the great range of views during that period. Here the concepts are used for a very rough grouping only.

¹⁸⁷ Blake 1960, p. 25-29.

¹⁸⁸ Blake 1960, p. 29-31. Westman 1975b.

¹⁸⁹ On Tycho see Blake 1960, p. 35-37. On Kepler see e.g. Westman 1972, p. 239-240, et passim. Jardine 1988b, p. 211-224, et passim.

which we can expect to find at Turku. But before going into it a general remark should be made. The entire concept hypothesis, or *suppositio* as it reads in Latin, still suffered very much in the 17th century from the connotations it had had in Aristotelian philosophy. Whereas the Aristotelian concept of science recognized demonstration as the only basis for scientific knowledge, the hypothetical reasoning associated with rhetoric and dialectic inevitably carried the stigma of not being demonstrated knowledge.¹⁹⁰ Thus, a hypothesis could not in principle stand as a foundation for legitimate philosophical argument.

Kexlerus refers at the beginning of his astronomical manuscript to the formation of an astronomical hypothesis. Hypotheses are based on observations, which if possible are made with the help of instruments. The meaning of hypotheses is then to "present and prove" the movements of stars and planets. He thus seems to favour the view that mathematical descriptions of the planetary movements are merely mental devices. In his discussion of the possible movement of the Earth Kexlerus does not refer to mathematical theories of planetary movements. Indeed, he accepts the daily movement of the Earth on *physical* and *theological* grounds, which leaves the status of mathematical hypothesis ambiguous.¹⁹¹ On the other hand the work which was probably written in co-operation by Kexlerus and Laurbecchius takes a much more strict stance towards astronomical hypotheses. The basic mistake made by the Copernicans is that they falsely attribute physical truth to their astronomical hypothesis. However, astronomical hypotheses should correspond to the observed phenomena as well as possible in order to fulfil their function of describing and predicting the movements of planets.¹⁹²

A clear and simple evaluation of astronomical hypotheses is given by bishop Gezelius in his *Encyclopaedia Synoptica* as well. He states that astronomical hypotheses are either physical or geometrical.¹⁹³ The

¹⁹⁰ Clarke 1989, p. 144-152. Moss 1993, p. 7-12, 46-49. On the nature of truth and the degrees of certainty in scholastic philosophy see Dear 1992.

¹⁹¹ Kexlerus A301, p. 7-8, 17-30.

¹⁹² Kexlerus-Laurbecchius 1661, Cap III, 4. "...fatendum est equidem, systema Ptolemaicum phaenomenis non satis congruere..."

¹⁹³ Gezelius 1672, p. 328 "*Physicae* sunt, quas à Physico mutuatas vel ut veras supponit, vel etiam observationibus suis ulterius confirmat." p. 330 "*Geometricae hypotheses* sunt ex Geometriae petita, sola quidem imaginatione coelo adscriptae, sed naturae rei convenientes, & proinde ab omnibus concessae, quibus phaenomena melius explicantur & declarantur."

former represent the physical truth - possibly reinforced by observations - whereas geometrical hypotheses are mere fictions intended for the explanation and declaration of natural phenomena. Gezelius is uncommonly open in his claim that the astronomers may accept even false hypotheses if they render the calculations of the planetary movements more easy.¹⁹⁴

Johannes Flachsenius produces the most elaborate discussion on hypothesis we can find at Turku. He not only produces a nominal definition of it, but also discusses its *genus* and *differentiae*, the efficient, formal and material causes of a hypothesis. I shall attempt to extract the most essential features of Flachsenius' presentation here, without going into its exhausting details. The general meaning of a hypothesis is according to Flachsenius manifold. Among other things, it means any physical or moral cause, or any demonstrative principle which sheds light on a problem.¹⁹⁵ Flachsenius distinguishes several uses of the word hypothesis, and it seems that the concept has a different content in every discipline. In physics a hypothesis has no connotation of uncertainty, although it deals with matters not so readily known to our senses.

In Physics [a hypothesis] follows less perfect understanding of causes, and it means a perception or conclusion which has arisen from comparison of things and the matters around them. When a physicist inquires into the position, figure, roundness and other characteristics of the earth, the heaven and the heavenly bodies, which he cannot see with his eyes and which cannot be explained and presented with apodictic demonstrations, he then anxiously proceeds from the causes of more apparent things. He nevertheless digs out certain judgements and conclusions, with which he indubitably shows that the matter can not be otherwise, and names these conclusions hypotheses.¹⁹⁶

¹⁹⁴ Gezelius 1672, p. 329. "Sive enim hoc, sive illud [hypothesis] verum sit, Astronomo etiam falsas hypotheses assumere licet, dummodo tales sint, quibus calculus totum coelestium, vere & facilius expediri possit."

¹⁹⁵ Flachsenius-Grimsteen 1679, Membrum Primum Thes. I. "Omnis causa sive physica sive moralis... Qvodvis principium demonstrationis, qvo posito rei cognitio elucescit."

¹⁹⁶ Flachsenius-Grimsteen 1679, Membrum Primum Thes. 2. "In Physicâ vero minus manifestam causarum cognitionem sequitur, & ex collatione rerum earundemque circumstantiis, humanae mentis beneficio, enatam perceptionem conclusionemque

According to Flachsenius physical hypotheses differed from astronomical ones. Whereas in physics a hypothesis follows from less certain cognition of causes, in astronomy a hypothesis has most of all instrumental value. His view is thus directly opposite to that of Kepler, for example, who explicitly urged the validity of astronomical hypotheses in the physical world.¹⁹⁷ For Flachsenius an astronomical hypothesis improperly speaking was the body of astronomical knowledge. Properly speaking a hypothesis was any concept which referred to the "real essence" of planetary movements, as inferred from observations and calculations.¹⁹⁸ What Flachsenius then means by the *verâ motuum coelestium essentiâ & habitudine* is somewhat ambiguous. In my reading he is not claiming a more "realist" reading for hypotheses, but simply means that some astronomical hypotheses describe the planetary motions better than some others. My reading is supported by Flachsenius' view of the *finis* of astronomical hypotheses. He states the aim of hypothesis to provide exact cognition of the movements of the celestial bodies so that they make it possible to discern temporal differences.¹⁹⁹ Indeed, Flachsenius stresses in his work that hypotheses are mental concepts which the mind builds up in order to organise and understand certain ideas better.²⁰⁰ Similarly Magnus Steen regards hypotheses primarily as mental concepts. He does not differentiate between a physical and astronomical hypothesis in this respect: "Physical and Astronomical hypotheses are cognitive principles, invented artificially by the Human mind, in order to ease the understanding of the subject matters of the discipline."²⁰¹

dicit. Cum enim Physicus de terre, coeli, corporumque coelestium positum, figuram, rotunditatem & habitudinem, qve nec oculis videri, nec apodicticis demonstrationibus πρῶ[?]ως ostendi ac declarari qveunt, inquirat, anxius sane de apparentiarum causis procedit; certa tamen διγμάτ[?]α ac conclusiones, qvibus rem non aliter sese habere indubitanter ostendit, eruit, easque hypotheseos nomine insignit."

¹⁹⁷ Westman 1972, p. 240. Kepler, on the other hand distinguished geometrical hypotheses from astronomical ones. For the former he did not demand any physical reality.

¹⁹⁸ Ibidem. "Idia propriâ, utputa, doctrinalem conceptum seu sententiam mentem inhabitantem, de verâ motuum coelestium essentiâ & habitudine, succursu instrumentorum, ingeniiqve industriâ cognitam, & calculo Astronomico comprobata innuit."

¹⁹⁹ Flachsenius-Grimsteen 1979, Membrum III Th. 7.

²⁰⁰ Flachsenius-Grimsteen 1979, Membrum II Th. 5.

²⁰¹ Steen-Petereus 1697, p. 2. "Physicis & Astronomicis hypotheses nihil aliud sunt quam principia cognoscendi â mente Humana artificiose excogitata, ut ad cogni-

Steen adopts a strikingly sceptical attitude towards astronomical hypotheses in his presentation. Similar views had been already advanced by Flachsenius, who counted them as "impeding causes" of astronomical hypotheses. Although Flachsenius sees the uncertainty of the hypotheses as due to the weakness of man's intelligence as caused by the lapse of Adam, he stresses the status of astronomy as science.²⁰² Steen also attributes the uncertainty of astronomical hypotheses to the weakness of our reason. Moreover, the subjects of astronomical study are so distant that our senses can scarcely reach them.²⁰³ An astronomical hypothesis can be physically false, and indeed some astronomical hypotheses are, because there are many of them, whereas the physical truth can be only one.²⁰⁴ All these sceptical arguments had been put at the end of the sixteenth century by Nicholaus Ursus and Nicodemus Frischlin. Flachsenius even cites Frischlin extensively.²⁰⁵ He does not nevertheless adopt Frischlin's extensive scepticism, which denied the possibility of knowledge of the heavens. Hypotheses were theories, which were assumed to be true as far as "demonstrations" and calculations of the astronomical phenomena were concerned, although no certain conclusions about the physical structure of the world could be drawn.

How can we account for the fact that these two men, who held such divergent views in astronomy, seemingly have such similar ideas about the nature of an astronomical hypothesis? Here we have to turn our attention to the *use* these men made of hypothesis in their work. What was the function of hypothesis for them? In Flachsenius' work the boundary drawn between astronomical and physical hypothesis obviously supported his anti-Copernican position. Astronomical hypothesis also gets a meaning for Flachsenius which it had for many other authors too: hypothesis is a *systema mundi*.²⁰⁶ It was a set of claims which presented a model of the structure of the world. Using somewhat anachronistic terminology we could say that in this sense

tionem objecti disciplinans eo melius perveniatur."

²⁰² Flachsenius-Grimsteen 1979, Membrum II Th. 3.

²⁰³ Steen-Petrejus 1697, p. 2-3. Cf. also Flachsenius op. cit.

²⁰⁴ Steen-Petrejus 1697, p. 1-2. "[hypotheses sunt] quae Astronomicè tantum, pro ut phasibus respondit, nec non demonstrationibus atque computationibus inserviunt, verae supponuntur, licet Physice possint esse falsae, ut ex diversitate illa Hypothesium, quarum uni tantum veritas Physica competit, facile liquet."

²⁰⁵ Jardine 1988b. Jardine 1988, p. 700-702.

²⁰⁶ Flachsenius-Grimsteen 1979, Membrum III. Achrelus 1682, p. 192-201.

a hypothesis was a fact-claim. But there were several of these fact-claims around and only one of them could win the prize, i.e. also be physically true or at least most truthlike. In much of the discussion there seems to be an implicit assumption that an astronomical hypothesis which would sufficiently match the physical expectations could indeed also be physically true, although its truth-value could not be judged by mathematical standards. Flachsenius's scepticism leaves room for the ultimate judge, the Bible, because human reason is incapable of settling the matter. The uncertain character of hypotheses is evident from the fact that many authors use words such as "opinion" in a similar context to that in which the word hypothesis was also used.²⁰⁷

Steen on the other hand expressly stresses the uncertainty of the hypotheses. However, the rest of his discourse implies that in fact he believed the Cartesian version of the Copernican hypothesis to be physically true. It seems Steen's main motive is to play the old game with a new goal. For the more traditional Aristotelians the hypothetical status of heliocentrism made it possible to reject its physical truth while taking advantage of the mathematical accuracy it offered. The lower status of mathematical/astronomical science secured the monopoly of truth for physics in this question. Steen however seems to use the cover of hypothetical presentation to advance an idea which was found unacceptable by most of the academic community. He could not be accused of defending mistaken ideas when he only was explaining a hypothesis. Probably for this reason he so explicitly throws the responsibility of deciding the superiority of the theories on the reader. Similar strategies had been used already by Osiander in Copernicus' *De Revolutionibus*, and by Descartes. He presented his vortex theory as a hypothesis, because it was to be feared that it would offend the theological dogma of creation.²⁰⁸

²⁰⁷ E.g. Kexlerus A301, passim, talks of "dhe lærdes åtskillige meeningar" or "the various opinions of the learned men" (p. 13). Achrelus 1682, p. 196-197 talks of astronomical systems as "*sententiae*".

²⁰⁸ However, for Descartes the vortex theory was not a hypothesis in the Aristotelian sense. In his rhetoric it sometimes functioned as if it were "only a hypothesis", though. For Descartes the hypothetical status of the theory primarily meant that it was *the most probable* and truthlike theory of all available explanations. Clarke 1989, p. 158-159.

The Influence of Heavenly Bodies upon the Earth

It has been shown above that in spite of Daniel Achrelius' and Magnus Steen's efforts to break the pattern of the traditional Aristotelian world-view, essential features of the old world-system were retained. Part of this traditional view was the belief in heavenly influences upon the Earth. Astronomy and astrology had intermingled as sciences at least from the times of Ptolemy, for whom knowing the movements of planets was just a means to a higher knowledge about their influences upon the Earth. On the other hand astrology could be viewed as something like physics, which explained terrestrial phenomena by reference to the celestial influences. In this sense astrology sought support from Aristotle's ideas: Aristotle had asserted in his *Meteorology* that the heavenly revolutions were the main cause of all movements and changes upon the Earth. During the Middle Ages and Renaissance the dogma about the cause-and-effect relationship between planets and the elementary world was then further developed, and astrology became intimately associated with Aristotelian physics. The enterprise of astrology was not without critics, however, as the Christian Church especially saw heretical features in much of it.²⁰⁹

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Belief in the influence of stars and planets upon the Earth was widely accepted in the 17th century as well,²¹⁰ and at Turku it was self-evidently a part of the official natural philosophy. Every star and planet would have virtual or "hidden" qualities, which could influence natural processes occurring on the Earth in several ways. There were, first of all, astrological influences which caused a certain kind of "magnetism".²¹¹ On the other hand, light was one of the most commonly observed influences, caused especially by the Sun. Let us turn first to the astrological influences.

It is possibly misleading to call these influences astrological, because the group of phenomena concerned refers to a much greater variety of processes than mere astrological events - if astrology is understood in its most usual meaning as the practice of reading future

²⁰⁹ On Ptolemy's astronomy see Taub 1993. Aristotle, *Meteorology* 339a20-33. On Medieval and Renaissance ideas see Steneck 1976, 90-104. Copenhaver 1988. Clulee 1988, p. 40-41.

²¹⁰ For a basic treatment of astrology in the 17th century see Thorndike 1958a, p. 89-152. Thorndike 1958b, p. 302-351.

²¹¹ Certain repulsive and attractive processes were called magnetism in Achrelius' natural philosophy. See Kallinen 1991b.

events from the stars. The heavenly influences were thought to cause various kinds of physical events: generation and corruption in general, sympathies and antipathies in nature and meteorological phenomena were, for example, always affected by the heavenly bodies.²¹² Judicial astrology was in fact a sort of subspecies of this general astrology. However, contrary to "physical astrology", judicial astrology was often met with disbelief. It is not reasonable to name here all the possible processes which were thought to be caused by the heavenly influences. Something more general about their causes and effects might however still be said.

The belief in heavenly influences rested most of all on evidence provided by everyday experiences and observations, which were obvious and attainable for all. For example the influence of sunlight on vegetation was clear for everyone to see. The regularity of certain processes on Earth was considered to follow from the regularity of the heavenly revolutions. The occurrence of tides and some processes in human body (say menstruation) were early associated with the moon.²¹³ Why would there not also be other phenomena - albeit not so readily recognizable by the senses - which were caused by the influence of the planets? Besides, it was argued that everything in nature had an end (*finis*), and the purpose of heavenly bodies was to regulate life on Earth by their influences.

What were these influences and how did they function? Was it a question only of the movement which the revolution of the planets caused and which was transferred to the elementary sphere? We are told only that the ability to influence the Earth was an essential property or affection of the heavenly bodies.²¹⁴ I think, however, that we can safely assume these influences not to be material but only virtual in the same sense that most medieval authors understood the point. The problem was how to attribute qualities such as hot or cold to planets which were located in the non-elementary part of the world.

²¹² Thauvonius-Holstius 1656, Th. 17. Thauvonius-Thuronius 1651, Th. 32.

²¹³ Alanus-Lacmannus 1648, Th. XXV. Thauvonius-Warelius 1652, Sectio II, Art. II. Ax. 5. Thuronius-Alanus 1664, Th. I. Achrelus 1682, p. 101-102, 120, 122, 124, 126, 131-135. Hahn-Wijsing 1685, Membr. III, § VI.

²¹⁴ Only Thuronius gives a fuller explanation. Thuronius-Alanus 1664, Th. VI. "Astra interventu solius lucis, non operantur, in hisce inferioribus, sed etiam, per alias occultas vires, quas communiter, influentias vocant. ...Sunt proinde Influentiae, qualitates astrorum nobis incongitae, per quas coelestia illa corpora, peculiares circa sublunaria exercent operationes."

It was claimed that planets did not have these qualities *formaliter* but only *virtualiter*, which meant that the aforementioned qualities did not inhere in them, but they were capable of producing such effects in bodies located in the elementary world.²¹⁵ In other words the influence was in a way qualitative, consisting neither of movement nor of material particles. Only in Achrelius' homogeneous cosmos were many qualities of the heavenly bodies really attached to their physical bodies, and indeed caused by the four elements. Material *effluvium* would then transfer these qualities from the planets to the Earth. In fact, according to Achrelius the influence of the stars on the Earth would be possible only if both consisted of the same kind of matter.²¹⁶ Gezelius, on the other hand stresses that the heavenly matter has the "excellent" property of being able to penetrate other bodies - something which the coarser elements were not able to do. In this way they could spread their powers more widely.²¹⁷

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Even though the whole enterprise of astrometeorology was based on the assumption that weather could be forecasted by calculating the movements of the planets, and thus the amount of various influences upon Earth, influences would not always act that directly. It was often stressed that stars could not force human will, because it was *ens immaterialis*. Only indirectly, by affecting the human body, could stars influence human behaviour. On the other hand, the influence of the stars was considered to be of a very general nature. For example in generation processes the heavenly influences acted only as a universal cause, which could not only by itself initiate the process (*sol & homine generant hominem*). No heavenly influences had fatal effects. The activity of influences could also be inhibited, for example if other more efficacious mundane causes intervened.²¹⁸

²¹⁵ Grant 1978, p. 286-289. See also Flachsenius-Lund 1679, *positio tertia*. "[Sol] Virtualiter vero ardorem excitat quod non facultate quadam innatâ ex formâ profuente, verum virtute diversarum rerum sibi adunitarum aliquid facit incalescere."

²¹⁶ Achrelius 1682, p. 11-12.

²¹⁷ Gezelius 1672, p. 245. "*Tertium [accidens coelis] est, vis penetrandi per alia copora, qua etiam coelum excellit; reliqua inferiora corpora seriatim decrescunt. Est enim ea coelestium corporum vis, ut latissime & longissime possint suas vires spargere, etiam per densissima corpora.*"

²¹⁸ Alanus-Lacmannus 1648, Th. XXVI. Petraeus-Wallenius 1674b, Th. XV. Thuronius-Alanus 1664, Corollaria 1-2. Thauvonius-Warelius 1652, Sectio II, Art. II. Ax. 5. Thauvonius-Holstius 1656, Quaest. 12. Thauvonius-Thuronius 1651, Th. 35, 36. Hahn-Chorinus 1685, Th. III. Hahn-Wijsing 1685, Membr. II, § VI, Qvæst. I-II. Flachsenius-Bergius 1682, Th. V. On the universality of influences Thu-

Light and Darkness

"Light is a quality of a luminous body, by the virtue of which it is luminous itself and illuminates others."²¹⁹ This was a very typical definition of light. Light was a quality which substantially pertained only to certain kinds of bodies. Stars and the sun had so-called *lux primaeva*, which was an inborn quality created in them by God. Although light was considered as a quality, it was also called the matter of these luminary celestial bodies.²²⁰ *Lux* spread from its source by *radii* and formed *lumen*, the visible light, which was in fact the precondition for all vision. Different types of radii (*rectus, obliquus, rursus, fractus, refractus*) were distinguished, but a more detailed analysis of them was never made, since it was considered to be the subject matter of optics.²²¹

Light and radius were called qualities for certain metaphysical reasons:

Who would doubt that light and radius are not qualities after I have above shown light to be like a quality. They are like progeny [of *lux*] as they disperse through the entire air, which bodies could not do without penetrating dimensions.²²²

ronius-Alanus 1664, Th. II-III, VII-VIII.

²¹⁹ Thauvonius-Lucander 1653, Th. III. "*Lux est qualitas corporis lucidi, quâ ipsum lucidum est & alia illuminat.*"

²²⁰ Alanus-Moderus 1645, Th. II. "*Stellae sunt corpora naturalia simplicia, à Deo conditore omnium, ex luce primogenia, quartâ creationis die facta...*", V. Alanus-Lacmannus 1648, Th. V, IX, XVII. Thauvonius-Lucander 1653, Th. X. Thauvonius-Thuronius 1651, Th. 13, 20-23. Thauvonius-Holstius 1656, Th. 9, 14. Achrelus widens the class of luminous bodies: Achrelus 1682, p. 20-21. "*Lux vero illa, quae corporibus concreta est, Originalis appellatur: residetque in stellarum plurimis, in Sole, in Cincidelis, Gemmis noctilucis & similibus, in quibus perpetua agitatione, lucida materia sese agitat, à centro ad peripheriam.*" Hahn-Wijssing 1685, Membr. II, § IV.

²²¹ Alanus-Moderus 1645, Th. VII-XI. Alanus-Lacmannus 1648, Th. XVIII-XXI. Thauvonius-Lucander 1653, Th. XV. Thauvonius-Thuronius 1651, Th. 26-28. Optics was the main theme only in one mathematical thesis published in the period concerned. Kexlerus-Lithovius 1650.

²²² Thauvonius-Thuronius 1651, Th. 27. "*Qualitates esse lumen & radios non est quod quis ambigat, tum quod lucis quam qualitatem esse supra probavim: sint soboles, tum quod per totum aera se diffundant, quod corpora sine penetratione dimensionum praestare non possunt.*" On the ideas on *penetratio dimensionum* see e.g. Grant 1981.

It was one of the metaphysical principles of the Aristotelian natural philosophy that two bodies could not occupy the same place. In scholastic terms, no *penetratio dimensionum* could occur.²²³ A quality was a nonmaterial and thus a nondimensional entity, thus explaining the almost ubiquitous presence of light.

Light was thus the most sensible one of the celestial influences. Warmth was another quality which often accompanied light. It had been usual in Aristotelian natural philosophy to see warmth being caused by the movement of the Sun. Indeed, this activity was even used as an argument against Copernicanism, defending the necessity of the movement of the Sun instead of its standing still in the centre of the world.²²⁴ Quite a few authors at Turku saw it as essential to refute this view. It was not movement which caused warmth and heat; rather, the rays of the Sun had the virtue of extracting fiery atoms from bodies, whereby the released atoms were enabled to utilize their quality or ability of warming up.²²⁵

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We have learnt that the existence of *privatio*, as the non-existence of form was refuted at Turku. There were, however, no obstacles to accepting privation in another sense. Privation of a quality was perfectly possible, because a quality was always dependent on the entire substance. Shadows and darkness were nothing more than privations of the quality of light.

Light is opposite to shadow and darkness. Shadow is privation of light caused by the interposition of opaque body in the direction of light. Darkness on the other hand is privation of light caused by the absence of the luminous body.²²⁶

²²³ See also Hahn-Herkepæus 1703, p. 3-5.

²²⁴ Sandblad 1944, p. 164-165. Aristotle, On the Heavens 289a20-35, Meteorology 340b12-14, 341a13-36.

²²⁵ Thauvonius-Warelius 1652, Sectio II, Membr. II, Artic. II, Ax. 1. Thauvonius-Thuronius 1651, Th. 33. Thuronius-Alanus 1664, Th. IV-V. Hahn-Wijssing 1685, Membr. III, § II. Flachsenius-Lund 1679, positio tertia.

²²⁶ Alanus-Moderus 1645, Th. XII. "Lumini opponitur umbra & tenebrae. Illa est privatio luminis ob interpositionem opaci facta in parte luci opposita; hae vero sunt privatio luminis ob remotionem corporis lucidi facta." See also Thauvonius-Lucander 1653, Th. XVI. Thauvonius-Thuronius 1651, Th. 29. Achrelius 1682, p. 26-30; on Achrelius' theory of medical effects of shadows see Kallinen 1991, p. 56.

It seems appropriate to deal with ideas on the formation of colours along with the theories of light. Doing this we have to notice the slight anachronism of this move, because these things were not usually handled together in the 17th-century dissertations. Theories of colours were dealt with very seldom, anyway. Light was a prerequisite for seeing colours, but otherwise they were not thought to be related phenomena. Colours were, so to speak, chemical properties of mixed bodies, caused by minute particles of sulphur. These colours were called real (*colori reali*). Although no variations of rarity and density or perspicuity and opacity could form colours, on some occasions reflections of light or mutations in the media between the coloured object and the eye could create the illusion of certain colours. These so-called apparent colours (as contrary to *colori reali*) could be seen e.g. in rainbows, clouds and the feathers of certain birds.²²⁷

3. METEOROLOGY

The rise of experimental science in the 17th century changed the whole image of physics. Meteorology also changed from an almost totally theoretical discipline to an experimental science *par excellence*. It started building its theories on Newtonian physics, and it made experiments and observations. Many of the measuring instruments developed in the 17th century which played a crucial role in the rise of modern meteorology have more or less come to symbolize the Scientific Revolution. The thermometer, barometer, hygrometer and anemometer among other instruments were all innovations of the 17th century, born along with the interest in and admiration for measurement in science.²²⁸

Meteorology was, however, an integral part of university curricula long before the meteorology based on observation and measurement was born. It was this antique and medieval tradition of meteorology which was taught at the University of Turku too. Faint echoes

²²⁷ Achrelius 1682, p. 30-36, 282-284. Hahn-Bjurbeck 1697.

²²⁸ Frisinger 1977, p. 47-95.

of the developments in the 17th-century meteorology in Europe were heard at Turku only during the first few decades of the 18th century. Two different kinds of meteorological tradition can be discerned at the University of Turku. Firstly there was a medieval tradition of astrometeorology, which only the professors of mathematics took an active interest in. Secondly, there was a tradition of philosophical meteorology, which was a part of the traditional physics. Even in the seventeenth century both were seen as separate from each other.

Astrometeorology

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Astrometeorology was an attempt to forecast weather from astronomical and astrological calculations. In the ancient Greek tradition weather had already been forecast by means of the ascension and descension of certain stars.²²⁹ Astrometeorology became popular in Europe during the Middle Ages. As early as the 11th century astrometeorological texts translated from Arabic to Latin circulated widely, but the activity of Latin authors reached its peak especially in the 12th and 13th centuries. Scholars well-versed in astrometeorology could be found in all educated classes of a medieval society, from university astronomers to court astrologers, monks and doctors.²³⁰

Astrometeorology was based on the assumption that heavenly bodies could influence weather conditions and the state of health. The influence of stars on weather and through that on health is an apparent supposition in the Hippocratic writings.²³¹ On the other hand the Aristotelian tradition, which established its position in European learning during the 13th century, presupposed very clearly a causal relationship between the movements of the planets and the changes in the elementary world.²³² The theory of four elements was interrelated with astrology since every planet would have characteristic cooling, heating, moistening or drying effects. The movements of the planets on the zodiac were of crucial importance in the theoretical construction of astrometeorology. If a planet was situated in its own house (i.e. in the

²²⁹ Taub 1993, p. 125. Aristotle's most famous disciple, Theophrastus also wrote a treatise "On Weather Signs".

²³⁰ Jenks 1983, p. 185-189, 195-197.

²³¹ Hippocrates 1983, p. 149. "...astronomy plays a very important part in medicine since the changes of the seasons produce changes in diseases."

²³² Grant 1978, p. 288-289.

sign in which it was created), the planet's influence was strengthened. On the other hand, if a planet was in a sign of a different nature or if another planet with a different nature was in the same sign, all influences were cancelled. During the seventeenth century especially the role of conjunctions and oppositions of planets in predicting the weather grew in importance. In principle, weather-forecasting was therefore a relatively simple process of adding up and subtracting relevant influences at a given time. The planet with the greatest influence would determine the weather.²³³

In Central Europe the basic dogma of astrometeorology held good until the 17th century at least. Occasional differences emerged in methods of calculating the movements of the planets and concerning interpretations of the meanings of different planetary constellations. Although not much was said about the theoretical grounds of astrometeorology, it seems that these same basic assumptions were held at Turku, too.²³⁴

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It was the professors of mathematics who dealt with astrometeorology. Because only they had the know-how for computing the planetary movements, it became a part of their job to compile a yearly almanac for the latitude of Turku. In the 17th century the so-called *prognosticons* were an integral part of the almanacs. Prognosticons were weather forecasts made by astrometeorological methods, usually covering the entire year. The professors of mathematics seem to have had no interest in astrometeorology other than almanac-making. No trace of astrometeorology can be found in their dissertations, which mainly concentrated on questions concerning arithmetic, geometry and mathematical astronomy. All in all astrometeorology was regarded as separate both from astronomy and from physics.²³⁵

In the middle of the 17th century the validity of astrometeorology had not yet been called into question, although the general restrictions of astrological prediction were approved. The physicists shared the belief in astrometeorology with the mathematicians:

²³³ Jenks 1983, p. 190. Kelly 1991, p. 156-160.

²³⁴ Thauvonius-Ikalensis 1656, Th. VIII. Kexlerus 1661, p. 49 ff. Angervo 1957, p. 89-96. On computation methods in almanac-making see Kelly 1991.

²³⁵ The only exception to this is Kexlerus 1661. *De Tempore* is a textbook on chronology and compiling almanacs, and thus it also deals briefly with astrometeorology.

6. Astrologers can make predictions which are based on observations of stars.

Some people deny this strenuously, some affirm it more eagerly than is justifiable. You will be on most secure ground in between these opinions. It is useless and vain to try to predict from the stars advice for individual persons, the course of their lives, marriages and deaths. This rejects the freedom of will and is unjust towards God. Astronomers can see rains, illnesses, colds and infertility, but not as they would happen necessarily but only contingently. It is up to the most supreme director to mutate it all.²³⁶

It seems, though, that in the latter part of the 17th century and especially at the beginning of the 18th century the results of astrometeorological forecasts and the basis of the theory itself were called into question more and more frequently.²³⁷ Mathematicians seem to have lost their reliance on astrometeorology earlier than those versed in physics. But the common folk wanted their forecasts: in spite of some unsuccessful attempts to omit astrometeorological prognosticons from the almanacs, some relics of this tradition were preserved as long as till 1887.²³⁸

²³⁶ Thauvonius-Warelius 1652, Sectio I, Membr. II, Artic. IV. Axiom. 6."6. Astrologi ex observatione syderum praedicare possunt. Quidam hoc strenue negant, quidam largius aequo affirmant; medio tutissimis ibis. Ex astris velle singulorum hominum consilia, vitae cursum, conjugia & mortem praedicere vanissima est vanitas; tollit enim libertatem voluntatis, & DEUM injustum facit. Possunt pluviae, morbi, frigora, sterilitates &c. praecerni non ut necessario sed ut contingenter fiant: Penes enim supremum directorem est ea immutare." See also Sectio II, Membr. II, Artic. III, Ax. 5. Flachsenius-Bergius 1682, Th. V.

²³⁷ Kexlerus, Almanach 1650, p. 18, Cap. I. Kexlerus A.S., Almanach 1678, p. 18. Tammelin, Almanach 1700, p. 15, et passim. Tammelin, Almanach 1705, p. 28. "Mutta mitä Almanacan kirjoittajat puhuvat ilmasta/ se on turha/ ja on se joca sen ensin alkanut on/ enämmin pyytänyt pettä cuin ylösraketa/ yhtestä cansa..." ("What the authors of the almanacs write about the weather is nothing, and the one who first started doing it has wanted more to cheat folk than to be useful.") Tammelin, Almanach 1722, Prognosticon. Hasselbom, Almanach 1726. Hasselbom, Almanach 1732. Et alia.

²³⁸ Vallinkoski 1957, p. 314-315. Angervo 1957, p. 93. Vilkkuna 1957, p. 12-13. See also Hasselbom, Almanach 1727, p. 15 ff. Hasselbom, Almanach 1732, p. 15-16.

Philosophical Meteorology

Whereas astrometeorology was mainly directed at the reading public outside the University, the other tradition of meteorology remained purely academic. Aristotle had already included meteorology in the field of natural philosophy. According to another great ancient authority in meteorology, Seneca, "*Omnis de universo quaestio in caelestia, sublimia, terrena dividitur.*" i.e. all research concerning the universe can be divided into astronomy, meteorology and geography.²³⁹

Classifying and making divisions was typical of Aristotelian and Scholastic natural philosophy. Although classifying the concepts was supposed to reveal knowledge about the causes of a phenomena, it was, on the other hand, quite simply a method of organizing complicated knowledge in a logical form. It would be false to claim, though, that classifying the phenomena was the main concern in dissertations written at Turku.²⁴⁰ The source and behaviour of meteorological phenomena were usually more deeply studied topics. The classification is, however, a key to understanding the meteorological theories.

Meteorological phenomena were usually classified by two principles: the material cause of the phenomena and the modes of their manifestations. The latter distinguished between the so-called real phenomena (*meteora hypostatica*) and apparent phenomena (*meteora empathica*). Real phenomena were based on some element or other substance which really existed in the physical world (like rain or wind). On the other hand, there were the apparent phenomena, which were not of the substance they seemed to be: "*Qvae speciem, qva adparent, non obtinent realem*". Most of these phenomena, such as rainbows, halos and parhelia could be explained by different reflexions of light. Some fiery phenomena appeared to be or were actually caused by the elementary fire.²⁴¹ Shooting stars and a number of other, fabulous phenomena also belong to this group.²⁴²

²³⁹ Aristotle 1978, 338a20-339a5, p. 4-5. Seneca 1972 II, 1.1-3, p. 98. See also Wallace 1988, p. 211. Seneca's division was adopted by Achrelius. In his *Contemplationes mundi* the first book deals mainly with astronomical matters, the second book is called "*Meteorologicus*" and the third "*Geotechnicus*".

²⁴⁰ An exception to this might be Gezelius 1672, p. 245-260, where classification and definition are the main concerns in presenting the whole system of knowledge.

²⁴¹ Thauvonius-Ikalensis 1656, Th. X. Hahn-Unnerus 1698, p. 12. Hahn-Melliin 1686, p. 15, 35. Hahn-Pryss 1691, p. 3. Gezelius 1672, p. 246, 257, 259.

²⁴² Hahn-Unnerus 1698, p. 11. "STELLA CADENS est Meteorum Emphaticum, ex effluvio superne accenso genitum, & ob loci frigiditatem repressum atqve deorsum

A phenomenon typical of the northern areas of our globe is the Northern lights or *aurora borealis*. Ancient authors most probably knew about the phenomenon²⁴³, and most of the scholars at Turku must have had personal experiences of the *aurora*. However, there is no common term for the Northern lights in classical and early modern literature. It is probable that at least some of the more fabulous nominations for apparent phenomena describe Northern lights of different forms. However, descriptions of e.g. *draco volans*, *capra saltans*, *trabs*, *fax*, *flamma*, *pyramides*, *clypeus ardens*, etc. are so short and vague that it is impossible to identify the phenomenon described.²⁴⁴ Scholars at Turku did not make any personal contributions in this field, confining themselves in writing of those phenomena which their model authors had also written about. At the end of the 17th century an interest in *aurora borealis* finally was aroused in Europe and at the same time this new term was adopted to describe the phenomenon and to distinguish it from others.²⁴⁵

The unusual composition of apparent phenomena provoked the question of whether they could be studied in physics at all. Physics would only study real entities, and apparent phenomena were not that.²⁴⁶ Pryss sought the solution to his own question from the various senses in which we could claim an entity to be *realis*. He ended up saying that the rainbow was real in the sense that it had an actual existence outside men's mind.²⁴⁷ In this way apparent phenomena could also be subject to physical enquiry.

Every real phenomenon was dominated by one of the four elements, which was at the same time the material cause of the phenomenon. We can easily imagine how water would dominate clouds, rain, snow, rainbows, dew and other "wet" phenomena. The element of air would be the material cause of winds and earthquakes, whereas thunders-

detrusum, Stellarum e coelo Cadentium imaginem offerens."

²⁴³ Stothers 1979, has tried to reconstruct the ancient auroral cycle by comparing mentions in classical literature. Stothers identifies some phenomena mentioned in literature as auroras on grounds, which can be severely criticized. Nevertheless, it seems that the *aurora borealis* was known at least to some scholars in the Greek and Roman period.

²⁴⁴ E.g. Achrelus 1682, p. 152-154. Gezelius 1679, p. 247-248, 258.

²⁴⁵ Briggs 1967.

²⁴⁶ Hahn-Pryss 1691, p. 3. "Meteora *Emphatica* vera sunt Phasmata & simulacra, quae mirifice nos fallunt atque ludunt, *Entia* non sint realia adeoque nec Considerationis *Physicae*, siquidem *Physica* ut Disciplina est *Realis*, ita *realia* tractat."

²⁴⁷ Hahn-Pryss 1691, p. 3.

terms, *igni fatui* and related phenomena were based on the element of fire.²⁴⁸ Earthquakes were also ranked among meteorological phenomena, because they were thought to be caused by moving air or winds in underground tunnels and cavities. This Aristotelian theory was the most popular during the 17th century together with another explanation which originates from Seneca stating that earthquakes were caused by explosions. This theory was modified in the 17th century by aligning it with the Paracelsian tradition. According to this version "chemical" substances contained by the air ("sulphur", "nitre") were fractured, and if they exploded in a closed cavity, an earthquake was caused.²⁴⁹

Some of the 17th-century authors on meteorology still maintained Aristotle's idea that comets were also atmospheric phenomena. According to Aristotle comets could be caused, when hot and dry exhalations caught fire in the highest parts of the atmosphere. Falling stars would be effected in the same way. On the other hand, comets could appear in the heavens if they were formed from an exhalation from moving fixed stars.²⁵⁰ These kinds of comets were thus halos of stars. The scholars most eager to explain comets and "new stars" as *meteora* were those who were devoted to maintaining the theory of the immutability of the heavens. This theory was threatened by the accumulating quantity of new observations by Brahe, Galileo and others.²⁵¹ However, although there was no complete agreement about the location of comets, the Aristotelian account of their composition had been discarded much earlier on certain optical evidence. Whatever their location, comets could not be formed of dry and hot exhalations. By the time of Brahe the view that comets had the form of spherical lenses had been accepted by most major astronomers in northern Europe. In other words, Aristotle's account of the constitution of the comets was rejected earlier than his ideas about their location, which was finally done mostly by Brahe and Maestlin.²⁵²

²⁴⁸ Thauvonius-Ikalensis 1656, Th. VII-IX.

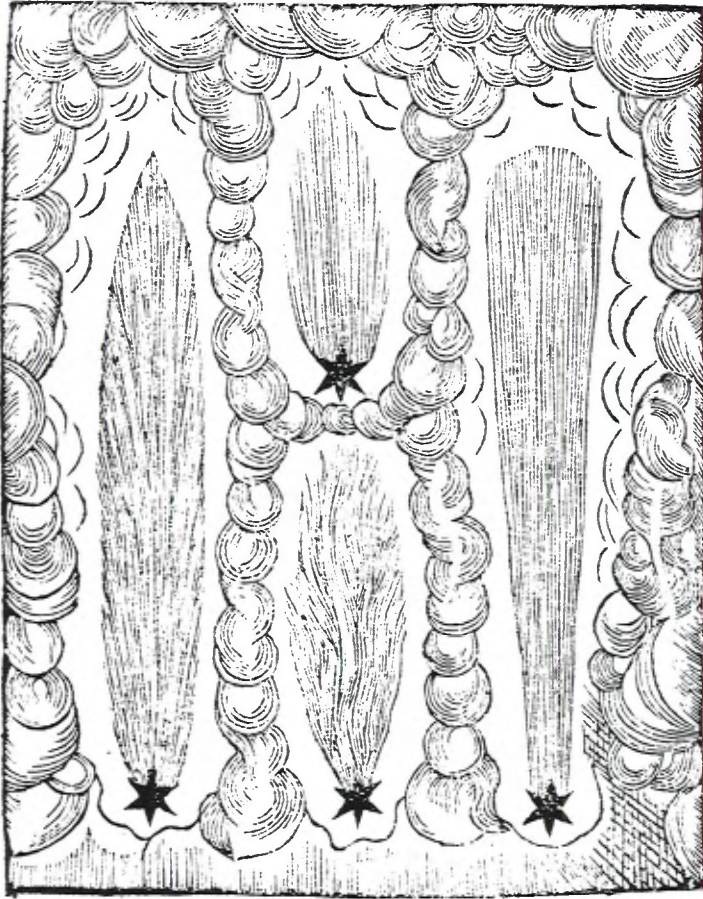
²⁴⁹ Aristotle 1978, II.7., 365 b 21-366 a 5, p. 204-205. Seneca 1972 VI, 12.1-2, s. 162-163. Frängsmyr 1969, p. 45-47. Thauvonius-Ikalensis 1656, Th. IX. Achrelius, s. 187-188.

²⁵⁰ Aristotle 1978, 344a8-b8, p. 48-53. See also e.g. Fromondus 1627, p. 88, 100-103.

²⁵¹ Debus 1980, p. 89. Drake 1981, p. 104-106, 267. On the Aristotelian response in general see Grant 1984. For a description of the development of the theory of comets see also the somewhat whiggish book of Yeomans 1991.

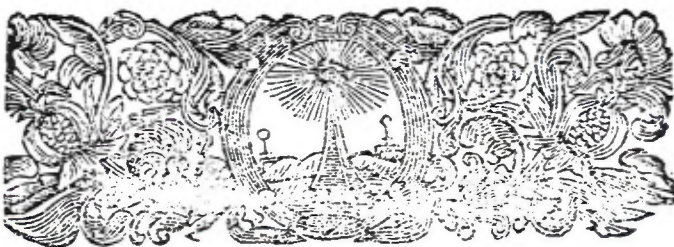
²⁵² Barker 1993.

VARIE COMETARUM FIGURÆ.



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Ekedahl distinguishes three explanations of comets in his thesis in 1695. "The Aristotelians" believe comets arise from dry exhalations rising from the earth to the higher atmosphere, where they are ignited by the fire of the stars. The second class of scholars think comets to be some kind of cloud, or conjunction of two stars. The third opinion states comets to be planets, and Ekedahl places Descartes in this group: Cartesian comets are just planets moving from one vortex to another. Ekedahl cannot accept any of these theories, but thinks comets to be portents originated by God.



תענית חמשה יומית וזמן



AD hunc egregium & multis nodis intricatum Discursum, de naturâ fatalium Aſtrorum, & crine ſanguineo horrentium Cometarum, non quidem illotis, ut ajunt, manibus eſſe accedendum, fate- mur ſed quândoquidem non licet, ut volumus, hoc enodare Inceptum, non tamen, ut quimus, erubeſci- mus. Et ſicut viator longè progreditur felicius, ſi antequam iter ſuſcipiat, vias habeat quodammodo ſibi cognitâs, quibus ſit eundum, ne infelicius in ignotâ viâ cogatur errare; ita è re eſſe putavimus, ſi & ipſi *συναρξαφιν* quandam tractando- rum præmitteremus, quæ inſtar ſtatue Mercurialis nobis viam, quâ eundum ſit, monſtraret. Hanc itaque Diſputationem quatuor Articulis abſolvere libet. Art. 1. quæſtionem an dentur Co- metæ? illorum definitionem nominalem & realem exponet. Art. 2. illorum cauſas, tam internas quam externas, explanabit. Art. 3. Illorum affectiones breviter demonſtrabit. Art. 4. diviſi- onem illorum, item diſtinctionem inter Cometas & alias novas *Stellas* *αἰετῶν* ſic dictas oſtendet, & tandem diſcurſus de *Stella* *Magorum* totum claudet negotium. Sit ergo in nomine Triadis.

A.

AR.

This viewpoint of the astronomers is by and large accepted in physics as well as in mathematics at Turku. Although it seems that there was long-standing uncertainty about the real nature of the comets, in dissertations written at Turku it is clearly denied that comets could be meteorological phenomena. Most authors at Turku considered comets too big to be made up of exhalations from earth.²⁵³

It is incredible that such an abundance of vapours would expire from the earth. If you think about the magnitude of comets, you find them with such a mass that even if the entire earth dissolved into steam, it hardly would be enough for forming and supporting even one of them.²⁵⁴

Besides, weather changed rapidly, whereas comets, the milky way, etc., always kept the same height and were also otherwise constant.²⁵⁵

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This kind of argument had been already proposed by Seneca, whose influence on the discussion on comets had greatly increased during the 16th century.²⁵⁶ As we have seen, the origin of these phenomena was regarded as supernatural at Turku. However, the old tradition of regarding them as meteorological phenomena was close enough, so that the question was occasionally handled along with meteorology.

The General Causes of Meteorological Phenomena

Before we turn our attention to the alleged efficient causes of meteorological phenomena, a word ought to be said about their location. As we have learnt, the (element) air occupied the space between earth/water and the sphere of the Moon. (Fire was to be found everywhere in nature.) The lowest layer of the atmosphere (*infima aëris regio*) was very warm, because Sun's rays reflected from the earth

²⁵³ Hahn-Ekedahl 1695, p. 7-8, et passim. Achrelus 1682, p. 135-136. In other meteorological dissertations comets were not even mentioned.

²⁵⁴ Achrelus 1682, p. 135-136. "Incredibile quoque est tam prodigiosa flatuum volumina è terris exspirari: Nam si quis magnitudinem cometarum considerare velit, inueniet tantam eorum molem esse, ut si tota in fumos tellus fatisceret, vix uni alendo & formando sufficeret..."

²⁵⁵ Thauvoniuss-Ikalensis 1656, Th. IV. Thauvoniuss-Eurenus 1655, Th. V.

²⁵⁶ Barker 1993, p. 3-4. Whereas in the Middle Ages discussion of comets was entirely based on Aristotle's *Meteorologica*, from the 16th century on Seneca's arguments achieve ever-growing popularity.

and winds warmed up by "underground fire" (*ignis subterraneus*) always tended to warm it up. The underground tunnels of air were counted in this region, too. The middle region of the atmosphere "begins from the region up to where the rays of the Sun are reflected back, and extends itself almost to the peaks of highest mountains."²⁵⁷ The coolness of this region was for the most part caused by vapours. The highest layer, which extended from "the peaks of the highest mountains" up to the sphere of the Moon, was in turn very warm, because it was nearest to the Sun. Because air was a continuous body, no precise altitudes of the regions could be given. It was said that exact numbers would easily mislead, because the borders of these regions changed according to the weather conditions. All in all, the physical differences between these layers of air played an important role in explaining the birth of most meteorological phenomena.²⁵⁸

Most of the real meteorological phenomena were caused by similar processes. Although God was always mentioned as the supreme and the most fundamental effective cause of all processes in nature, more particular causes were also always sought. The most essential role was played by the Sun. The rays of the Sun had power to extract vapour or *effluvium* from the earth, water and all other material objects. Two types of this effluvium existed, the one was dry, so-called *exhalatio* and the other moist, consisting chiefly of water vapour.²⁵⁹ Sometimes the contents of the *effluvium* was presented in a very dramatic way:

...the director of years and months, days and nights, the magnet of the World, life and soul, i.e. the Sun often agitates this inferior region together with all the army of Celestial bodies. This also extracts and resolves with its attractive virtue sulphurous and greasy exhalations from swampy tracts, fields destined for execution of criminals, butcher's markets and graveyards. These released particles are then elevated and spread to form auroras which are sometimes to be seen towards the rise of the Sun.²⁶⁰

²⁵⁷ Achrelus 1682, p. 149 "*à spacio reflexionis radiorum solarium incipit, & ferè ad altiora culmina montium sese extendit*".

²⁵⁸ Thauvonius-Wellerius 1653, Th. 13-27.

²⁵⁹ Thauvonius-Warelius 1652, Sect. II. Membr. II. passim. Hahn-Widebeck 1702, p. 22-31. Hahn-Melliin 1686, p. 12, et passim. Hahn-Unnerus 1698, p. 6, 27. Hahn-Heurlin 1702, p. 6-7. Hahn-Melander 1693, p. 12-13, et passim. Achrelus 1682, p. 147, 155, 160, 163, et passim. Laurbecchius-Wännergren 1688, p. 5.

²⁶⁰ Hahn-Unnerus 1698, p. 15. "...annorum nempe et mensium, dierum & noctium

Exhalations consisting of various matter would be elevated up to the middle region of the atmosphere, which was cooler than the regions above and below it. Vapours were condensed by cold either to rain or to snow or hailstones, depending on the intensity of the cooling. The movement of the *effluvia* in itself caused a meteorological phenomenon, namely the wind.²⁶¹ Vapour containing "sulphur" and "nitre" could explode and cause a thunderstorm and lightning.²⁶² In other words, the composition of the vapour played a crucial role in determining what kind of phenomenon would actually develop.

Composition and Essence of Meteorological Phenomena

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The composition of the vapour not only determined what kind of phenomenon was to come into existence but it also decreed what kind of effects it was to have. Meteorological phenomena were, in a sense, something like a sum of their component parts. The structure of meteorological phenomena gave rise to a peculiar problem about their ontological status. In order to clarify what this problem was all about, we have to look at the way the essence of meteorological phenomena was defined.

These phenomena were thought to be bodies which were made of imperfectly mixed elements. Therefore they had no permanent, substantial form or essence, but only an accidental one.²⁶³ Now we have learned that accidents could not exist separately, without belonging to some substance proper. How could it then be said that meteorological phenomena were only accidental? The explanation given might not

Rector, Mundi magnes, anima & vita *Sol* videlicet, cum toto Coeli exercitu, qui nunquam non in hunc orbem inferiorem agitat: quae & *elevans*, quod virtute sua adtractiva, exhalationes sulphureas & oleaginosas è paludibus uliginosis, campis suppliciiis sceleratorum desti natis, macellis, coemiteriis extrahit atque resolvit, partesque resolutas quod ad ortum solis interdum videre est, in auras spargit."

²⁶¹ Hahn-Alm-Qwist 1688, p. 3. Hahn-Melliin 1686, p. 25-26, 29, 33. Achrelius 1682, p. 169.

²⁶² Hahn-Melliin 1686, p. 18. Hahn-Heurlin 1702, p. 4-5. Achrelius 1682, p. 155. A competing Cartesian theory of the birth of lightning was argued by Hahn-Melander 1693. Warm air condenses a cloud located higher than others. A condensed cloud is heavier and it falls on other clouds below it. It is this collision which finally causes lightning. There were thus a "chemical" theory and a mechanical one. Hahn-Melander 1693, p. 23-25. Descartes 1644, p. 260, 282.

²⁶³ Hahn-Melliin 1686, p. 7. Hahn-Alm-Qwist 1688, p. 10-11. Hahn-Bjurbeck 1696, p. 6. Hahn-Heurlin 1702, p. 8. Achrelius 1682, p. 148.

be totally satisfactory from the philosophical point of view. It was stated that accidents never actually left their proper substances, i.e. the minute particles which constitute the vapour or exhalation. These accidents have, however, a power to affect other things outside themselves. In my reading these accidents are able to bring forth a more general, but still an accidental form, which keeps all the particles of the phenomenon together.

And this mass and congeries of Elements is what we call a Shooting Star. This is not an entity *per se* as State, Congregation, army and forest are not. This is because it is not caused by one substantial form, but by an accidental one. It has as many forms as it has constituent parts or components. In this way there is in an army as many distinct forms as there are individuals. ...This falling of Stars is connected by a kind of common form, but not a substantial and specific one, which gives an entity an independent essence, and distinguishes it from others and makes it act. But it [is connected by] an accidental form which unites it *per accidens*.²⁶⁴

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This theory was closely connected to corpuscular theories - in this case *minima mixta*.

If any man insists like grim death that lightning ought to be conceded a form, we would not admit any other kind of a form to exist but that which belongs to the bodies from which these particles have come loose. These particles have then gathered up and conglomerated into this inflammable exhalation. These very small particles, risen high in the air... do not give up their proper forms, but each one of them keeps its own nature and form...²⁶⁵

²⁶⁴ Hahn-Unnerus 1698, p. 4. "Sed cumulus & congeries Elementorum, & hoc ipsum est, quod Stella audit Cadens; & cum illa, aeqve ac Respublica, Ecclesia, exercitus, sylva, non sit ens per se, quod sit vi unius formae substantialis, sed per accidens, quod tot habet formas, quot partes integrantes vel componentes; ut in exercitu, tot formae numero distinctae, quot individuae; ...hanc Stellarum trajectionem, communi quadam formâ connecti, verum non substantiali & specifica, quae dat rei esse per se, datque distingvi & operari; sed accidentali, quae dat per accidens." See also Achrelus 1682, p. 148. "...corpuscula enim minima, sublata & inter se permixta, retinent quaelibet suam naturam ac formam..."

²⁶⁵ Hahn-Melander 1693, p. 19. "Si quis mordicus insisterit aliquam fulmini concedendam esse formam, tum nullam aliam admittimus, quam ipsorum corporum, è quibus progressae sunt particulae illae in exhalationem inflammabilem collectae

Meteorological phenomena were the first type of mixture, which were not proper mixtures at all in the sense that they did not form a new *compositum*, a new substance. Therefore they retain a somewhat ambiguous position in the natural philosophical system favoured at Turku.

Observing and Forecasting the Weather

As far as it is known to us, no series of observations of the weather were made at Turku in the 17th century. Occasional notions did exist, of course, like Achrelius' very general comment that thunderstorms are most frequent "in the northern regions" in summertime and in early autumn.²⁶⁶

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In certain parts of North Germany meteorological observations had been made as early as the 1530's. Although no official organization for observation existed, relatively long and regular series of observations dating from the 17th century are not rare. It is worth noticing that all people making the observations were laymen and none of them was a proponent of the academic natural philosophy.²⁶⁷ Of course, because all measuring equipment and uniform standards were still lacking, the notes have a very general character: "cold", "rainy in the evening", "south wind" or perhaps "mild springlike weather".

The purpose of these observations was to control forecasts made by astrometeorological methods. It was usual to think that weather conditions were repeated every seven or nineteen years, because of certain regularities in the phases of the moon. Therefore many astrometeorologists tended to make at least seven-year series of observations.²⁶⁸ Because the astrometeorological tradition was well established in Finland also, it would be reasonable to expect such attempts at control to have existed here, too.

All notes of (astro)meteorological observations made in the 17th century are very fragmentary. They consist of sporadic notes in ca-

& conglobatae, minutissima enim corpora in altum sublata, ...formas suas non deponunt, sed quodlibet suam naturam & formam retinent..."

²⁶⁶ Achrelius 1682, s. 156. "Apud nos v. hic sub septentrione, aestate conspiciuntur fulmina crebra, ut & autumnus totis noctibus, si modo Coelum fuerit serenum, quod me saepius notasse memini, quando circa Litora, ad retia cum piscatoribus cubarem."

²⁶⁷ Klemm 1976, s. 5, 24, 28-37, et passim.

²⁶⁸ Klemm 1976, s. 19, 20, 24, 28, 31, 37, et passim.

lendars and are moreover very difficult to trace to any greater extent. In the eighteenth century meteorological observations became more common, but they were no longer related to the astrometeorological tradition. They had, instead, motives which were inspired by something like mere curiosity concerning the nature's regularities, or by the spirit of the Era of Utility.²⁶⁹

Forecasting weather was mainly a concern of astrometeorology, but philosophers also suggested some general instructions for interpreting the signs of nature and other portents. Kexlerus' instructions for making prognosticons reveal that knowledge was already very standardized at that time: "It is customary to predict for the peasants as many stormy rains for the summertime as there are days in March of misty constitution. And as many snowfalls will come after Easter, and as many clouds will empty themselves in August as there are rainy nights in March."²⁷⁰

It was typical of this kind of forecasts that they attempted to forecast weather (or other occurrences concerning health or society) on the basis of the weather conditions at the moment of making the forecast.

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In January...

Clear Paul's day means a good year:

If there are winds, they signify fights among people:

If there are fogs, some animals will die:

If snow or rain, the times will be dear.

²⁶⁹ Tammelin, Almanach 1725, Prognosticon. "Efter några nästförläddne wintrar warit aldeles sålsamme/ och lika såsom ifrån then wanlige natursens gång förändrade, observerade jag och upskref förläddit åhr wäderleken/ på alla dagar i de tre första månaderna/ hwilka woro såsom följer... Widare observerade jag intet/ eller gaf så noga acht på naturens sålsamma omwärling/ efter winteren war förbij/ och währ wederleken syntes blifwa favorablare och lijka som draga naturen uti sitt förra skick." Hellant, Almanach 1748, made notes concerning the break-up of ice in the river Tornio. He wanted to find out whether the late breaking-up of ice, which correlated with crop failure, followed at any certain intervals and whether they could thus be predicted.

²⁷⁰ Kexlerus 1661, p. O4. "*Usitatum est colonis praedicere tot tempestates pluvias aestate oborituras, quot dierum in Martio nebulosa fuerit constitutio, totque Pascha consecuturas pruinas, & Augusto mense effumaturas nebulas, quot noctibus Martius irrorârit.*" Kexlerus' book is difficult to place entirely into the astrometeorological or to the philosophical tradition, having some features of both.

Do not believe this as certain, because the rule yields so often:
If God so will, he solely can change this all.²⁷¹

Often these "rules" for forecasting weather resemble peasant folklore which still flourishes in many parts of Finland. It is not, however, within the scope of this study to find out how this fading academic tradition has influenced folklore - or vice versa.

These forecasts are based on different natural signs: it was crucial whether the sky was clear or hazy, whether there was a halo around the Moon, or whether there was foam on the sea.²⁷² It seems that academic authors did not think two different weather conditions had a causal relationship, but they possibly saw a more or less (self) experienced correlation or connection between them. The style of language used lends support to this impression. Conjunctive sentences and expressions like "indicates" (*indicat*), "insinuates" (*insinuat*), "signifies" (*significat*), "it will be expected" (*expectanda erit*), "forecasts" (*pronunciat*) seem to repudiate a causal connection.

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In a way, other kinds of natural signs were also closely related to weather forecasts. This type of portent had its roots in the classical age. The behaviour of animals was quite generally supposed to indicate future weather. "The magpie chatters exceptionally loud, the raven croaks, the mosquitos bite; you say this foretells rain. Indeed, you are right and there is a reason for it. Animals have subtle senses, and they feel the coolness which increases in the air gradually when the clouds are about to resolve into rain."²⁷³ As the quotation shows, pre-sages derived from animal behaviour were based on very natural causes. Animals had sharper senses than humans, and therefore they could sense mutations in weather conditions earlier than humans.

Philosophical meteorology was after all more interested in weather portents than forecasts. It was usual to see phenomena which somehow deviated from the "normal" course of nature as portents of becoming

²⁷¹ Kexlerus 1661, p. O3. "In Januario. ...Clara dies Pauli bona tempora denotat anni: Si fuerint venti, designant praelia genti: Si fuerint nebulae, pereunt animalia quaeque: Si nix aut pluviae, tunc fient tempora cara. Non credas certè, quia fallit regula saepè: Nam si vult Dominus convertit is omnia solus."

²⁷² Kexlerus 1661, p. O2-O3. Hahn-Melliin 1686, s. 28.

²⁷³ Thauvonius-Warelius 1652, Sectio II, Membr. II, Artic. III, Ax. 4. "*Garrit ultra modum pica, crocitat corvus, pungit musca, pluvias futuras dicis, rationem adde, vera dixeris, subtili sensu sunt animalia, frigiditatem sentiunt, quae in aëre minutim fit, dum resolvitur nubes.*"

events. Comets, "bloody rains" and various light phenomena on the sky were typically seen as divine portents, which ordinarily preceded destruction of sinners or other catastrophes. Most of the horrifying examples mentioned were repeatedly copied from Pliny, Vergil, Tacitus or other classical authors.²⁷⁴

Unusual meteorological phenomena had been seen as portents of catastrophes since classical antiquity. In the Middle Ages, another interpretation expressed by Albertus Magnus for example gained support, according to which comets especially really *caused* the disasters they anticipated.²⁷⁵ At Turku the attitude towards portentous meteorological phenomena was clear; they were premonitions of catastrophes, which God would send down to earth in order to frighten sinful people. No causal connection existed between the phenomena and the disasters. It was the Augustinian spirit that dominated: the trials of life were a consequence of people's sins, cataclysms were only instruments of God.²⁷⁶

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4. GEOGRAPHY

The Structure of the Globe

The difference which the physicists and mathematicians had in their respective approaches to astronomy and meteorology is also visible in geography. Whereas physicists showed more interest in the physical structure of the Earth, formation of wells and mineralogy, mathema-

²⁷⁴ Hahn-Iflander 1691, s. 9-10. Hahn-Melliin 1686, s. 27-28, 38-39. Hahn-Melander 1693, s. 9-11. Achrelius 1682, s. 148-149, 164, et passim. On ancient ideas about weather portents see Krauss 1930, passim.

²⁷⁵ Schechner Genuth 1990, s. 299-300. See also Steneck 1976, p. 86.

²⁷⁶ Achrelius 1682, p. 148, 154, 163 "...prodigia ...â solo Deo ita disponi, ut praemoneantur homines, de luctuosis futurarum rerum cladibus.", et passim. Hahn-Melliin 1686, p. 10, 14, 27, "...satiis est in causa prima acquiescere, quae hominum peccata justissimis solet ulcisci poenis.", 41. Hahn-Iflander 1691, p. 9-10. Hahn-Ekedahl 1695, s. 15. "COMETA est Stella extraordinaria, Divinâ virtute in Coelo accensa, ut de futuris malis hominem praemoneat." Thuronius 1665, HYK Ms/Mf 550.

ticians concentrated on measuring the dimensions of the Earth, dividing the globe into zones and proving its sphericity. Mathematical geography was closely connected to the general scheme of *Geographia Generalis*, which studied the affections (figure, magnitude, location and immobility) of the terrestrial globe.²⁷⁷

Most of the arguments in favour of the spherical figure of the Earth were already known to Ptolemy, but interest in the question was revived in the discussions about the place of the Earth. The sphericity of the *Terr-Aquaeus globus* was an important matter if one wanted to prove that both the centre of gravity and of magnitude was at exactly the same place in the centre of the universe.²⁷⁸ At Turku, however, the discussion concentrated on proving the sphericity of the Earth, the further implications of the fact not being brought into discussion.

In proving the sphericity of the Earth astronomical arguments intermingled with arguments derived from experience. First of all it was pointed out that the Sun, the Moon and the stars rise and set earlier in Oriental parts of the Earth. If the Earth was flat, however, eclipses would be seen in all parts of the world simultaneously. This was not the case - *ergo*. Earth was also spherical in a north-south direction. This was proved by observations made by travellers. It could be shown that the number and position of stars seen in the sky changed when moving from the south to the north or vice versa. Navigation produced yet another argument: land could first be seen from the mast, i.e. from the highest possible position on the ship, and only later from the level of the deck.²⁷⁹ One of the strongest arguments for the sphericity of the Earth could, however, be induced from eclipses of the Moon. Lunar eclipses were known to be caused by the interposition of the Earth between the Sun and the Moon. The shadow of the Earth which was cast on the Moon was round, which proved its sphericity.²⁸⁰

²⁷⁷ See e.g. Kexlerus 1666, Lib. I, Cap. I. Gezelius 1672, p. 252-290. Lehti 1984.

²⁷⁸ Grant 1984, p. 22-32.

²⁷⁹ Kexlerus 1666, Lib. i, Cap. I, (B3-B5). Gezelius 1672, p. 253-259. Flachsenius-Steen 1682, Th. III. Flachsenius-Bergius 1682, Th. VII. Flachsenius-Rothovius 1688, Th. V. Tammelin-Almhenius 1712. Tammelin-Gjöslung 1704, Th. IV. Tammelin-Tammelin 1711, Th. I. There were similar arguments in some theses at Uppsala, but expressly to show the central position of the Earth. Sandblad 1944, p. 162-163, et passim.

²⁸⁰ Flachsenius-Forsman 1678, Th. I. Flachsenius-Steen 1682, Th. III.



Si vero Terra esset tetragona, umbra quoq; tetragonæ figuræ in Eccipsi Lunari appareret, sicut hoc schemate demonstratur,



Quod si Terra esset triangularis, umbra quoque triangulari figura in Luna appareret.

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Denique si Terra hexagona esset, hexagonâ quoque umbrâ Lunam obfuscaret.



Interim tamen notissimum est, Lunam non aliâ figurâ terræ umbram recipere quam rotundâ, ergo & ipsa talis erit.

Johannes Flachsenius and Johannes Forsman published a "*Philosophical thesis which presents some mathematical and some other suppositions*" in 1678. The first theorem stated that the Earth is a globe. This could be proved by inspecting the eclipses of the Moon, since a tetragonal Earth would cast a tetragonal shadow on Moon, a triangular Earth a triangular shadow, etc. Flachsenius also discussed claims such as that the Earth does not move, nature does not degenerate because of old age, and not all people who go into a civil career are good politicians.

The physicists naturally had no different opinions about the question.²⁸¹ They were not, however, as profoundly interested in proving the matter as the astronomers were since the figure of the Earth was just one of its general affections. However, while for students in mathematics the study of the shape of the Earth offered an opportunity to show their basic knowledge in the field, not all arguments in mathematics were properly speaking mathematical, but certain *a priori* reasons were considered at least as valid as the strictly mathematical ones. First of all, the Earth was supposedly created analogous to the whole *mundus*. The cosmos, on the other hand, had to be spherical, because this was the most spacious and noblest possible form. The figure of the Earth naturally followed the figure of the Universe, because residing in the middle of the world it would be everywhere equally distant from the heavens.²⁸²

According to mathematicians the principal task of geography was to study the longitudes, latitudes and other zones of the Earth. The knowledge of equator, horizon, meridian, etc. was important as soon as one went from geography towards cartography, navigation and other practical applications of geographical knowledge.²⁸³ Cartography and geodesy were important subjects in 17th century Sweden, where the crown laid much emphasis on surveying the country.²⁸⁴ Instead of these mathematical interests, in physics "geography" meant general study of the internal and external structure of the Earth.

Most of the geographic dissertations written at Turku are typically very descriptive. Contrary to general geography this practice was called *geographia specialis*. The parts of the Earth were studied first of all by defining various geographical terms: what is a sea, lake, continent, etc. Examples of these were then given. After studying the *structure* of the Earth, the geographical *positions* of the continents and countries situated on them, rivers and winds characteristic of certain areas were listed in a rather monotonous way.²⁸⁵ Achrelius especially

281 Tålpo-Rhydelius 1682, Th. XIX. Hahn-Alm 1688, p. 21-22. Hahn-Flodin 1707, p. 22-25.

282 Kexlerus 1666, *Cosmographia Methodice Digesta*, Cap. I, (A4-A5). Flachsenius-Steen 1682, Th. III. Tammelin-Tammelin 1711, Th. I.

283 Kexlerus 1666, Lib. I. Gezelius 1672, p. 246-252, 257-290. Flachsenius-Tålpo 1675, Th. XVIII. Tammelin-Odelin 1712, p. 15 ff.

284 Lindroth 1975, p. 481-492.

285 Kexlerus 1666, Lib. II. Gezelius 1672, p. 291-320. Hahn-Alm-Qwist 1688, p. 25-32. Flachsenius-Frisius 1685. Achrelius 1682, p. 207-213.

loves to use the micro-macrocosmos analogy conversely. He describes the globe as analogical to the human body; just as our bodies have bones, the Earth has chains of mountains. Just as we have our intestines, nerves and vessels, the Earth is full of cavities filled with air, fire and water. These tunnels were essential for the vital functions of Mother Earth and explanations of many nature's processes could therefore be referred to these tunnels.²⁸⁶ For example the existence of *ignis subterraneus* was rather obvious. Warm natural thermae and volcanic eruptions especially proved that there were fiery cavities inside the Earth. Why would not the same be true of the other elements as well?²⁸⁷

It was sometimes asked, whether all zones of the Earth as defined by the equator, tropics and polar circles, were habitable. The answer was yes, since if only the temperate zones were habitable, the other parts of the world would have been created in vain, an unacceptable notion. Related to the question of the habitability of the Earth was the problem whether antipodes existed. It was stated that this had originated from the ignorance of the ancient authors. They did not know the Earth was spherical, but in "our times" several explorers had shown all zones of the Earth to be really habitable. Therefore, instead of the fabulous creatures of classical literature, antipodes were now considered as ordinary people living on the same meridian, but on the other side of the equator.²⁸⁸

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If the Earth is spherical... it follows necessarily that Antipodes exist. The reason why they do not fall is that all which is heavy tends downwards. If they fell from there, they would fall upwards towards the Sky, which is contrary to experience and the nature of heavy bodies.²⁸⁹

²⁸⁶ Miltopaeus-Achrelus 1672, Sect. II, §3-4. Achrelus 1682, p. 202-206. Hahn-Arelius 1689, passim. Hahn-Ring 1688, p. 29 "Formavit namque Altissimus mirabili quodam consilio totum hoc Geocosmi systema, ad analogiam ac similitudinem Corporis humani." On micro-macrocosmos analogy in geography see Frängsmyr 1969, p. 27.

²⁸⁷ Alanus-Ulstdadius 1647, Th. VI. Hahn-Lundelius 1693, p. 12-30.

²⁸⁸ Kexlerus 1666, Lib.I, Cap. III. Gezelius 1672, p. 274-277. Flachsenius-Tälpo 1675, Th. XX. Flachsenius-Bergius 1682, Th. X. Hahn-Flodin 1707, p. 27-29, 35-39. Tälpo-Höök 1685, Th. II. Steen-Pryss 1694. Pryss-Forbus 1711.

²⁸⁹ Hahn-Flodin 1707, p. 37-38. "Si Terra est Spherica... necessariò sequitur esse Antipodes. Quod autem non decidunt, causa est, quia omne grave tendit deorsum, si autem deciderent, caderent versus Coelum sursum, quod experientiae & naturae gravium contrarium."

歐洲

EUROPA.

Locorum Nomina,	Long. Lat. Bo.	Antipod.	Long. Lat. Deg.
<i>Frigania</i> vlg. Toledo,	9. o. 40. 4f.		39. o. 40. 4f.
<i>Frugiellia</i> Conimbr,	9. o. 40. 10.		39. o. 40. 10.
<i>Gallia</i> Paris	10. o. 48. 1f.	His respondet 110. o. 47. 3f.	
<i>Britannia</i> Londin Angl.	10. 20. 51. 2f.	Terra Australis 190. 20. 51. 2f.	
<i>Normania</i> Dronen,	19. 30. 64. 0.	210. 30. 64. 0.	
<i>Scythia</i> Halon,	34. o. 59. 10.	214. o. 59. 10.	
<i>Finlandia</i> Abo,	39. 40. 61. 3f.	229. 40. 61. 3f.	
<i>Lapponia</i> Finmarkia,	3f. o. 69. 0.	23f. o. 69. 0.	
<i>Dania</i> Helsing.	26. 10. 55. 1f.	207. 10. 55. 1f.	
<i>Germania</i> Heideb. Palat.	27. 30. 49. 0.	207. 30. 49. 0.	
<i>Brit. I. Celtae</i> Annaburgh,	33. 10. 5f. o.	204. 10. 5f. b.	
<i>Polonia</i> Moldavia,	47. 10. 47. 10.	227. 10. 47. 10.	
<i>Russia</i> Podolia,	48. 30. 44. 10.	228. 30. 44. 10.	
<i>Alba Regal.</i> Curandla,	36. 10. 47. 18.	216. 10. 47. 18.	
<i>Italia</i> Roma,	12. 10. 44. 20.	216. 10. 44. 20.	
<i>Transylvania</i> Romania,	26. 0. 46. 30.	216. 0. 46. 30.	
<i>Helvetia</i> Helvetia,	34. 30. 45. 40.	212. 30. 45. 40.	
<i>Utria</i> Oria,	34. 30. 45. 10.	212. 30. 45. 10.	
<i>Dalmatia</i> Dalmatia,	36. o. 44. 30.	216. o. 44. 30.	
<i>Serbia</i> Serbia,	40. o. 41. 10.	220. o. 41. 10.	
<i>Wallachia</i> Wallachia,	44. 10. 45. 20.	224. 10. 45. 20.	
<i>Moesaria</i> Moesia,	48. o. 43. 20.	228. o. 43. 20.	
<i>Romania</i> Romania,	42. 30. 41. 38.	224. 30. 41. 38.	
<i>Grecia</i> Grecia,	44. 30. 38. 0.	222. 30. 38. 0.	
			Loco.

非洲

AFRICA.

Locorum Nomina,	Long. Lat. Bo.	Antipod.	Long. Lat. Deg.
<i>Barbaria</i> Fezzie	9. o. 32. o.		189. o. 31. o.
<i>Tibetania</i> Tibetania	19. o. 33. 1f.		192. o. 33. 1f.
<i>Tartaria</i> Tartaria	16. o. 34. o.	Terra Australis	199. o. 34. o.
<i>Barthia</i> Barthia	45. o. 30. 30.	M. Pacificum.	206. o. 31. 04
<i>Bitulid.</i> Bitulid.	22. o. 29. 30.	part. Terr. Austr.	217. o. 30. 30.
<i>Gralia</i> Gralia	4. o. 29. 2f.	Terra Australis	202. o. 29. 30.
<i>Haden</i> Haden	4. o. 19. 2f.		184. o. 21. 30.
<i>Genacha</i> Genacha	3. 30. 18. o.		184. 30. 18. 2f.
<i>Tombul</i> Tombul	10. o. 17. o.	M. pacificum	190. o. 17. o.
<i>Melli</i> Melli	6. 30. 16. 2f.	vulgo, del Zur.	186. 30. 16. 2f.
<i>Gessia</i> Gessia	16. 30. 7. 2f.	Inf. Salomonis	196. 30. 7. 2f.
<i>Duma</i> Duma	22. 10. 8. 30.		204. 30. 8. 30.
<i>Gano</i> Gano	21. o. 16. 4f.	Mare del Zur	203. o. 16. 4f.
<i>Calina</i> Calina	18. 3f. 14. 30.	Malarta Infula	208. 3f. 14. 30.
<i>Zofera</i> Zofera	3f. 29. 14. 2f.	M. del Zur.	207. o. 9. 27.
<i>Borno</i> Borno	4f. o. 14. 10.	Infula quasi	21f. 29. 11. 2f.
<i>Magdalen</i> Magdalen	4f. o. 14. 10.		221. o. 13. 20.
<i>Nubia</i> Nubia	48. o. 15. o.		228. o. 15. o.
<i>Buira</i> Buira	36. 30. 6. 30.	Mare del Zur.	216. 30. 6. 30.
<i>Medra</i> Medra	4f. o. 7. o.		224. o. 7. o.
<i>Dafila</i> Dafila	61. o. 17. 20.		221. o. 17. 10.
<i>Barnagallo</i> Barnagallo	61. o. 14. 20.		221. o. 14. 10.
<i>Dangall</i> Dangall	69. o. 10. 10.		229. o. 10. 10.
<i>Dobas</i> Dobas	67. 30. 9. 30.		227. 30. 9. 30.
<i>Superior</i> Superior	Trigemalensis 30. 9. 30.		228. 30. 9. 30.
<i>Angioncan</i> Angioncan	48. 30. 6. 30.		226. 30. 6. 30.
<i>Vangre</i> Vangre	44. 20. 6. 30.		226. 20. 6. 30.
<i>Betragante</i> Betragante	17. o. 4. 30.		217. o. 4. 30.
<i>Angue</i> Angue	61. 30. 4. 30.		241. 30. 4. 30.
<i>Bull</i> Bull	49. o. 4. o.		249. o. 4. o.
<i>Falgar</i> Falgar	67. 30. 4. o.		247. 30. 4. o.
<i>Obbi</i> Obbi	61. 30. 3. 30.		242. 30. 3. 30.
<i>Bata</i> Bata	64. 30. 2. 30.		244. 30. 2. 30.

Magnus Steen and Andreas Prys published a geographical thesis in 1694 which among other things discussed the problem of the existence of antipodes. They regarded it as the ignorance of the ancient philosophers to claim that people could not live on the "lower" hemisphere of the Earth. Steen and Prys mean by antipodes people who live at the point formed by the respective latitude of the southern hemisphere, and longitude opposite to the location of the spectator. This table shows the degree points where the antipodes for certain European areas are located.

There were no problems with gravity for the antipodes. Every *corpus gravis*, including the bodies of men tend towards the centre of the Universe, which is the centre of the Earth, irrespective of whether they are located on the northern or the southern part of the globe. The concept of gravity as it was understood in qualitative physics was in general very consistently applied to different kinds of explanations. In a thesis dating from the 1690's we meet the idea that all people living on the other side of the globe actually had originally descended from the northern hemisphere. There were isthmuses between continents, which had made it possible for the people to migrate in the distant past.²⁹⁰ The idea of Scandinavia as the cradle of peoples was one of the favourites of gothic historiography, which was prevalent at the time.²⁹¹

Much of the Earth consisted of water in addition to continents. Ocean, it was thought, was one big continuous body, which simply had different names in different parts of the world. Lakes situated in the middle of the continents were also connected to the big ocean by underground tunnels, which occasionally enlarged into huge underground lakes or water reservoirs. Whirlpools and maelstroms were caused in seas where the seawater was being sucked into the underground tunnels.²⁹² The salinity of seawater received attention in one dissertation. It was thought impossible that the water could be as salty as it was if salt dissolved into water from soil. It was ultimately the form of the Ocean which determined its salinity, but the final causes also explained why this was so:

...we shall say that God created seas Salty in the first Creation, doing this for two purposes especially; namely so that certain fishes... would have a suitable and appropriate dwelling place, ...and that moreover the water would end up more coarse, dense, and full-bodied in order that its middling density would carry loaded ships comfortably.²⁹³

²⁹⁰ Steen-Pryss 1694, p. 10, § V. "Robur probationi nostrae tertio addet, quod com-pertissimum sit & viam ad Antipodes esse & hos originem ex nostro Orbe tra-here."

²⁹¹ Urpilainen 1993, p. 33-37, 185-188.

²⁹² Hahn-Melliin 1687, p. 2-4. Hahn-Arelus 1689. Achrelus 1682, p. 205-206, 213-222. Achrelus-Hagman 1681, Mom. II. Tammelin-Thorwöste 1703, p. 10-18. Hahn-Hahn 1702, passim. Hahn-Ring 1688, p. 41.

²⁹³ Hahn-Melliin 1687, p. 16. "...dicimus Deum ab initio creationis mare Salsum creasse, & hoc, ob finem duplicem praecipue, scilicet ut quidam pisces, ...aptum

Physical discussions about the structure of the Earth are not extensive. They are either very general and descriptive in character or they deal with isolated problems such as the existence of antipodes or the salinity of the seawater. A relatively popular problem was the question about the origin of springs.

The Origin of Springs and Rivers

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If the form of seawater explained its salinity, there was another problem related to it which was less easily solved, and had already occupied the minds of Aristotle and Seneca: what was the origin of springs and rivers? Where did the water come from? What was the secret of their supply, why did they not run dry? Basic explanations of these problems had been already given in classical antiquity. Either there had to be a huge underground water reservoir, or hidden channels would have to bring the water from the Ocean to the springs. The amount of rainwater was considered to be too small by itself to maintain huge streams. Aristotle's answer to the question had been that the water of rivers and springs was "sweat of mountains", i.e. underground vapour condensed into water. Seneca, on the other hand, based his explanation on the transmutation of the elements. The element earth could turn into water, and because everything was made of the elements, which were in a constant process of transmutation into one another, the adequacy of water was guaranteed. As Seneca puts it, "Nothing which returns to itself will run out."²⁹⁴ Because the theory of the transmutation of the elements was rejected at Turku, Seneca's theory was not approved of either.

The generally accepted theory at Turku runs as follows. Winds and tides agitate the surface of the Ocean. This creates pressure which pushes water forward into underground tunnels. The pressure is high enough for the water to run through these tunnels all the way up to the tops of high mountains. Achrelius, who seems to have been especially keen on the problem, mentions an experiment made by the great encyclopedic scholar Athanasius Kircher, who "tried to illustrate

commodumque nanciscerentur habitaculum, ...cum exinde corpulentius, crassius densiusque evadit, adeò ut hac sua mediocri crassitie comode pondera ac navigia sustinere posset."

²⁹⁴ Aristotle 1978, I Ch. XIII. Seneca, 1971, III, 4-13. "*Nihil deficit quod in se redit.*" On transmutation of earth into water 10-13.



The so-called internal explanation models for the functioning of the hydrological system of Earth were fashionable in the seventeenth century. This model is presented by Athanasius Kircher in his widely-read book *Mundus Subterraneus* (1664). The entire circulation of water happens on the surface or underground. Seawater is sucked into subterranean channels, which causes dangerous whirlpools on the surface of the sea. The underground channels lead water upwards, where they can form lakes or wells, and the rivers bring the water back to the sea.

with his instruments, invented for this purpose, that the waters of a stormy sea can rise with the power of pressure."²⁹⁵ Although Kircher's experiment had not been very successful, his theory was nevertheless considered true. Seawater rose in the tunnels partly in a liquid, partly in an evaporated form. (The evaporation was caused by the underground fire.) Near the earth's surface the vapour finally condensed and thus formed a spring.²⁹⁶

²⁹⁵ Achrelius-Hagman 1681, Mom. II. "*machinis suis ad hanc rem inventis modum illustrare coepit, quo aquae aestuantis maris vi pressae sursum ferri possunt*".

²⁹⁶ Achrelius-Hagman 1681, Mom. II. Achrelius-Rungius 1686, p. 12-13. Hahn-Ring 1688, p. 23 ff. See also Frängsmyr 1969, p. 26-32. Kajander 1986, p. 32-46, 125-127.

The question was not settled by this, however. If springs and rivers were made of seawater, why was the water in springs not salty as well? Achrelius rebuffs this potential counter-argument by saying that water percolated through the soil on its way, so that no salt was left in the spring-water. Some springs were also known to have either medical or lethal properties, leached *from* the soil into the water. From springs water ran to small brooks, which gradually grew into rivers. All rivers ran into lakes, seas and finally to the Ocean, which thereby received back the water which had been sucked into underground channels. Water was in constant circulation, just like humours in human body. It was a sign that the Mother Earth was alive.²⁹⁷

Mineralogy

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Minerals were classified into four groups: stones, gems, metals and "ordinary soil". All of them were meant to be useful for and to be used by men. Uses of minerals ranged from agriculture to mining and from medical purposes to showing off gold and precious stones.²⁹⁸ In 17th-century Sweden, the copper mining industry had experienced a boom. Mercantilism saw iron and copper mines as the surest source of wealth for the nation. University scholarship, however, stayed aloof from the mining business and research on either the minerals or the techniques for treating the ore were neglected.²⁹⁹ At Turku, only one dissertation dealing with iron and steel was published, written in accordance with the usual academic tradition.³⁰⁰ This situation changed only in the 18th century, when regional descriptions became popular. These descriptions included a growing amount of knowledge about natural resources.³⁰¹

²⁹⁷ Achrelius-Hagman 1681, Mom. II. Achrelius-Rungius 1686, p. 14-15, 18, on medical properties, etc. p. 19-58. Achrelius 1682, p. 218-222. See also Kallinen 1991a, p. 77-83.

²⁹⁸ Thauvonius-Warelius 1652, Sec.II, Membr. III, Art.II, Th. 2. Thauvonius-Waënerus 1655, Th. VII. Hahn-Pijhlgreen 1705, p. 15-16 is sceptical about the benefits of gold in medicine. Achrelius 1682, p. 244-249, 255-261, 265-269, et passim. Hahn-Ståålhöös 1688, 26-27, et passim.

²⁹⁹ The development of chemistry and geology in Sweden were linked to the industry only sporadically during the 17th century. See Lindroth 1975, p. 515-529.

³⁰⁰ Hahn-Ståålhöös 1688.

³⁰¹ Klinge 1987, p. 623-630, 634-639, 668-703. Leikola 1987, p. 631-633, 640-667.

It was a well-established theory in the alchemical tradition that metals and minerals consisted of sulphur and mercury. Paracelsus added a third ingredient, salt, to metals. Salt, sulphur and mercury were material constituents of metals according to the theories favoured at Turku too. These principles were responsible for certain properties in them. For example, salt gave iron its hardness, sulphur made it meltable in fire and mercury malleable,³⁰² but these three principles played a further role in the *generation* of metals.

According to the theories favoured at Turku in the 17th century, metals and minerals would generate like all other species in world. This was because

The Divine Architect decreed wisely that generation follows from corruption and corruption from generation, in an alternating order of which the duration of things consists of. And he founded the order and perfection of the world on this admirable alternation of things following each other in their turn.³⁰³

All generation was mediated by semen, even the generation of metals and minerals. Metallic semen consisted of salt, sulphur and mercury, which were omnipresent in nature - *prima mista* as they were. Thus the seminal virtue was everywhere and initiated the generation of metals as well as animals. Unlike the forms of animals and plants, the forms of metals were not animated. Theirs would lie hidden in the seminal salt-sulphur-mercury mixture, until astral influence stimulated the generation process to begin. The "petrifying form" (*forma lapidifica*) attracted humours from the soil with its magnetic ability, and the underground heat gradually coagulated and hardened the mixture. The materials available and the duration of the process determined the quality of the metal. For example, gold was made of the noblest materials and its process of formation was long.³⁰⁴

³⁰² Hahn-Ståålhöös 1688, p. 4. Achrelius 1682, p. 243-244.

³⁰³ Hahn-Pijhlgreen 1705, p. 4. "Divinus Architectus, quo consisteret rerum duratio, sapienter ordinaverit, ut alternis legibus, generatio corruptionem, & corruptionem nova exciperet generatio, staretque ordo mundi & perfectio in hac admiranda rerum alternatim sese consequentium vicissitudine." See also Hahn-Ulholm 1689, p. 6.

³⁰⁴ Thauvonius-Waënerus 1655, Th. II-III. Thauvonius-Warelius 1652, Sec.II, Membr. III, Art.II, Ax. 1-2. Miltopaeus-Achrelius 1672, Sect. II. § 5. Achrelius 1682, p. 239-242, 265-266, et passim. Hahn-Pijhlgreen 1705, p. 5-6. Hahn-Ståålhöös 1688, p. 4-11. Hahn-Ljungdahl 1704, p. 34-36.



Stones, which represented almost perfect images of plants and animals were the subject of great wonder during the seventeenth century. A Danish philosopher, Nicolaus Steno claimed that these "figured stones" were actually remains of extinct animals. This view was not accepted at Turku, where neither the extinction nor the birth of new species was considered possible. These figured stones were discussed by Kircher in *Mundus Subterraneus*. Kircher also described stones which represented images of the Virgin Mary and other saints.

Stones could be generated wherever the seminal virtue and the ingredients necessary were present: in wine bottles, in fruit and in human intestines. Stones could even be generated in the air and be thrown to earth with lightning.³⁰⁵ The most curious kind of stone was that, in which "images of certain animals, plants and herbs are being inprinted."³⁰⁶ Several causes of the origin of fossils³⁰⁷ were suggested. First of all, plant and animal figures could be formed by chance, purely

³⁰⁵ Hahn-Ulholm 1689, p. 20-24.

³⁰⁶ Hahn-Ulholm 1689, p. 26. "...quorundam animalium, nec non plantarum & herbarum imagines exprimuntur".

³⁰⁷ I deliberately choose here to use an anachronistic concept "fossil". In the 17th century, fossils were usually known as "figured stones".

by the function of the *spiritus lapidificus*. However, "in those which have been formed by chance there are always some defects and they do not constitute a coherent figure."³⁰⁸ Perfect animal figures could actually be animals, which had been displaced from their normal environment, like fishes thrown on land by storms. Lapidification could happen rather easily, because animal bodies also contained salt, which was the primary matter for stones. All that was needed for the formation of a fossil was a minor change in the state and order of the salt particles.³⁰⁹ The questions that were so puzzling about the fossils were never asked aloud at Turku, where the extinction of species was thought to be a theological and philosophical absurdity.

Not only was the generation of minerals a frequently studied question in 17th-century natural philosophy, but the old question about transmutation of metals was also discussed regularly. The extent of these transmutations and the reliability of the results was also under discussion among alchemists themselves.³¹⁰ At Turku there was no suspicion about the possibility of transmutation of "imperfect" metals (copper, iron, tin and lead) into each other or into gold. Sometimes metals could transmute spontaneously, without any human intervention. In these cases it was usually a question of more noble metals degenerating into less valuable ones. But how was this transmutation possible, if the very transformation of elements was refuted because of the doctrine according to which specific forms could not change? The answer was based on the concept of subordinated forms:

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The transmutation of these metals occurs by nature, though it is assisted by art. ...It is true however that their specific forms cannot mutate; but after they have dissolved, the subordinate forms which previously were hidden under the dominance of the specific form, can then exert their powers.³¹¹

³⁰⁸ Hahn-Ulholm 1689, p. 27. "...in hisce, quae fortuito fiunt, semper aliquid desit ad integram figuram constituendam."

³⁰⁹ Hahn-Ulholm 1689, p. 26-30. See also Achrelius 1682, p. 255-259. Kircher 1664 II, p. 22-36.

³¹⁰ Debus 1973, p. 27-34.

³¹¹ Alanus-Ulstadius 1647, Th. VII. "Horum itaque metallorum inter se transmutatio fit per naturam, succurrente arte. ...Sed id verum est de formis eorum specificis, quae mutari non possunt, sed cum illae tolluntur, subordinatae, quae antè latuere, cum sub specificae dominio fuere, postea vires suas exerunt."

Subordinated forms belonged to the realm of nature, but it would need human help to manipulate the specific form so that it would give way to the subordinated forms. Another thing which was called on to testify for transformations was just "the experience of learned men" (*virorum doctorum experientia*). The experiments described by Danish chemist Bartholin especially were referred to with respect.³¹² From the point of view of matter transmutation was possible, because everything consisted basically of the same elements and chemical principles. Changing their relations could at least in theory transform one metal into another.³¹³

Magnetism

In the 17th-century natural philosophical thought nature was filled with many kind of "forces", either recognisable or occult. One of the most important was called magnetism, which was of two kinds. On the one hand there was the phenomenon which we also know as magnetism, i.e. mineral magnetism. On the other hand there was a varying group of phenomena, which were explained by the function of "magnetic forces". Very often this "occult" magnetism was related to the so-called forces of sympathy and antipathy.

Mineral magnetism was a phenomenon which was known already to Theophrastus in antiquity, and its basic features had been relatively accurately described in the Middle Ages. For example a little book written by Petrus Peregrinus in 1269 describes the relation of the magnet to iron and the tendency of a magnet to attract its opposite and repel the similar parts. At turn of the 17th century discussion about magnets intensified, not least due to William Gilbert's famous *De magnete*.³¹⁴

The descriptions of mineral magnetism written at Turku did not add much to the picture we get from the medieval authors. Magnets were formed in the same way as all other stones "from Magnetic vapour in its proper matrix being solidified by the petrifying force".³¹⁵

³¹² Alanus-Ulstadius 1647, Th. VII. Thauvonius-Waënerus 1655, Th. VI. Thauvonius-Warelius 1652, Sec.II, Membr. III, Art.II, Ax.3.

³¹³ Hahn-Pijhlgreen 1705, p. 17-19, adopts a cautious and somewhat suspicious attitude towards transformation of gold. His suspicions are the classical ones already expressed by Agricola in his *De re metallica* in 1555.

³¹⁴ Dijksterhuis 1969, p. 153, 391-396.

³¹⁵ Hahn-Procopoeus 1698b, p. 11, et passim. "*ex vapore Magnetico in sua matrice*

Some properties of magnets caused a serious anomaly in Aristotelian physics. How was it possible that magnet could attract iron at a distance, since one of the most fundamental principles of the Aristotelian physics was that "all action happens through a contact" (*omnis actio fiat per contactum*). Traditionally this problem had been solved by claiming that magnet emitted a quality or a magnetic spirit which filled the space between iron and magnet. At Turku, the corpuscular theory that magnets emit atoms which attract iron provided a solution to the problem.³¹⁶ Explanations based on corpuscular and atomic theories are not necessarily mechanical, and not in this case either. The power of the magnet to attract or repel iron was clearly a qualitative one and thus pertained to the form originally created by God to be such.

Mineral magnetism was in fact just another manifestation of the magnetic force which was thought to pervade inanimate as well as living nature.³¹⁷ It was regarded as a some kind of code or a pattern of inevitable behaviour in nature, which pattern resides in the forms of things. As a phenomenon magnetism was closely related to sympathy and antipathy. The theory of sympathy and antipathy in nature already proposed by Empedocles was still popular among some 17th-century scholars. It is often difficult - and it might even be factitious - to differentiate between magnetism and sympathy-antipathy relations.³¹⁸ However, magnetism was in principle a one-sided process of repulsion or attraction, whereas for sympathy-antipathy relations two active agents were needed. Because the causes of both of these processes were similar, I shall not discuss them separately.

The causes of magnetism were diverse. Because of the great variety of effects, it was thought inappropriate to refer all of them to one single universal cause, say, the action of intelligences or celestial influence.³¹⁹ The most profound and systematic discussion of the causes

per vim lapidificam coalescente". Achrelus 1682, p. 262-265. Kallinen 1991a, p. 94.

³¹⁶ Hahn-Procopoeus 1698b, p. 20-21.

³¹⁷ See e.g. Hahn-Procopoeus 1698, p. 3. "amicam certè ejus [magnetis] cum stella polari consentionem, qva licet in hujus amplexus pondere suo praepeditus, non possit peringere..."

³¹⁸ Miltopaeus-Achrelus 1672, Sect. III. §1. "siquidem omnis hujusmodi virtus rebus inexistens secundum analogian quandam magnetis, per attractuum dispulsionem-que contigit: qui quidem attractus, sicut in amore quodam, quo res naturali appetitu similia sibi, bona, amicaque unire appetunt, ita dispulsus in odio quodam, quo dissimilia, mala inimicaque à se removere conantur consistit."

of magnetism and sympathy-antipathy can be found in writings of the professor of eloquence, Daniel Achrelius.³²⁰ However, similar ideas appear in several other dissertations by other authors, some of which show very well what kind of processes were presumed to exist in nature.

Primary qualities were responsible for sympathy-antipathy relations e.g. in those cases, when a "cold" disease could be cured by restoring the harmonious state of the body with a "hot" medicine. It was also believed, for example, that an ostrich could develop such a heat in its stomach that it could digest an iron needle in a day. Objects could also emit vapour or *effluvium*, which included certain qualities, which affected a receiver. Therefore there was an eternal animosity between vine and cabbage; certain diseases were contagious, and some people hated cats. The different qualities or dispositions of subjects (receivers of *effluvia*) also played an important role in sympathy-antipathy relations. It was the disposition of the subject which caused some diseases to be harmless to European people, but lethal to the population of *Nova Hispania*. The influence of the heavenly bodies also caused considerable effects on earth. Not only did some plants follow the movements of their respective planets, like the sunflower the movements of the Sun, but tides and the movements of the Ocean were agitated by the Moon.³²¹

Several more effects of magnetical or sympathy-antipathy relations could be described. In all, these phenomena form a curious mixture of causes. Only on occasions was there clearly a mechanical element combined with the theory of *effluvia*. For example some processes "...have their causes in the constitution of the pores. In this way, because of the tightness of the pores, steel is immune to the fire."³²² However, the absolutely greatest role was played by the substantial qualities of objects. These qualities always functioned immaterially, by virtue. Even the tiny corpuscles forming the *effluvia* were subject to qualitative physics, for every corpuscle bore all the substantial qua-

³¹⁹ Achrelius-Hagert 1689, p. 8-9.

³²⁰ On Achrelius' concepts of magnetism and sympathy-antipathy see Kallinen 1991b.

³²¹ Miltopaeus-Achrelius 1672, Sect. III. Achrelius 1682, p. 48-59, 227-232, et passim. Achrelius-Hagert 1689, p. 9-14, 25-30, et passim. Hahn-Aeimelaus 1698, passim.

³²² Achrelius-Hagert 1689, p. 12. "*causas petunt à constitutione pororum, qva ratione Adamantem, ob pororum angustias, ab igne immunem volunt*".

lities of the body which it was emitted from. This was possible because form was immaterial and could exist "*tota in quolibet parte totius*".

In this section I have somewhat artificially mapped under the same title such widely differing subjects as mathematical geography, mineralogy and magnetism. These subjects were not seen to form any coherent branch of knowledge called "geography". However, this procedure might be justified for purposes of discussion, especially if seen in the sense in which Seneca discerned three main areas for the scrutiny of nature; namely, the celestial, the sublime, and the terrestrial. But our study of the latter region has only been begun by examining inanimate nature. "Biology", the study of living nature, was even more central to 17th-century physics.

5. LIVING NATURE

There is a multitude of old and new approaches to the study of the living nature to be found in the 17th-century European history of science so that it is not easy to outline the background of natural history at Turku either. We can in general discern at least two different trends in all studies of living nature during the sixteenth and seventeenth centuries, although they became intertwined to some extent. On one hand there was the Aristotelian study of the general concepts of life, such as generation or soul. On the other hand natural history (including both botany and zoology) saw a great upswing during the Renaissance. Tended in the herbaries of the medieval monasteries, botany began to have a much wider economic importance since the Age of Discovery. The flood of new and unknown plants from the 15th century on encouraged the work of naming and describing plants, drawing attention to the domestic species too, which had for the most part been neglected in the Dioscoridean tradition. Moreover, much of botany was still connected more with medicine than natural philosophy.³²³ In zoology huge compilations e.g. by Gesner and Aldrovandi were published. Gesner started a typically Renaissance genre of zoo-

³²³ Morton 1981. Schmitt 1984, XIV. Reeds 1991.

logy, which reached its full expression in the work of Aldrovandi. Its main aim was not to describe animal anatomy and place animals in their proper taxonomic slot, but most of all to display the complexity of the associations and symbolic meanings of each animal species. By the 1660's this rich "emblematic" approach had disappeared to leave natural history to confront the ever-growing flood of "new" species devoid of allegorical or mythological connotations.³²⁴

The Renaissance interest in classical authors not only revised their texts but also revived long-forgotten perspectives on nature. For example plant physiology, which had been favoured to some extent by Theophrastus, was the subject of new interest. New approaches to living nature were formed by it together with the rise of anatomy (especially human anatomy after Vesalius) and physiology, some less directly "biological" studies, and finally the new empirical and mechanical philosophies. The investigation of the structure, growth and germination of plants became a favoured branch of study especially among the 17th-century microscopists and mechanical philosophers such as Nehemiah Grew, Marcello Malpighi and John Ray.³²⁵ A similar tendency can be discerned in zoology, where dissection - and in the 17th century microscopic examination - opened new views on the theories of the vital functions of animals. If the sixteenth century had been the one of emblematics and anatomy, the 17th century was characterized by mechanization of vital processes in plants, animals and even humans.

In Sweden scholastic study dominated at the Universities. Plants and animals were studied from the viewpoint of Aristotelian causal theory, and classified according to classical standards. Cartesian ideas reached Uppsala in the 1660's, which caused a certain agitation in almost all learning and scientific practices. Botany in Sweden was also affected by these new ideas.³²⁶ At Turku traditional views kept their place for much longer. Scholastic-style classification still played an important role, although some studies on individual species were also published. Let us now see what kinds of biological problems were studied at Turku during the 17th century, and how scholarship there can be related to wider European traditions.

Two themes dominated the study of living nature in 17th-century

³²⁴ On Renaissance natural history see Ashworth 1990.

³²⁵ Morton 1981. Ashworth 1990. Brown 1968.

³²⁶ Eriksson 1969.

Turku. Firstly, the faculties of vegetative, sensitive and rational souls were accurately analysed. This was because all species in nature were different in their degree of perfection. It was important to understand the number of faculties of the souls of living beings, because in this way could the degree of the species' perfection be induced.³²⁷ Perhaps more important was, however, that the physiological functions in plants and animals were explained by referring to faculties. The second central theme in "biology" was generation and corruption. Theories of generation were closely connected to metaphysical and natural philosophical ideas on the propagation of form. In the following chapter I shall offer an overview of thinking in botany and zoology, but the main interest will be focused on the theories concerning generation and corruption and the vegetative and sensitive soul. A certain amount of repetition is difficult to avoid in doing this. The properties of the rational soul will be dealt with more appropriately in the context of human psychology.

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Vegetative and Sensitive Souls

In traditional Aristotelian philosophy living beings were grouped into three classes according to the number of organic functions they could perform. It could be said that an unofficial fourth class of quasi-living minerals was later added to this scheme. As we have seen, minerals were thought to generate from a semen-like entity, but they were not considered to be really alive. The lowest degree of living forms or souls was that found in plants. Plants were only able to generate and grow, whereas animals could in addition to these functions also sense and move. The sensitive soul of animals was really at a relatively well-developed level of existence. It was, however, only the rational soul of humans to which intelligence, volition and ability to speech and laughter also pertained. We can possibly see the sense in the Aristotelian practice of scrutinizing the faculties of souls better, if we keep in mind the connection these faculties had to the actual state of being of the whole organism. The faculties were not important only from the point of view of metaphysical theory, but the soul of each living being expressed itself as different physiological functions.

³²⁷ Cf. Steneck 1976, p. 106-107, 112-113.

The vegetative soul was the general form of all plants, although every species had an additional specific form. Every plant had three principal faculties: *facultas generativa*, by which the plant produced new individuals of the same species, *facultas augmentativa*, which was responsible for the growth of the plant and thirdly there was *facultas nutritiva*, which maintained the living functions of a plant. Nutrition had moreover some additional, "secondary" faculties, which made the process of digestion possible by attracting, repelling and "cooking" the nutriment. The generative faculty also had so-called formative and imitative forces assisting it.³²⁸

Every animal soul had, first of all, the faculties of the lower rank of beings. It was typical that in animals certain secondary faculties were more complicated than in plants, like those assisting digestion.³²⁹ The proper faculties of sensitive souls were *facultas cognoscens*, *appetens* and *loco movens*. The locomotive faculty enabled an animal to move from place to place in order to reach an object or to escape from it. Knowing whether it was salutary for the animal to escape or to reach for an object was obtained by the appetitive faculty. It was, however, the *facultas cognoscens* or sensation, which "perceives and judges upon sensible objects by mediation of certain bodily organs", which received most attention among writers.³³⁰ The techniques of animal movement however were left totally without notice. The faculties of vegetative and sensitive souls did thus explain to a great extent the diverse functions of plants and animals. Physiology and anatomy were seldom dealt with independently. For example in discussions of sensation the structure of sense organs, especially of the eye and the ear, was sometimes described.³³¹

The existence of the animal soul had been called into question by Cartesian philosophy, which claimed that since animal bodies were nothing but finely-structured machines animals could not sense or feel anything. This concept was fiercely objected to by Aristotelian philosophers. Although some bodily functions could be caused by the mechanical principles, the variety of movements and expressions of

³²⁸ Gezelius 1672, p. 280-281. Hahn-Hasselqvist 1698, p. 14-15. Thauvonius-Rosander 1652, Th. XXVI. Thauvonius-Thuronius 1656.

³²⁹ Thauvonius-Thuronius 1656, Th. III.

³³⁰ Thauvonius-Rosander 1652, Th. XXVIII-XXXI. "... mediante certo corporis organo objecta sensibilia percipit & dijudicat..." Petraeus-Ignatius 1673. We shall treat sensation more closely in the chapter on human perception.

³³¹ Thuronius-Teeth 1664, Sectio II.

sensation could not be explained without recourse to an immaterial substance. Some authors went as far as to grant feelings like love, hatred, hope and fear to animals.³³²

Spontaneous Generation

Aram Vartanian defines in the *Dictionary of the History of Ideas* spontaneous generation as follows:

SPONTANEOUS GENERATION is the idea that life is derived from any source other than an already existing, genetically related parent organism. Its two main versions will be further defined as *abiogenesis*, or the production of living things from nonorganic matter, and *heterogenesis*, or the rise of living things from organic matter, both animate and inanimate, without genetic resemblance or continuity.³³³

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In this definition, we have to adopt a very broad meaning for the word "genetic" in order not to be anachronistic when talking about ancient and Renaissance ideas about generation. The conception of spontaneous generation has been an integral part of biological thinking since antiquity both in philosophy and in popular beliefs. The question was also closely linked with the origin of form and was widely discussed during the 16th and 17th centuries.³³⁴ Although abiogenetic theories attracted the mechanistically-orientated philosophers in the 17th century especially, it was usually refuted at Turku. On one occasion only was a problem related to the possibility of abiogenesis handled as a more positive possibility.³³⁵ Cartesianism posed problems related to abiogenesis, too, in its denial of the animal soul. This difficulty will be handled in chapter "Cartesianism and Natural Philosop-

³³² Miltopaeus-Pryss 1668, Th. XIII. Achrelius 1682, passim. Hahn-Ruda 1695, passim. p. 9: "Materia enim seipsam informare & determinare nequit, illa enim semper habetur principium non activum sed passivum, qvo videlicet anima utitur ut instrumento." Hahn-Nidelström 1704.

³³³ Vartanian 1973, p. 307.

³³⁴ Lindroth 1939, p. 162-166, et passim.

³³⁵ Achrelius 1682 studied the possibility of palingenesis, which was supposed to be a process in which a new plant of the same species would be formed from ashes. Achrelius denied the possibility of mechanical regeneration, but conceded that semen contained in the ashes might produce growth. See Achrelius 1682, p. 294. Kallinen 1991a, p. 97-99.

hy at Turku". But not even heterogenesis was accepted without reservation. At least the scholars at Turku were reluctant to refer to it by the term *generatio spontanea*.

What kind of attitude did the scholars at the Academy of Turku adopt towards spontaneous generation? Certainly, there were some animals which were supposed to originate in cadavers and dirt. Insects, for instance, would arise from decaying bodies and worms would be generated in human intestines.

It is nevertheless true that bed-bugs generate in beds, crickets in mud, lice in animals, moths in clothing and furs, and small worms, etc. in all places in fruits, herbs, trees and animals.³³⁶

But the question is not as simple as it seems. For example professor Alanus' standpoint has been interpreted in the most obvious way as being favourable to spontaneous generation,³³⁷ but more detailed interpretations could and should be given. We should examine in *which sense* this view can be called advocating spontaneous generation. It is most interesting that the scholars at Turku themselves clearly denied the possibility of spontaneous generation and did not regard the theory of generation they stood for as presupposing it. How did they understand "spontaneous generation", then? How did they understand generation?

According to professor Alanus, "Generation is the production of a new natural body in respect to an individual, not to species, serving the purpose of continuously conserving the species of natural bodies."³³⁸ There was a clear distinction between generation of individuals and the creation of new species. God had created all species at the beginning of the world; none would become extinct or emerge after the sixth and last day of creation. The purpose of generation was to conserve the species, and the means for this was the animated semen. It was expressly the soul (=anima/forma) in semen, which carried the characteristics of both the species and the individual parents.³³⁹

³³⁶ Alanus-Kempe 1647, Th. 34. "Verum quidem est, generari cimices in lectis, gryllos in limo, pediculos in animalibus, blattas in vestimentis & pellibus, ubivis locorum in fruticibus, herbis, arboribus & animalibus vermiculos &c."

³³⁷ Eriksson 1969, p. 55.

³³⁸ Alanus-Lidenius 1643, Th. III. "Generatio est corporis naturalis quoad individuum non quoad speciem nova productio, ut corporum naturalium species perpetuo conserventur."

³³⁹ Alanus-Lidenius 1643, Th. VI, XI, XXIV. Alanus-Jurvelius 1647, Th. XII-XXXIX. Alanus-Kempe 1647, passim. Tålpo-Höök 1690, Th. VII. Hahn-Justander

While fully recognizing the anachronistic character of this analogy, I hope it elucidates the point to say that the soul here played a somewhat similar role in the process of generation as DNA does in modern theories.

The scholars at Turku understood by spontaneous generation the production of individuals of new *species* by generation, but without semen. In fact, it was a sort of "spontaneous creation".

They miss the truth (Albertus Magnus and others) who say that certain animals, which did not exist in the prime creation of the world, originate from putrid matter without any sort of semen, because the world founded by GOD was perfect and complete, thus including all species, hence GOD did not omit any species of the animals which now are to be seen in the world. ...therefore the animals which seem to have arisen from putrefying matter, cannot be denied the semen to which they owe their birth.³⁴⁰

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Spontaneous generation was equated with *generatio aequivoca*, which means either generation outside any existing species, i.e. without semen, or the mutation of species in normal reproduction. As vehemently as the existence of *generatio aequivoca* was refuted, the reality of its opposite, *generatio univoca* was assured: "for every animal in the whole world reproduces from a perfect and pre-existing seminal principle, because nothing can be its own cause and immediate principle".³⁴¹ However, the question of how was it to be explained that there *were* species of plants and insects, which "seem as if they generated spontaneously?" was posed.³⁴² There had to be a theory which would explain the truth of every-day observations. The

1707, Th. VII-VII.

³⁴⁰ Hahn-Imbergh 1704, p. 30-31. "Veritatem etiam celant (Albertus Magnus alique), qui dicunt quædam animalia jam ex putrida nasci materia absque aliquo semine, quæ non fuerunt in prima mundi creatione: quia mundus à DEO conditus fuit perfectus & omnibus numeris absolutus, ergo nullam DEUS omisit speciem illorum animalium, quæ nunc in mundo visuntur. ...Itaque animalibus, quæ videntur ex putrida oriri materia, suum non negandum est semen, cui natales suos debent."

³⁴¹ Hahn-Ljungdahl 1704, p. 11. "nam omnia in universum animalia, & perfecta & ex præexistente seminali principio quotidie generentur, nihil enim potest esse causa & immediatum principium sui ipsius". See also Alanus-Jurvelius 1647, Cor. II. Alanus-Kempe 1647, Th. 9 "...Non dari generationem Aequivocam, qua generans & genitum sunt diversæ speciei..." Hahn-Kjellberg 1703, p. 11-12. On *generatio univoca* & *aequivoca* see Leikola 1965, p. 101 and 1983a, p. 240-241.

³⁴² Hahn-Kjellberg 1703, p. 6. "sponte quasi provenire videntur"

basic explanation had been already given by Alanus and the view did not change for decades. It was the dogma of subordinated forms, which was called to assist:

But furthermore, in investigating the true origin of spontaneously arising insects, it seems true to state that there are underlying and subordinated forms in living creatures. ...these subordinated forms are assistant as long as the superior or specific form of the creature dominates. ...but as soon as this more noble specific form of the living being leaves its seat, which happens in death, the subordinated forms are released in the body and become independent. And excited by the surrounding warmth they reach their due disposition, and elevate into the status of a soul, and join their souls to a body...³⁴³

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This view was derived from the great authority in biological matters, Daniel Sennert, whose theories became popular in Sweden in the 1630's and retained a dominant position at Turku for the whole period.³⁴⁴

There was, however, still another way how apparently spontaneous generation could be explained. It was thought that nature was full of seminal principles or virtues. According to Achrelius, the seminal virtue was hidden in the Paracelsian salt-sulphur-mercury-principle. Being constituted directly of the four elements these principles were present in all matter, and thus their seminal virtue was also ubiquitous. All that was needed for the activation of seminal principles was suitable surroundings or a "matrix" and the presence of a seminal form.³⁴⁵ Here matter would also play a role. It would on its own behalf create the right conditions for the formation of certain species of insects. Achrelius writes:

³⁴³ Hahn-Kjellberg 1703, p. 12-13. "Sed ulterius in indaganda vera insectorum sponte nascentium genesi, consentaneum videtur, formas in viventibus sucenturiatas & subordinatas statuere; ...Hae formae subordinatae, quamdiu forma illa superior sive viventis specifica regnat, ministrae sunt, ...Quamprimum autem forma illa nobilior viventi specifica suo domicilio egreditur, quod fit per mortem, evadunt in cadavere formae subordinatae sui Juris, & à calore ambiente excitatae idoneamque dispositionem nactae sunt, in animae modum elewantur, & corpori suo sese in animam communicant..."

³⁴⁴ On spontaneous generation in Sweden and on Sennert see Lindroth 1939.

³⁴⁵ Achrelius 1682, p. 270-274, 296-298, et passim. Hahn-Uhlholm 1689, passim. Hahn-Ljungdahl 1704, p. 12-15. On Achrelius' conception of seminal virtue see Kallinen 1991a, p. 96-99, 104-105, et passim. Lindroth 1939, 167-168, 176-177.

And the spermatic seeds, warmth and inner virtues of the semen concealed in it [=matter] are fermented and digested, and convenient things are joined to form the suitable dispositions for generation. They form such an animal as postulates the matter, the putrefactions from which the animal is educed. Therefore the constitution of insects arising from rotten mud is different from those arising from water polluted by decay or whatever earthly dirt there is. In the same way the characteristics of those originating from plants is different from those arising from animals.³⁴⁶

Frequent experience would confirm the existence of seminal principles. Young boys and women, who greedily ate sweet fruits exposed themselves to premature death, because the fruits contained *semina* of worms. It was at least as dangerous to drink water from ponds and bogs, because the water was suffused with frog and toad semen.³⁴⁷

Judging by the present criteria of what we understand by spontaneous generation, the scholars at Turku believed in it. Nevertheless, their stand is far from trivial in this matter, because they repeatedly emphasized the crucial role of semen - or subordinated forms - in *every* kind of generation. There seems to have been a desperate need to stress the difference from old, especially Roman Catholic views on generation. This was precisely because of the connection the discussion of spontaneous generation had with the problem of the propagation of form, which was in many ways also a theological matter.

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Botany

In Sweden the two classical literal genres of botany still flourished in the 17th century. On one hand botany was dealt with as a part of Aristotelian-Scholastic natural philosophy. On the other hand, herbals and lists were published, which had more in common with the medical tradition of botany. Scholastic botany acquired a rival in the 1650's,

³⁴⁶ Achrelus 1682, p. 298. "In quæ latentia spermatica initia, calor & interiores seminis virtutes, junctis dextris, ob proximas ad generationem dispositiones, fermentant, digerunt, & in tale animal efformant, quale postulat materia, è cujus putredine educitur, hinc alia est constitutio insectorum, quæ ex limo putrido, aqua tabe correpta, vel ex foetidis quisquilis terreis prodeunt: Alia itidem eorum indoles, quæ ex vegetabilibus & animalibus nascuntur." See also Miltopæus-Achrelus 1672, Sectio II, § 10.

³⁴⁷ Hahn-Ljungdahl 1704, p. 13. See also Hahn-Ulholm 1689, p. 78-79.

when the energetic Olof Rudbeck Sr. was appointed professor of medicine at the University of Uppsala. Having studied abroad he did not hesitate to introduce the new ideas he had learned. In the 1660's he started to promote the new mechanical botany, inspired by Robert Boyle, Marcello Malpighi and Edme Mariotte.³⁴⁸ At Turku, however, botany took a more conservative stance in the 17th century.

Unlike the medieval tradition, which was still followed at Uppsala, botany was clearly associated with general natural philosophy instead of medicine at Turku. The new order was emphasized by the title of the physics professor, which was *Physices & Botanices professor*. The close centuries-old relationship between botany and medicine was not, however, completely broken by this move.

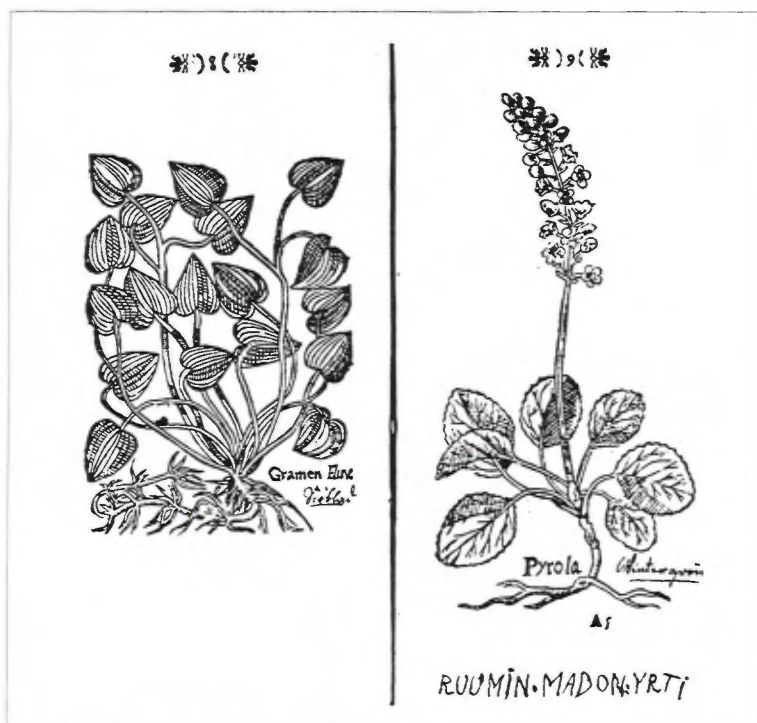
In 1673, the professor of medicine Elias Til-Landz published a list of plant names. Ten years later it was published in a revised edition together with another book, which contained over 150 illustrations of plants,³⁴⁹ clumsy copies from earlier herbals. The main reason for this was probably the expense of printing more refined picture-plates, and more generally the poor equipment of the University Press at Turku. However, it is not self-evident in the 17th century that the pictures necessarily were expected to produce perfectly realistic reproductions of the plants. The "rhetoric of realism" in illustration was certainly a rising trend during the 17th century, and the most spectacular books in this respect, Otto Brunfels' *Herbarium vivae eicones* and Leonhard Fuchs' *De historia stirpium*, had already been published in 1530 and 1542 respectively. But were the cheaper books expected to meet the same standards? In a way, a good picture was like an authoritative statement: it was simple enough to be replicated whenever necessary, and everyone knew what was meant by it.³⁵⁰

In spite of the not so realistic character of illustration in Til-Landz's plantbook, his effort was an interesting one, not least because it described local plants growing in the surroundings of Turku. Swedish and Finnish names of the plants were given in addition to Latin names. Like its well-known models, the herbal books of Fuchs, Matthioli,

³⁴⁸ Eriksson 1969.

³⁴⁹ Til-Landz 1683a and 1683b. See also Leikola 1993, p. 63-64.

³⁵⁰ Reeds 1991, p. 145-146. The immediate advantage which the illustration might have brought to the identification of plants is more than dubious. Most printers favored cheap, ready-made plates, which were not always very realistic in style; they were also often used carelessly. See also Kemp 1993.



The 1683 edition of *Catalogus plantarum* also included pictures of the main species of the plants. Although some of the plants can be recognized from the pictures, it was not self-evident that the images were even meant to be perfectly realistic. Teaching the medical use of plants was the motivation in Til-Landz's book: the "winter-green" or "cadaver-worm herb" (on the right) was mentioned as especially good for curing wounds.

Tabernamontanus and Lobelius - to mention just a few of the most established botanical works - Til-Landz's book displayed knowledge relevant to medical botany: descriptions of plants and their habitats, their medicinal properties and pharmaceutical use, his own notions and observations, etc. Here the properties of plants were expressly based on Galenic humoral doctrine.³⁵¹ Had medicine been a more popular subject at Turku, herbal medicine might have flourished more.

³⁵¹ Til-Landz 1683a. Advanced medical studies were carried abroad until the mid-18th century. The first professor in medicine, Eric Achrelius (professor 1640-69) could not publish any dissertations because of the lack of students. See also Reeds 1991, p. 146-147.

During the sixteenth century Italian universities rose to a leading position in botany. Moreover, the instruction in botany was there strikingly practical in nature.³⁵² Echoes of this had reached Turku too, for it was not unusual for Til-Landz to take his students out on excursions, to identify plants and herbs on site.³⁵³ There also obviously was a small botanic garden in Turku, although its significance for academical teaching has been regarded as low during this century.³⁵⁴ Naming and classification of plants seems otherwise to have been an almost neglected branch of knowledge at Turku. In this respect it is Achrelius who presents in his *Contemplationes mundi* the largest scheme for the classification of plants. He borrows his classification principles from Theophrastus, although he is not totally satisfied with the grouping. In establishing criteria for subgroups, the most various kinds of principles could be made use of: the colour of flowers, their odours, the form of fruits or almost anything else could serve as grounds for classification.³⁵⁵

But we must realize that the main aim of the Aristotelian philosophical botany was not to classify plants, but to give as perfect a definition of the subject of study as possible. In order to achieve a full definition, much attention was naturally paid to the four Aristotelian causes of plants, especially the effective cause. The spontaneous generation discussed above was far from the only way for plants to generate. Normal seeding, sprouting, plantlets and grafting were mentioned as more common ways of plant reproduction.³⁵⁶ It may be needless to point out that before Linnè, plants were not ascribed sex.³⁵⁷

Other physiological functions of plants such as nutrition, growth, sympathy-antipathy relations etc. were also discussed. Most authors attributed these functions to the vegetative soul, whilst Achrelius re-

³⁵² Schmitt 1984, XIV, p. 39-40, et passim.

³⁵³ Leikola 1993. According to Leikola professor Thauvionius would also have taken students out on excursions, p. 61.

³⁵⁴ Bremer 1920. The "botanical garden" would actually have existed on Til-Landz's own plot.

³⁵⁵ Achrelius 1682, p. 279-281. On Achrelius see Kallinen 1991, p. 100-102. Hjelt 1896, p. 27-29. See also Hahn-Hasselqwest 1698, p. 32-34 classification of trees. On Theophrastus and his authorship of various biological treatises see Huby 1985. On the philosophical background to (botanical) taxonomy see Slaughter 1982, Ch. 2-3.

³⁵⁶ Alanus-Lidenius 1643, Th. XXV-XXXVII. Hahn-Hasselqwest 1698, Th. XVI-XVII. Achrelius 1682, p. 270-272.

³⁵⁷ Alanus-Lidenius 1643, Th. XXV. Alanus-Kempe 1647, Th. 20. Hahn-Ljungdahl 1704, p. 33.

mained silent about it altogether and explained nutrition by the "magnetic virtue" of a plant.³⁵⁸

These nutriment are not contained only by the interior of the Earth, in the channels of which a copious amount of liquid is wandering for the nourishment of plants, but it is also to be found in the air as well. From there the plants suck this subtle fluid. And should someone wonder how on the same field such a variety of plants can be nourished by attracting one and the same fluid, the explanation is that every plant reaches for only that nutriment which is suitable to its nature, and nothing else.³⁵⁹

This was not, however, the only departure from the Aristotelian faculty theory in explanations of physiological processes. Most conspicuously, Hahn and Lönnwall made use of corpuscular theory in their thesis when explaining the nutritional functions of a plane tree.³⁶⁰

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...the plane tree benefits from its tighter pores, and the material parts in it are connected with each other more tightly than is usual for dry woods, ...elementary particles which nature has intended as nutriment for the trees are attracted through the pores and arranged in various parts of the tree. It should not be called into question that the trees each have their pores, their veins and arteries analogous to similar parts in animals. In these the particles which have ended up as nutriment then circulate, ferment and are converted into the substance of the tree.³⁶¹

³⁵⁸ Achrelius 1682, p. 275-278. See also Kallinen 1991b.

³⁵⁹ Achrelius 1682, p. 277. "Continentur autem ista pabula, non modo intra terram, in cuius rivis copiosus humor ad alendas plantas errat, verum etiam in ipso aere, unde succum, subtilem & defecatum, hauriunt vegetabilia. Nec quempiam moveat, in uno campo, ex unius humoris attractu, tantam diversitatem plantarum nasci; quia una quaelibet herba, ex communi alimento, id tantum & non aliud appetit, qua quod naturae suae oppido est conforme."

³⁶⁰ Hahn-Lönnwall 1695, p. 12-13, et passim. Eriksson 1969, p. 88, 123 sees botany at Turku as heavily influenced by Cartesianism. "Med Petrus Hahn slutligen ...erövrar naturläran inklusive botaniken definitivt av cartesianismen även i Åbo." Whilst it is true that Achrelius refers in 1682 to Descartes in his treatment of the colours of plants (p. 282-284), the claim is nevertheless quite overstated. For example Lönnwall's corpuscularism is restricted almost exclusively to the theory of nutrition, and even that resembles not only Cartesian but Sennertian corpuscularism as well.

³⁶¹ Hahn-Lönnwall 1695, p. 12-13. "...arctioribus gaudeat platanus poris, arctiusque

Lönnwall attributes circulation of nutriments to plants, analogous to the circulation of the blood, and offers a vivid image of the physiology of the plane tree.

Although no comments on the respective validity of these three theories are known, it is fairly safe to suppose that no fundamental disagreement arose. These theories could have been seen as presenting the same thing from different viewpoints: a vegetative soul would have a "magnetic virtue", which performed its functions with the aid of corpuscles. After all, it had never been fully explained, in what way the nutritive faculty of the vegetative soul physically operated, which left room for various physiological explanations. In this respect 17th-century natural philosophy was very flexible and tolerant.

Although it was clearly stated that once created, species could not change nor become extinct, it was supposed that some individual plants were able to change generically.

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So the *European apple*, planted in Indian soil, produces an entirely different kind of a fruit, whether you inspect its figure, colour, smell or taste. In the same way poisonous plants brought from Asia to Europe produce the most wholesome fruits. *So the authors say that cinnamon, landed outside its proper tracts degenerates to laurel and pepper to ivy. Ginger also, if it is deprived of its native climate, wanes away in its sorrow on foreign land.*³⁶²

Not only were expensive exotic spices subject to alleged mutation. Even more serious problems were caused in agriculture because wheat tended to degenerate into ryegrass (*Lolium*) or barley, and cress into

sese invicem connectant partes materiales, quam alias fit in arboribus siccioribus, ...attrahuntur namque & in varias partes arboreas per poros disponuntur particulae elementares, in alimentum arborum à natura destinatae. Nec in dubium revocari debet, arboribus suos esse poros, suas venas, suasque arterias, per quamdam analogiam cum partibus ejusmodi in animalibus, convenientes, in quibus circulantur, fermentantur, atque in substantiam arboream convertentur, particulae in nutrimentum cedentes."

³⁶² Achrelius 1682, p. 278. "*Sic pomus Europæ, in Indiæ solo plantata, toto coelo differentem fructum parit, sive figuram, colore, odorem, saporemve spectes. Sic venenosæ herbæ, ab Asia vectæ in Europam, saluberrimum fructum producant. Ita cinamomum extra p[ro]p[ri]am, commissum terræ, in laurum; Piper in hederam degenerare, auctores referunt. Zingiber pariter nativo coelo privatum, in aliena tellure maerore conficitur.*"

mint.³⁶³ Explanations of this were several in addition to climatic factors as quoted above. Achrelius accepted a view which emphasizes the role of external physical factors in change.

The cause of these metamorphoses is to be sought in the quality of the location, the operation of the Sun and the stars, the strength of the powers of elements, some characteristic of the nutriments, the various and wondrous mixture of earthly fibres; also from the effect of subterranean fire, which alters and agitates matter by 'cooking' ...³⁶⁴

There was, however, another type of explanation also, which was built on the metaphysical dogmas. Degeneration was caused by the same subordinated forms which were responsible for spontaneous generation too. This explanation was also seen as a saviour from the perilous thought of transmutation of species.

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The specific form of a plant does not mutate into the specific form of another plant, because such transmutation of natural species is impossible. But the inferior form, which in a way was under the superior form like specific matter, is now liberated from its domination and independently constructs itself a suitable dwelling place, and so it becomes a specific form and starts to fulfil the functions belonging to the specific form.³⁶⁵

The tendency to evaluate nature from man's point of view was deeply rooted in natural philosophy. Of course, grain *is* more valuable for man than weed. Philosophically it was also quite a natural thought

³⁶³ Thuronius-Pryss 1664, Th. II. Daniel Sennert's *Hypomnemata physica* was mentioned as a source to this information. Of course, some cultivated plants really do "degenerate" which leads to reduction of crops.

³⁶⁴ Achrelius 1682, p. 278-279. "Quarum metamorphoseon causa, quærenda est, in loci genio, solis siderumquæ operatione, elementarium virtutum energia, alimentorum alia aliave facultate, principiorum naturæ in terrenis fibris varia & mirabili permixtione; tum subterranei ignis efficacia, quæ coquendo alterat agitatquæ materias..." See also Hahn-Ulholm 1689, p. 44-46.

³⁶⁵ Thuronius-Pryss 1664, Th. II. "Non enim forma specifica unius plantæ mutatur in formam specificam alterius plantæ, talis enim transmutatio specierum naturæ est impossibilis, sed forma inferior, quæ antea superiori nempe specificæ instar materiæ suberat, jam dominio illo excusso, ipsa sui juris facta sibi conveniens domicilium extruit, tumquæ fit specifica & specificæ formæ edere incipit operationes."

that transmutation of plants was at the same time always deterioration or degeneration. The phenomenon was caused by subordinate forms, which were already by concept weaker than the specific form. More worthless forms could produce nothing but more useless plants. The concept of subordinated forms was not thus merely a technical term but also had an evaluative tone.

Zoology

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Classification of animals was more or less just a method of presenting the different species in a systematic order in the Renaissance and 17th-century zoological literature. Taxonomy as such was not the main point of interest. Although the classification was chiefly based on Aristotle's old grouping of animals into quadrupeds, birds, fishes and insects, different types of general classifications or orders of presentation of the animal kingdom were introduced during the 17th century.³⁶⁶ In the old Aristotelian system the classification of animals involved a rating of the degree of their perfection, but this was not an explicit motive in studies carried on at Turku. Moreover, it was not usual there to produce any general view on the animal kingdom. The only comprehensive classification scheme which we meet at Turku was offered by Achrelius, who divided animals into the four usual groups and into several subgroups.³⁶⁷ Animals were often given human attributes. It seems that it was one of the more noble aims of zoology overtly to mirror human moral values in animals. Thus lions were considered noble, wolves greedy, doves chaste, camels patient and so on.³⁶⁸

Over and over again one comes across theses where generation is discussed in different contexts. Generation of animals had already been a dominant theme in some medieval treatises, and it was central to zoological inquiry during Alanus' professorship too.³⁶⁹ Professors

³⁶⁶ There is a broad discussion on the importance of classification in Aristotle's zoology. On the more recent research on the subject see e.g. Boylan 1983, p. 59-66, 141-217. Lloyd 1991, p. 4-7. Pellegrin 1986. Slaughter 1982, p. 32-37, et passim. On medieval classification schemes see also Steneck 1976, p. 110-112.

³⁶⁷ Achrelius 1682, p. 306. Hahn-Justander 1688. On Achrelius see Kallinen 1991a, p. 108-114. Hjelt 1896, p. 29-33.

³⁶⁸ Achrelius 1682, p. 307-321. Hahn-Hielmerus 1691, p. 6-7. On association of moral attributes with animals see Ashworth 1990.

³⁶⁹ Steneck 1976, p. 107.

Thauvonius and Thuronius seem to have been less interested in the study of the animal kingdom. Studies on the animal soul were, however, published under their supervision. In the latter part of the 17th century Achrelius and Hahn revived the interest in zoology. Compared with Alanus' time there was a different emphasis in framing the questions and subjects. Studies on individual species or classes of animals, their causes and "differences" now dominated the field.³⁷⁰ Despite the differences between Alanus' and Hahn's literal production there were also some common areas of interest. Most of all, animal anatomy and physiology were discussed regularly.

The importance of generation was based on the fact that it was the act by which the final cause of all plants, animals and humans was completed, namely the conservation of species. This aim had been ordained by God, when he told all his creatures to be fruitful and multiply and to replenish the earth.³⁷¹ Generation from semen in decaying bodies or dirt was only an extreme form of generation among animals as it had been among plants too. Different modes of procreation were considered: viviparous animals (quadrupeds) and humans bred by copulation and oviparous (birds, fishes, reptiles) by coition or spawning. Some extravagant theories were also advanced; pheasants, for example, were thought to have oral copulation.³⁷²

Although contrary to Aristotle's opinion, the idea that both male and female semen were essential for insemination was commonly accepted.³⁷³ A more seriously discussed question seems to have been what semen actually *was*. An opinion which was eagerly rebutted was that semen would be a some sort of an excrement.³⁷⁴

³⁷⁰ This is actually a very Aristotelian practise. For Aristotle the search for differences in animals ("classification") served the purpose of finding the causes of their parts and of their generation and other living functions. Balme 1987, p. 80-89.

³⁷¹ Alanus-Lidenius 1643, Th. VI, IX. Alanus-Jurvelius 1647, Th. XVI, XXI. Alanus-Kempe 1647, Th. 1, 23. Hahn-Ulholm 1689, p. 47-50. Hahn-Ljungdahl 1704, p. 7, 26, 40, 51.

³⁷² Alanus-Lidenius 1643, Th. XXXVII. Achrelius 1682, p. 296-298, 319. Compare: Hahn-Helinus 1694a, p. 12-13 mentions this and other similar theories, but does not seem to believe in them. On other ways of generation see Hahn-Ulholm 1689, *passim*.

³⁷³ Alanus-Kempe 1647, Th. 38. Achrelius-Hwal 1683, p. 57. Hahn-Ulholm 1689, p. 52-53, *et passim*. "...semen autem eorum [leonum], est liquor quidam crassus, candidus & spumans, qui ab utroque sexu emissus digeritur...". Hahn-Helinus 1694a, p. 35.

³⁷⁴ Alanus-Jurvelius 1647, Corollaria I. Hahn-Ljungdahl 1704, p. 24. Pagel 1976, p. 87.

But it is false to think that semen is mere rotten excrement, because if we are talking about the semen of animals, it is cooked and prepared laboriously in a certain organ from pure blood. Certainly nature would never have constructed such an amazing structure of preparatory organs for producing excrements. ...to be an excrement and to be useful is as contrary as to wear red mourning clothes.³⁷⁵

Semen was thus prepared from blood in testicles by elaborate processes of concoction.³⁷⁶ (Females were also supposed to have some kind of internal testicles.) Achrelius expressed the matter somewhat differently:

A great portion of seed is cut from the brain and from singular soft and solid parts of the entire body as well. Indeed, if semen did come from all these members, the respective parts could not be formed in the foetus.³⁷⁷

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Although this idea reflects Gassendi's atomistic theory, it can in fact be found in Hippocratic writings already, where this so-called pangenesis theory served to explain the similarity between parents and their offspring.³⁷⁸ The 17th-century proponents of corpuscular philosophies naturally espoused the doctrine with pleasure. It was, after all, very much compatible with their own modes of thought.³⁷⁹ Achrelius followed the Hippocratic line of thought when he argued that this theory would best explain why some characteristics of people and

³⁷⁵ Alanus-Kempe 1647, Th. 14. "Sed falsum est semen esse purum putum excrementum, cum si de semine animalium loquamur, in peculiari organo ex puro sanguine, non sine labore coquatur & elaboretur. Certè tot vasorum praeparantium & coquentium mirabilem structuram pro excremento nunquam formasset natura. ...excrementum enim esse, & utile esse, oppositum in appposito & atramentum rubrum est."

³⁷⁶ Alanus-Kempe 1647, Th. 13. Petraeus-Ignatius 1673, Th. XVII. Hahn-Ulholm 1689, p. 49. Hahn-Helinus 1694a, p. 37. Hahn-Ljungdahl 1704, p. 20-21.

³⁷⁷ Achrelius 1682, p. 347. "Multa quidem seminis portio à cerebro, ab universo corpore, à singulis ejus tum mollibus tum solidis particulis, dicendum est. Sane vero nisi ab omnibus membris deflueret, neque ex eo omnes & singulae foetus partes possent formari."

³⁷⁸ Dean-Jones 1994, p. 162-166.

³⁷⁹ Hippocrates 1983, p. 317, 319, 321-322, et passim. See also Le Grand 1979, p. 796. It is not sure whether Achrelius got this idea directly from Hippocrates or from Le Grand. We know, however, that he had relatively good knowledge of Le Grand's writings. See Kallinen 1991a.

even diseases were clearly hereditary.³⁸⁰ Semen was not totally material, however. No semen could fertilize and grow unless it was animated. Generation was essentially production of a new form or soul - a task which could be completed by two living souls only.³⁸¹ However, the soul was not so much a *part* of the semen as co-existing with and acting upon it. Semen was the vehicle of the soul.

Ideas on the physical development of an embryo were mainly discussed in connection with the human foetus. An interesting exception was made by Johannes Helinus, who in his massive thesis of ninety pages on birds discusses the structure of an egg, the brooding and hatching of a chicken at considerable length. In addition to books by Aristotle and Aldrovandi, Helinus refers quite often and with approval to Harvey's research on the subject.³⁸² Here it may suffice to say that according to the standard opinion every semen had so called *vis plastica* or *formatrix*, which were faculties of the vegetative soul. It was their task to guide the development of the embryo.

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The formation process did not work out successfully in all individuals of a species. The results were called monsters. The word "*monstrum*" had several meanings. The meaning of the word covered a) malformation, b) hybrids, and c) fabulous monsters known e.g. from classical Greek and Roman literature. It was by no means self-evident that the causes of malformations should be studied in physics. *Scientia* was usually attainable from the necessary and normal regularities found in nature. Now "monsters" were by definition contrary to nature, and hence not illuminating of the natural order. It becomes evident against this background why the opposite view that even the abnormalities could tell us something about nature was expressly stated at Turku. These unlucky creatures had a meaning in life too. According

³⁸⁰ Achrelius 1682, loc. cit. Hippocrates 1983, p. 322. "If from any part of the father's body a greater quantity of sperm is derived than from the corresponding part of the mother's body the child will, in that part, bear a closer resemblance to its father; and vice versa."

³⁸¹ Alanus-Lidenius 1643, Th. XXIV. Alanus-Jurvelius 1647, Th. XVI-XX, XXIII, XXV, XXVII-XXXIII, XXXVIII-XLII. Alanus-Kempe 1647, Th. 5, 11-12, 17-19. Hahn-Ulholm 1689, p. 50, et passim. Hahn-Helinus 1694a, p. 36. Hahn-Ljungdahl 1704, p. 44, 46-47. Pagel 1976, p. 86-87, 89.

³⁸² Hahn-Helinus 1694, p. 34-54, et passim. See also Hahn-Ulholm 1689, p. 56. Helinus also seems to have adopted something of Aldrovandi's Renaissance style, in which a wide variety of aspects concerning each animal species are studied. This is somewhat atypical at Turku. For Aldrovandi see Ashworth 1990, p. 313-316.

to Achrelius "Malformations redound on their part the glory and majesty of God. They are also partly signs of the punishment to come, when people mix with each other without proper mode, without any law and in a shameful intercourse."³⁸³ On the other hand those people who strove to produce hybrids (like mules) for human use, committed a grave sin. God had created species to be constant and it was not man's business to mix them with each other.³⁸⁴

Both the flora and fauna had their deformities. There were several causes of malformation. The excess or scarcity of matter caused redundancy and deficiencies of limbs and organs. The formative virtue could also get lost and form organs in inappropriate places or otherwise deform them. A dangerous source of malformations was maternal imagination. For example a pregnant woman startled by a bear could give birth to a completely hairy child.³⁸⁵

Anatomical descriptions of animals were an integral part of zoology in those theses which concentrated on certain species of animals. The whale was described in detail by Elisaeus Hwal, who had chosen the subject because of his family name, which is old Swedish and means "whale". At the beginning of the 1690's there was something like a renaissance for birds at Turku: in addition to the thesis by Helinus already mentioned, two dissertations on doves were published. Perhaps the most exotic contribution to zoology at Turku was presented in 1709, when the student Lannerus published his theses on elephants and their uses as war machines.³⁸⁶ Elephants, camels, crocodiles, giraffes and many other African animals were already known in antiquity, and camels and elephants were not unheard of in 15th-century European courts. The classical bestiaries were well-provided with knowledge about these animals. It is remarkable, though, how little the discoveries of new animals effected biological theory. Most often

³⁸³ Achrelius 1682, p. 342. "Enarrant autem monstra partim Dei gloriam & majestatem; partim futura sunt ultionis signa, quando homines sine modo, sine lege, nefando concubitu se miscent." On monsters generally and their being against nature see Huet 1993.

³⁸⁴ Thauvonius-Gyllenius 1655, Th. XIII.

³⁸⁵ Alanus-Kempe 1647, Th. 62-65. Thauvonius-Gyllenius 1655, Th. XI, XIX-XXI, et passim. Achrelius 1682, p. 337-341. Hahn-Ulholm 1689, p. 50-51. On early eighteenth-century ideas on maternal imagination see Wilson 1992. For a more general survey of the role of imagination in natural philosophical theories see Southgate 1992. Huet 1993.

³⁸⁶ Achrelius-Hwal 1683. Hahn-Lannerus 1709. Hahn-Helinus 1694a-b. Hahn-Hielmerus 1691.



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The "physical and historical" thesis on elephants and their use in war was published by professor Hahn and Daniel Lannerus in 1709. Lannerus concentrates first on studying the origin of the word "elephant" and he discusses what ancient authors have said about the animal and its habits. According to Lannerus elephants are made martial and prepared for fight by letting them drink wine. Showing them something of white colour is said to make them pugnacious as well.

in the 17th-century books the new species - if described at all - were pushed into the traditional classifications.³⁸⁷

Usually the descriptions of animals were restricted to the external structure of the body. The anatomy of sense organs, especially the eyes was, however, relevant from the point of view of physiology and the theory of perception as well. Therefore the anatomical structures and functions of these organs are relatively accurately described both

³⁸⁷ George 1980.

in dissertations dealing with zoology and the sensitive soul.³⁸⁸ Related to this is the interest which was occasionally shown in the production of voice. Although animals could produce only inarticulate voices, they could still express joy, fear or anger. Differences in animal voices were caused either by different epiglottal and thoracic structures or by the varying temperaments of their dispositions.³⁸⁹

It was typical of the scholarship at the 17th-century University of Turku that local knowledge and every day observations of nature were very seldom made use of. Most of the information was taken either directly from the classical or from 17th-century Aristotelian authors' texts. A few exceptions naturally exist, though. In botany, Elias Til-Landz described plants in the vicinity of Turku. In zoology an author outside of the discipline of natural philosophy proper contributed most to the knowledge of local fauna.

The thesis which the professor of poetry, Torsten Rudeen, published in 1707 has a fresh view on its subject. The author's personal knowledge and expertise is visible in the way he describes the anatomy, habits and subspecies of the Gulf of Bothnia seals. He also spends half of the dissertation describing the methods and equipment used in sealing.³⁹⁰ Rudeen clearly had Cartesian sympathies and he was often critical of old beliefs and mythological stories. His attitude is displayed for example in his thesis on the song of the swan. He does not believe that a dying swan would sing in a heavenly voice: "...all times' experience rather teaches the contrary: the voice of this bird is rough and hard as long as it lives."³⁹¹ The same conclusion was reached six years earlier in a somewhat more traditional-style thesis *On the Swan*.³⁹² It had been typical of Renaissance and 17th-century natural science to refer to ancient mythology. Sometimes the stories in classical literature, which were actually meant as metaphors, were taken literally. However, it is also possible that the younger generation in the late seventeenth and early eighteenth century exaggerated the cre-

³⁸⁸ Achrelius-Hwal 1683, p. 61-75, 81-87. Hahn-Weckelman 1697, p. 14-17. Hahn-Helinus 1694b, p. 8-11.

³⁸⁹ Hahn-Lindebergh 1687, p. 14-19. Achrelius 1682, p. 42-45. Hahn-Helinus 1694a, p. 82-87.

³⁹⁰ Rudeen-Wijkar 1707, p. 5-7, 10-15, et passim, on sealing see p. 23-44.

³⁹¹ Rudeen-Granroot 1703, p. 15. "...quin prorsus contrarium omnium docuit temporum experientia, esse scilicet asperam streperamque huic avi vocem quamdiu vivit."

³⁹² Hahn-Weckelman 1697, p. 28-34.

dulity of Renaissance authors in order to emphasize their own critical attitude.³⁹³

We have seen that the study of living nature operated in the framework of the Aristotelian "research programme". Most theses approached the subject by following the established order of presentation, in which most attention was paid to the real definition of the subject. In pursuing living nature the scope of the *differentiae* scrutinized had naturally to be modified. In addition to causes (especially the efficient cause or generation) things such as birth, habitat, magnitude, voice, etc. were relevant.

No account of living nature was complete without consideration of its most perfect production, man. In the following chapter we shall turn our attention to the ideas which deal with this microcosm. Many of the ideas concerning man had much in common with the theories about the other parts of living nature.

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6. THE HUMAN BEING

The study of man was a not insignificant part of natural philosophical inquiry. Not only were various aspects of human anatomy and physiology discussed, but a major concern was human psychology, i.e. the faculties of the rational soul. Although intelligence was a particular feature of the rational soul, the study of human perception and the physiology of the sense organs was considered essential for understanding human psychology, since Aristotelian empiricism claimed that our concepts were derived from the senses. In this chapter I shall first present the views held about the structure and functions of the human body, then consider ideas of the rational soul and perception processes. From the point of view of 17th-century natural philosophy it was not without relevance to study the moral aspects involved in the position of the human being in the world. The relationships between man and nature and man and supernatural beings (angels and

³⁹³ Rudeen e.g. argues that it is a fairy tale of Ovid that a human being could transform into a swan. Rudeen-Granroot 1703, p. 8-12.

demons) revealed the limitations of humanity. This third theme is also briefly considered at the end of this chapter.

6.1. Anatomy and Physiology

The 16th and 17th centuries have become known as revolutionary centuries in human anatomy and physiology. The publication and great success of Vesalius' anatomy in 1543 launched new interest in medicine - a tradition which flourished in Italian universities especially. Another fruit of this Paduan tradition was William Harvey's discovery of the circulation of blood. New instruments such as microscopes opened new view on the subject in the course of the 17th century. The microscopic studies of Malpighi and Antoni van Leeuwenhoek for example are revered as major advances in "biomedical" sciences. On the other hand, Paracelsian medicine and pharmacology were partially transformed from deviant "science" to an accepted branch of medicine by 17th-century scholars like van Helmont, Sennert and Erastus.³⁹⁴ The use of metals and minerals as medicines gained support among the practitioners of medicine. Along with these two traditions the old Galenic medicine still held its established position in many European universities.

One of the leading seats of medical learning in the 17th century was the University of Leiden. Many students from Sweden (including Finland) finished their medical degrees at Leiden. New ideas were rapidly carried to the University of Uppsala,³⁹⁵ whereas at Turku scholars preferred to cling to the old dogmas.

The Structure and Functions of the Human Body

During the 17th century only lower studies in medicine were carried out at the University of Turku, although in principle the professorship in the subject would have enabled more thoroughgoing studies.³⁹⁶ Under the first professor of medicine, Eric Achrelius (1642-1670) no

³⁹⁴ Pagel 1967, 1976, 1986. Singer 1962, p. 88-144. Singer's straightforwardly progressive view on the development of anatomy and physiology has been criticised e.g. by Nutton 1993. See also articles in Wear, French & Lonie 1985.

³⁹⁵ E.g. Olof Rudbeck discovered the lymphatic system in 1650 and also demonstrated it in 1652 to Queen Christina. See e.g. Lindroth 1975, p. 390-401.

³⁹⁶ On medicine at Turku see Perret 1985. Fagerlund & Tigerstedt 1890.

theses were published on the subject. Achrelius was several times reproached with neglecting his duties by the Senate; he for his part complained of the lack of students.³⁹⁷ His follower Elias Til-Landz seems to have been more active as professor and tried to raise the students' interest in his subject. Til-Landz had studied at Uppsala and Leiden and was probably aware of the latest developments in medicine; at least he referred to many of the most up-to-date physiologists and anatomists in his graduate thesis on malnutrition, which he wrote in Leiden.³⁹⁸ He not only practised medicine in addition to his teaching, but also prepared drugs in his own small laboratory. This was particularly significant, because no regular chemist's store existed in Turku (or in the whole of Finland) in those days.³⁹⁹ He even arranged a hospital to be opened for lepers. Til-Landz probably based his pharmacology and medical treatment on humoral pathology, his herbal indicating that he considered the effects of plants to be mainly in accordance with the principles of Galenic medicine. In addition to this the Paracelsian theory of salt, sulphur and mercury belonged to the basic repertoire of medicine. In 1695 Laurentius Braun still trusts in both of these in his medical dissertation.⁴⁰⁰ The last professor of medicine before the Great Northern War was Petrus Hjelm. No theses were published under his guidance, but he seems to have lectured regularly on basic medical subjects.⁴⁰¹

Dissection was a practice which became usual from the beginning of the sixteenth century on, and during the following century anatomy was still very much a discipline in vogue. In addition to the scientific importance of anatomy, it had become a matter of prestige for academic institutions to have the most up-to-date equipment. One of the most fashionable status-symbols of the 17th-century universities was

³⁹⁷ Klinge 1987, p. 393. Perret 1983, p. 73.

³⁹⁸ Gronovius-Til-Landz 1670. In Th. IV he mentions the lymphatic system as carrying and distributing nutrients; in Th. IX he discusses Malpighi's theory, according to which fattenig starts in those parts of the body where the nervous system does not reach, and in Th. XI-XX Til-Landz refers to the British physiologists Glisson and Charleton. Gronovius was professor of Greek and history, not a medic.

³⁹⁹ Leikola 1987, p. 579. Leikola 1993.

⁴⁰⁰ Braun-Stecksenius 1695. Braun 1695 is based on traditional medicine as well.

⁴⁰¹ Elenchus Praelectionum, Catalogus 1706: Hjelm lectured on principles of medicine in public and on constitution of the human body in private. 1708: explains principles of medicine and Hippocratic Aphorisms in public. 1711: lecturing cancelled because of war duties. 1712: teaches practical medicine.

the anatomy theatre.⁴⁰² At Uppsala an anatomy theatre was built in the 1660's, just opposite the main entrance of the cathedral, but at Turku such a building was not needed. It has been claimed that professor Til-Landz would have done some anatomical demonstrations at his own house, in a room which he had arranged for the purpose.⁴⁰³ However, in my view it is improbable that he would have dissected human corpses there (animals might have been possible), because this practice was closely regulated in the statutes. Anatomical dissections also acquired very rapidly other cultural meanings than strictly scientific and therefore arranging a dissection was a matter to be prepared for with tact and diplomacy.

The statutes of 1626 for the University of Uppsala already decreed that anatomical dissections should be arranged every year. (In later statutes, however, only one every two years.)⁴⁰⁴ Obviously dissections were thus not even meant to be principal teaching methods. Clearly the function of such events was very much social too, not least because of the delicate moral character of dissecting a human body. It was usual long into the 19th century to dissect mainly the bodies of criminals or of the extremely poor. Exposing man's intestines to the public was thought extremely humiliating and therefore it could in a way become a part of the punishment of the criminal.⁴⁰⁵ Indeed, the Brahean statutes for instance decreed that the body for dissection should be provided by the castellan, which directly indicates that it was bodies of criminals which were supposed to be dissected.⁴⁰⁶ However, even the criminal body had to be treated with proper respect. The statutes tended to regulate more the social code surrounding dissection than the benefits which the event might bring to medical learning (these regulations were originally intended for the University of Uppsala, which had two professors in the Faculty of Medicine, whereas Turku had only one.):

⁴⁰² Rupp 1990.

⁴⁰³ Leikola 1987, p. 579. Perret 1977, p. 92. "Tillandz gjorde ofta anatomiska dissektioner i sitt eget hus..." On anatomy in Finland see also Niemi 1990, p. 7-16.

⁴⁰⁴ Annerstedt 1877, p. 249-250. Schybergson 1918, p. 233-224. Schybergson 1920, p. 168.

⁴⁰⁵ Rupp 1990.

⁴⁰⁶ Schybergson 1920, p. 168. "Han bör också åtminstone en gång på två år hålla en anatomisk sektion, varvid slottsfogden bör anskaffa ett människolik."

The first of the medical professors should teach the principles of medicine together with the methods of healing. The other should instruct in physics together with knowledge of herbs and the parts of human body. He should also perform a dissection once a year. The 'prefect' shall supply the body, and each of the spectators shall pay two marks: one for the anatomist, the rest for the funds of the faculty. But if both of the physicians lead the dissection in turns, they shall divide the money among themselves equally. Professors shall be admitted free. When the dissection is finished, the body must be buried according to the usual ceremonies, which shall be attended by the anatomist and students of medicine.⁴⁰⁷

The first public dissection of a human corpse was arranged in the greater auditorium of the University of Turku in 1686. This occasion became a memorable academic festivity whose main purpose was to enhance the prestige of the University and its medical faculty. It was to show that "real" anatomy was practised at the Academy. A solemn program was printed and an entrance fee of one silver mark was set for the event.⁴⁰⁸ Dissections did not, however, become an established practice at Turku, most probably because there was neither need for them in medical education nor the capacity to arrange them. The next dissection was organised more than twenty years later in 1709.

Compared with his practical achievements Til-Landz produced relatively little written material. In addition to his botanical treatises he published only two academic dissertations. The first dissertation in medicine ever published at Turku (1673) discussed for the most part the nature of the art of medicine. The various meanings and origin of the term "medicine" were carefully scrutinized. However, the greater part of the thesis discusses the pros and cons of medical schools.⁴⁰⁹ It was obviously intended as an introduction to medicine, and as such

⁴⁰⁷ Annerstedt 1877, p. 249-250. "Medicarum primus institutiones medicinae enarabit cum medendi methodo, alter physicen cum herbarum et partium humanis corpori cognitione, sectionem ipse administruet quotannis. Cadavera praefecti subministrabunt, spectatorum singuli marcas binas solvant, unam anatomico, fisco facultatis reliquum. Si per vices uterque medicorum sectioni praesit, pecuniam aequaliter inter se dividant. Professores gratis ad inspectionem admittantur. Peracta sectione cadaver ritu consueto sepuliat, comitante anatomico et medicinae studiosis." The organisation of dissections was socially regulated elsewhere also. On the situation in the Netherlands see Rupp 1990, p. 265-270.

⁴⁰⁸ Perret 1985, p. 71. Leikola 1987, p. 580.

⁴⁰⁹ Til-Landz-Aschlinus 1673. See also Pitkäranta 1984.

it was well in line with the lively textbook tradition at Turku during the 17th century. The another thesis written by Til-Landz, *Ostheologia*, was printed in 1692. It gave Latin, Swedish and Finnish names to the human bones, and it was illustrated with clumsy copies from Vesalius' *anatomia*.⁴¹⁰

On the other hand it is notable that both Til-Landz's first thesis and the only thesis published under professor Braun in 1695 both deal with the basic features of the art of medicine. They try to define what medicine is and what it is not; Til-Landz for instance rejects veterinary medicine from the proper area of the practice. Both authors also explain the branches of medicine such as physiology, anatomy, pathology and hygienics.⁴¹¹ Braun also distinguishes between practical medicine, which aims at healing, and theoretical medicine, which had more in common with natural philosophy. Both authors also have a cursory look at the history of medicine. For Braun especially this has the function of defending and legitimizing the use of Galenic medicine.⁴¹² The history of science has frequently been used to legitimate the scientific practices of the time. There obviously was a need to outline the contents and status of the discipline, which otherwise had poor status at the Academy.

The efforts to raise the status of medicine were slow to succeed. However, from the 1690's on the number of dissertations discussing physiological matters rises rapidly. Not only did the traditional subjects of sense physiology become popular, but the first theses on specific physiological themes such as digestion or the brain also appeared. One relevant factor in the boom of physiology at Turku undoubtedly was Cartesianism. First of all, it propagated new physiological ideas. Cartesianism was also very popular in the Faculty of Medicine at the University of Uppsala, from where the influences gradually spread to Turku. These theses were, however, published under the *presidium* of the professor of physics, Petrus Hahn.

Thus the human body was not only the subject of medicine, but also of natural philosophical inquiry. As I have shown in section "The Order of Disciplines" this is in itself nothing peculiar, since the boundaries between certain parts of medicine and natural philosophy were very flexible indeed throughout the 17th century. The subject of phy-

⁴¹⁰ Niemi 1990, p. 11-13.

⁴¹¹ Pitkäranta 1984, p. 78-82. Braun-Stecksenius 1695, p. 26-31.

⁴¹² Pitkäranta 1984, p. 83-84. Braun-Stecksenius 1695, p. 2-14, 21, et passim.

sics was the "natural body", and the body of man was, after all, a *corpus naturalis* consisting of matter and form. In dissertations written in physics, anatomy and physiology walk hand in hand, so that it is almost impossible to separate their spheres.

When the form, structure, movements and functions of a bodily organ were discussed, it had to be done in accordance with the Aristotelian scheme. The definition of an organ was not complete without knowledge of the good it served, or in other words, its function in the organic whole. The descriptions of the internal and external structures of the human body were usually rather superficial, though. Traditional categorizations such as the Aristotelian division into *partes similes* - *dissimiles* were used to portray bodily structures,⁴¹³ but other kinds of approaches to the subject were also employed. Bishop Gezelius especially loved to salt his otherwise dry and laconic scholastic text with axioms, in which he claimed e.g. that women were not monsters (referring to Aristotle's idea that women were imperfect men), that both men and women had the same number of ribs (although Eve had been created from one of Adam's ribs) or that head was the principal place of the sensitive faculty because nerves lead to the brain.⁴¹⁴

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In natural philosophical dissertations the human body was typically described as a microcosm. The theory was simply accepted as a fact by which certain phenomena, especially antipathy - sympathy relations could be explained. Although generally recognized as true, the micro-macrocosm theory was nevertheless no rigid guiding principle in natural philosophy.

But, having abandoned these Hermetical dreams, we shall assert man to be a microcosm; not in the strict sense so that he would contain all natural bodies in reality, but Symbolically and Analogically. ...Some people also say that man has a peculiar analogy with all species in the world. His heart would in a way correspond to the Sun, his brain to the Moon, and the rest of his parts to other species.⁴¹⁵

⁴¹³ Gezelius 1672, p. 317-326. Achrelius 1682, p. 360-363. See also Thauvonius-Warelius 1652, Sect. III, Membr. III, Art. III. Thauvonius-Anxelius 1655, Th. 48-52. Similar parts were homogeneous in structure, e.g. blood or muscle, whereas dissimilar parts such as a hand consisted of various kinds of materials. Boylan 1983, p. 181ff., 191-2ff., et passim. Furth 1988, p. 80-83.

⁴¹⁴ Gezelius 1672, p. 317, 321, 325.

⁴¹⁵ Hahn-Chydenius 1697, p. 6, 12. "Sed, missis Hermeticis hisce somniis, mikro-

Man could be called microcosm because his form included all degrees of being from the vegetative soul to the rational.⁴¹⁶ He was also the most perfect being, created as the image of God. His bodily structure was no less perfect and wonderful, consisting of the same four elements as everything else in the world.⁴¹⁷ But most of all there was a symbolic resemblance between certain parts of human body and nature. This relationship between a human organ and, say, a plant or a planet could be determined by a similarity of the external shape, or by the similar functions which they performed. No theory was, however, put forward on whether these correspondences would be found by empirical methods, mystical experience, or by something else.

In physiology one of the most important innovations in the 17th century was the theory of the circulation of blood. The prevalent system before Harvey's theory was of course the Galenic one. However, it was not an unalterable bulk of theories either, but from the 1530's on especially had been criticised and modified in many respects.⁴¹⁸ We do not know exactly what kind of theory concerning the cardiovascular system was held at Turku during the first four decades of teaching and learning there. The matter was simply not discussed in print. The "acceptance" of the theory of the circulation of blood at Turku is a good example of the ways in which knowledge is transformed at different stages of the very process of its diffusion. Moreover, this example illustrates the claim that there are different modes in which a theory can be "accepted".

The theory of the circulation of blood first appeared in print with professor Achrelius' *Contemplationes mundi*. It is very likely that Elias Til-Landz was at least aware of this theory long before it was first published. Achrelius presents a Cartesian version of the circulation of blood. There had been some disagreement between Harvey and Descartes concerning certain features of the system; they disagreed particularly on the proper explanations of the formation of blood and the movement of the heart. The main reason why Descartes rejected Har-

kosmos dici hominem asserimus, non propriè & per realem omnium corporum naturalium continentiam; Sed Symbolicè, & per Analogiam. ...Quidam etiam dicunt hominem cum quâvis specie mundi peculiarem fovere analogiam. Quasi cor ejus corresponderet soli; cerebrum Lunæ, & reliquæ partes aliis speciebus." See also Braun-Stecksenius 1695, p. 19-21.

⁴¹⁶ Thuronius-Kinmundt 1662, Quaest. I.

⁴¹⁷ Hahn-Chydenius 1697, p. 6-13. Achrelius 1682, p. 359-360.

⁴¹⁸ Bylebyl 1969.

vey's theory was that the cause of the movement of the heart seemed to him to require an unconscious mental act. This, of course, was against the principles of Descartes' dualistic ontology.⁴¹⁹

According to Descartes the movement of the heart was dilation not contraction. As an author at Turku put it, the dilatation of the heart was caused by the expansion of blood due to the heat residing in the heart:

It is worth knowing that in the porous tissues of the ventricles of the heart there exists a certain kind of a fire without a light. It makes heart very warm and burning. At the same time as blood enters one of its ventricles, it swells and dilates especially because the fire, which I described residing in the heart, serves no other end in this machinery, but that... it would cause motion by dilating, heating and diluting blood.⁴²⁰

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In Achrelius' text the role of respiration remains unconnected to the circulation of blood. He only says that respiration was to "maintain the fire residing in the heart, cool the blood and force it into motion".⁴²¹ The main purpose of the blood was, according to Achrelius, to spread *spiritus animales* around the body. It was these spirits, which caused the movement of the muscles. Contrary to Harvey's theory Achrelius supposed, in accordance with the old Galenic dogma, that the blood was formed from food in the liver.⁴²² The "concoction" or "fermentation" of food into blood was described in still greater detail in a dissertation on digestion published in 1708.⁴²³

Achrelius had adopted the Cartesian version of the theory of the circulation of blood. This is quite natural, because Descartes was one of the most powerful disseminators of the theory, and his influence was also strong at the University of Uppsala. It was typical of the

⁴¹⁹ Gorham 1994, p. 212, et passim.

⁴²⁰ Hahn-Gezelius 1691, p. 8. "Scire quoque operæ pretium est, in poris Parenchymatis cordis contineri ignem qvendam sine lumine, qvo istud tam calidum fervidumqve redditur simul ac sangvis alterutrum ejus ventriculū intrat illico intumescat ac dilatetur praeterea ignis, qvem describo in corde, machinae contentus nulli alii rei subservit, qvam dilatando calefaciendo & attenuando sangvini... omnino sequitur motum."

⁴²¹ Achrelius 1682, p. 363-364. "...ignem in corde latentem fovere, sanguinem refrigerare, eumque in motum compellere." Leikola 1983b.

⁴²² Achrelius 1682, p. 363. See also Hahn-Gezelius 1691, p. 10-11.

⁴²³ Hahn-Dycander 1708, on the formation of blood p. 19-22.

developments at Turku that later - in those very few dissertations where the theory was referred to - it was associated with Cartesianism. Laurentius Gezelius for example asserted in his *De Sangvine* that he would follow the road shown by "*novi Philosophi*", especially Descartes, in matters of the circulation of blood.⁴²⁴ Nevertheless the same author turns out not to be so wholeheartedly on the side of the circulation theory, proposing instead an ambiguous statement in which the "circulation" of blood seems more likely to be composed of two motions, of which at least the first is linear.

The scope of this study does not allow us to examine any more closely whether the local motion of fluids is direct or circular, or whether it is a third, mixed motion outside of these two alternatives. Suffice it to say that the last alternative seems to me most convincing. It is obvious to anyone who looks at the subject with open eyes that all this aims at conserving all the precious parts of the entire body, and [the blood flows] in a straight line to all parts of the body, however in a way that it must at some point return and seek other channels for this.⁴²⁵

The connection of the theory with Cartesianism is strengthened by the fact that non-Cartesian authors remained silent about it. For example, there is a dissertation written at the end of the 1690's, in which the author takes a critical stance against the theory, according to which dead bodies bleed in presence of their murderers. However, the theory of the circulation of blood is neither defended nor refuted in this connection.⁴²⁶

Harvey's theory of the circulation of blood was variously received in different European countries. In this battle for acceptance several philosophers developed both empirically and rationally-based arguments *pro* and *contra*. Although we can safely assume that at least some of these arguments might have been known at Turku, no atten-

⁴²⁴ Hahn-Gezelius 1691, p. 8.

⁴²⁵ Hahn-Gezelius 1691, p. 8. "Non permittit instituti ratio longius examinare, num sit hic fluidorum motus localis, rectus an circularis, an ex his redundans tertius mixtus, quod mihi verosimilium videri, sufficiat dixisse. Cuivis enim, qvi totis oculis rem intuetur, obvium est, qvam tendant haec omnia conservationis aman-tissima, lineâ rectâ in universas corporis partes, sic tamen, ut cogantur nonnunquam regyrare, aliasque ductus qvaerere."

⁴²⁶ Hahn-Polviander 1698.

tion was paid to them. The theory was stated as a fact, confirmed by references to foreign authors. No arguments for the theory were needed, nor was its truth explicitly called into question anywhere. By 1690 it had already achieved the status of a self-evident proposition, i.e. functioning as the premise of another theory, as in Andreas Lundius' thoroughly Cartesian dissertation. He uses the theory of the circulation of blood as a presupposition for his theory of the cause of certain mental disorders.⁴²⁷

Digestion, circulation of blood, sensation and other bodily functions occurred in living creatures only. But what was life in itself? According to the Aristotelian form-matter scheme it was naturally the form or soul which was responsible for life. On the physical and physiological level, however, other concepts were also introduced to describe vitality.

This vital principle was called *calidus innatus*. Actualized in generation it was coexistent with the composition of matter and soul in all living creatures. Nevertheless, as a substantial part of form it was separate from matter.⁴²⁸ The heart was the principal seat of internal heat, whence it was propagated throughout the body by blood either by circulation or by the Galenic to-and-fro movement.⁴²⁹ It was especially the extremely penetrative small corpuscles in blood, called *spiritus*, which distributed the warmth around the body.⁴³⁰ The physical qualities warmth and humidity arising basically from the matter of man, the four elements were the essential ingredients of life. Deprivation of either of these qualities had lethal consequences: plants struck by drought soon withered away and animals removed to excessively hot or cold environments died.⁴³¹

External factors strongly affected *calidus innatus*. First of all, a sufficient amount of fresh, non-poisonous and non-infectious air was essential for maintaining the vital principle. Appropriate diet, regular

⁴²⁷ Hahn-Lundius 1690, p. 25.

⁴²⁸ Hahn-Linstorpius 1688, p. 4-8. Hahn-Frostman 1708, p. 16.

⁴²⁹ Hahn-Linstorpius 1688, p. 13-14. "Motum cordis arteriarum & musculorum fieri à dilatatione sanguinis per cor transeuntis idque à latente igne seu calore in cordis thalamo disserit Excellens Achrelius." Hahn-Frostman 1708, p. 17-20. Neither author clarifies his stance on whether the blood circulates or not. Hahn-Linstorpius relies more on Galen, Aristotle, Curtius and other classical authors.

⁴³⁰ Hahn-Frostman 1708, p. 17-20. Their idea that the *spiritus* in blood are material particles and not spiritual entities of course resembles the Cartesian reading of this Galenic theory.

⁴³¹ Hahn-Linstorpius 1688, p. 8-9, et passim.

defecation, sufficient sleep and the absence of emotional upsets were further requirements for sustaining it - and thereby health.⁴³² However, not even the most extreme external conditions could always disturb "internal heat":

It is to be said that the Finns, when they have been exhausted by the heat in a sauna, deliberately plunge into cold. They are not afraid to descend to rivers or lakes even in the winter, and they do this without any damage. But we cannot say for sure whether this really helps to refresh the internal heat.⁴³³

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The internal composition of the creature was equally important for the duration of life. Fish, which were cold by nature, lived shorter lives than "warmer" quadrupeds. Sanguine temperament was best equipped for life because of its well-balanced composition. Choleric and plegmatic temperaments, dominated by fire and water respectively, prognosticated shorter lives, whereas the cold and dry melancholics had it worst. The ageing of man or animal was also due to weakening or decrease of the *calidus innatus*.⁴³⁴

The idea of vital or innate heat is based on Aristotle's texts and is therefore to be found in some form or other in medieval and Renaissance Aristotelian tradition.⁴³⁵ This is then combined with the Galenic doctrines of spirits or *pneuma*⁴³⁶ (the word *pneuma* is never used in our dissertations) and the theory of temperaments, which of course was based on humoral pathology. On the other hand the idea that the vital principle lies in (particles of) blood might easily be inspired by the Bible, where it says that blood is alive and animated. The connection seems not too far-fetched if one considers how often the Bible was used as both a direct and indirect source of information in 17th-century natural philosophy.

The essence of life was, quite naturally, an area where metaphysical

⁴³² Hahn-Linstorpius 1688, p. 10-15. These aspects were discussed by that part of medicine called hygienics. Braun-Stecksenius 1695, p. 27-28.

⁴³³ Hahn-Linstorpius 1688, p. 16. "Fennonum docet, quæ calore balnearico macerata frigidam suffundere, in amnes & puteos vel ipsa hyeme descendere non veretur, & quidem sine noxâ. Ast an his reficiatur calidum, certi quid statuere non possumus."

⁴³⁴ Hahn-Linstorpius 1688, p. 8-10. Hahn-Frostman 1708, p. 13-16.

⁴³⁵ Aristotle 1957, *Parva Naturalia*, 469b8-20.

⁴³⁶ Singer 1962, p. 62-64.

and physiological ideas crossed and inter-bred. It was by no means the only area where these disciplines met each other. One of the most important subjects of natural philosophy in which metaphysical and theological ideas played a major role, was human generation.

The Generation of Man and the Development of the Foetus

The origin of man had fascinated many classical philosophers, who presented both mythical folklore stories and their own "scientific" theories about this question.⁴³⁷ Although these theories were discussed, they were of course found incompatible with the Christian view that God created the first man. Nevertheless, classical authors were referred to because their stories formed an antithesis to the Christian dogma. As ancient theories were labelled ridiculous fiction, the validity of the current view was reinforced.

The human being was generally acknowledged to have two kinds of origin: *origo extraordinaria* and *origo ordinaria*. The extraordinary or supernatural origin of man was entirely accomplished by God.

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...GOD produced man in three ways: 1. He made a man without a woman, that is he made Adam. 2. He fabricated a human from man without a woman, that is he made Eve. 3. In a peculiar and miraculous way Christ was born from a woman without man. This kind of generation is above all the powers of nature and thus is not subject to physical consideration.⁴³⁸

The extraordinary origin of man was thus not handled more deeply in physics dissertations, because supernatural phenomena were not supposed to be subject to natural philosophical inquiry. The other means of the generation of man was more in the field of physics. Unlike *origo extraordinaria*, natural or ordinary origin or reproduction was achieved by man without direct interference by God. Of course, God had given the ability to procreate to all species, including humans, in his prime act of creation. His order to multiply and to replenish

⁴³⁷ Thuronius-Kinmundt 1662, Quaest. III.

⁴³⁸ Hahn-Ljungdahl 1704, p. 12. "...tribus modis DEUS hominem produxit: Nam 1. fecit hominem sine foemina & viro, ut Adamum. 2. fabricavit hominem ex homine sine foemina, ut Evam. 3. modo singulari & mirabili de foemina sine viro natus est Christus, talis generatio est supra cunctas naturae vires & per consequens non est Physicae considerationis." See also Miltopaeus-Enebergh 1667, Th. XX.

the Earth was seen as the fundamental efficient cause for human procreation.

The the boundary line between metaphysical and theological speculations and physical processes was very elastic, the transition from one area to the other being easy. However, the metaphysical ideas on the propagation of form and the theological dogmas involved in the generation of man formed only the background or the fundamentals which the physical explanations were based on. Physically, the soul was propagated by semen, a material but animated substance secreted from blood. Both male and female were considered to have semen. Nevertheless, ideas on conception itself were quite vague in the 17th century: "Conception is a reception, retaining, mixing, fomentation and stimulation of male and female semen in the womb."⁴³⁹ Conception, as well as the growth of the foetus was thought to happen in the uterus. The knowledge of the anatomy of female sexual organs seems to have been weak, since they were just not described. This may be for several reasons. In classical Greek medicine the external female genitalia were generally poorly described, because they were not assumed to play a role in health and disease, and only pathological conditions were described.⁴⁴⁰

According to the theory favoured at Turku, the process of the formation of foetus starts immediately after the conception. All the "mixings, dispositions, congelations, separations, thickenings, rarefactions and condensations" are caused by the "formative faculty" residing in the semen. If this *facultas formatrix* went astray for some reason, or the maternal imagination disturbed its function, serious misformations could occur.⁴⁴¹ The coarser parts of the semen would form a cover for the foetus.⁴⁴² The cover consists of two parts:

Chorion is a strong fibrous cover, which surrounds the foetus completely. It is supported by the umbilical cord and is connected through it to the wall of the womb. Amnion is a thinner coat. It immediately surrounds the foetus and holds all the liquids.⁴⁴³

⁴³⁹ Alanus-Kempe 1647, Th. 48. "*Conceptio est seminis maris & foeminae in utero receptio, retentio, mistio, fotio & excitatio.*" Cf. Pagel 1976, p. 84-89.

⁴⁴⁰ Dean-Jones 1994, p. 78.

⁴⁴¹ Alanus-Kempe 1647, Th. 49, 62-66. "*mistiones, dispositiones, concrectiones, secretiones, densationes, rarefactiones, contractiones*" See also Hahn-Ulholm 1689, p. 105-106, 110-112, et passim.

⁴⁴² Alanus-Kempe 1647, Th. 49, 54. Hahn-Ulholm 1689, p. 107.

⁴⁴³ Alanus-Kempe 1647, Th. 56. "*Chorion est tunica nervosa, valida, foetum totum ambiens vasa umbilicalia fulciens, & eorum interventu utero adhaerescens. Am-*

At the same time the finer parts of semen were being formed into the foetus. This so-called imperfect formation was completed in seven days after conception. In this phase all organs of the foetus were formed from pure semen without maternal blood. When the *vena umbilicali* had been formed, the second phase of the process began, the so-called perfect formation. This development would take 30 days for male foetuses and 42 for female.⁴⁴⁴ The foetus was nurtured by menstrual blood, which differed from normal blood only by its greater quantity.⁴⁴⁵ We are also told certain anatomical details about the nutrition of a foetus; the veins would carry nutritional blood to the foetus and the arteries "spirituous blood".⁴⁴⁶

The ultimate phase of formation was thought to take place two to three months after the completion of the second phase of the formation process. During the rest of its time in the womb the foetus mainly grew in size and began to move. When the foetus was ready, which happened after seven to ten (though usually nine) months of pregnancy, it was born. The pain suffered by mother in childbirth was equivalent to the amount of lust she had felt during intercourse. Some theses also mention that premature births or miscarriages may occur. A deliberately-caused abortion was considered homicide, although not in the strict sense of the word, because the human foetus was not yet a perfect human.⁴⁴⁷ Knowledge of the formation of the foetus was based mainly on traditional knowledge, though Alanus also valued more modern knowledge: "...the knowledge of these things has been acquired from the teachings of physicians who have studied aborted foetuses and dissected women who have died pregnant..."⁴⁴⁸

The development of a foetus was sometimes considered to follow a phylopeutic pattern. As we remember, the rational soul included all

nios est tunica tenuior, proxime foetum ambiens ac sudores recipiens."

⁴⁴⁴ Alanus-Kempe 1647, Th. 55-57. Hahn-Ulholm 1689, p. 107-109.

⁴⁴⁵ Thuronius-Allenius 1661, Th. 19, 21-23. Cf. Dean-Jones 1994, p. 200-209, et passim.

⁴⁴⁶ Alanus-Kempe 1647, Th. 59. "Per venam umbilicalem foetus sanguinem venosum ad nutritionem & augmentationem accipit. Per arterias sanguinem spirituosum ducit. Per urachum urinam expellit." Hahn-Ulholm 1689, p. 113-114. Achreluis 1682, p. 347-351.

⁴⁴⁷ Alanus-Kempe 1647, Th. 61, 67-73. Thuronius-Allenius 1661, Th. 16, 25-32. Cf. Dean-Jones 1994, p. 209-215.

⁴⁴⁸ Alanus-Lidenius 1643, Th. XXX. "...ex medicorum tamen traditionibus, qui ex inspectis abortibus, & dissectione matrum praegnantium mortuarum, circa illud tempus, aliqualem hujus rei cognitionem acquisiverunt..."

faculties of the lower souls. In an early phase, when the foetus was nurtured by blood, it could be said to live the life of a plant.⁴⁴⁹ At that phase, only the faculties belonging to the vegetative soul were active. Later on so-called animal spirits began to be formed in the brain of the foetus. Thus it entered the level of sensitive souls, and began to move and feel.⁴⁵⁰ In other words, only some parts of the soul were active to start with. But the more elaborate the stage the matter of the foetus reached, the more complicated the possible functions of the soul. We are not told, however, when the final stage, in which the rational soul is activated, begins. Although this kind of phase could be discerned, it was nevertheless stressed in the dissertations that man's soul is one all the time.

Note. There is only one soul in the foetus, although diverse lives. First of all it lives the life of a plant, after that of an animal, and finally life of man. However, this does not happen in respect to the form which is one and indivisible, but in relation to the matter or organs.⁴⁵¹

The form of man thus governed a fully developed body. From then on the form of man was the subject of scrutiny in psychology.

6.2. Psychology

The Renaissance tradition of psychology continued uninterrupted into the 17th century. No radically new competitive theories emerged as had happened in cosmology or anatomy. The Renaissance synthesis of Aristotelian, Galenic and other classical theories was by and large accepted as such, and most of the questions discussed arose from inside the tradition. Psychology⁴⁵², or the philosophical study of the soul and its properties was not considered an independent discipline.

⁴⁴⁹ Alanus-Lidenius 1643, Th. XXXIV, "Porisma: *Embryo in utero vitam plantae quodam modo vivit.*"

⁴⁵⁰ Hahn-Ulholm 1689, p. 113-114.

⁴⁵¹ Thuronius-Allenius 1661, Th. 20. "Nota. Una est anima in foetu, sed diversa vita, primum enim vivit vitam plantae, post animalis, tandem hominis, non quidem ratione formae quae una adeoque indivisibilis, ast ratione materiae, hoc est organorum."

⁴⁵² The term was probably introduced by J.T. Freigius in 1575. See Park & Kessler 1988, p. 455.

It was in the first place a part of physics or natural philosophy, in which the human soul was studied as the formal cause of man. What was this subject matter of the study really like? The formal cause or soul of the man, rational soul, and the Christian immortal soul were all the same; the difference lay only in the viewpoint from which the soul was contemplated.

Since psychology examined soul in connection to the body, ideas on the disposition and functions of the soul/mind were to a great extent based on physical and physiological study. The study of sense organs was especially concentrated upon, because according to Aristotelian epistemology all concepts in our mind were ultimately derived through the senses. On the other hand, knowledge of the cognitive processes of man had further implications for epistemological theories. Of course, the relationship between the body and the soul was also more generally relevant to physical studies.

The most serious critics of these traditional views came from Cartesianism. For Descartes soul/mind was an entity totally separate from the body and thus it was no longer equivalent to the principle of life in a body. Reactions against Cartesianism feature in much of the psychological writing in the latter part of the 17th century. To start with I shall discuss the theories of perception and cognition. Physiological aspects of perception will also be taken into account. The problem of innate ideas and general capacity for knowledge will also be discussed in this chapter.

Perception and the Senses

The two primary properties of the rational soul were intellect and volition. These two faculties distinguished the rational soul from lower types of souls. In order to understand how intellect and volition work we have to look at the ideas concerning perception and the abstraction of thoughts or ideas from sense perception.

Perception in itself was a faculty of the animal soul. Although animal perception, or perception on a very general level was dealt with in some dissertations,⁴⁵³ it was principally the needs of human psychology which inspired the study. The senses were divided into external (vision, audition, etc.) and internal senses (fantasy and *sensus com-*

⁴⁵³ E.g. Achrelus-Hwal 1683, p. 53-61, et passim.

munis).⁴⁵⁴ Let us first turn our attention to the external senses, because they were the first to receive perceptions.

The study of the external senses occurred in two different phases. From the 1640's to the 1660's it was normal to deal with senses on a very general level. They were seen primarily as faculties of the sensitive soul. The aim was to search for universal prerequisites of perception, or those characteristics which were in common to all creatures with a sensitive soul. In the 1670's and 1680's the problems of perception seem to have been more out of fashion and they were dealt with only incidentally. Then in the 1690's there is a sudden boom in theses discussing senses and perception. Compared with the earlier phase they concentrate on much more specific topics and on greater detail. Some of these theses were inspired by Cartesianism, regardless of whether they opposed or defended it. We might ask whether the majority of theses, which were strictly traditional in style and content, were also indirectly inspired by the threat posed by Cartesianism. Although opposing ideas were not disputed, the vehemence with which traditional dogmas were defended might indicate that there really was a need to do so.

The theses published up to the 1660's typically considered the general requirements for a perception to occur. First of all, a creature must have a sensitive **soul**, which directs the perception processes in general. If the sensitive soul perishes, perception ceases too. The second crucial requirement was a material **object** of perception. Because the senses could receive only qualities which emanated from the material objects, immaterial entities would remain beyond sense perception. It was frequently pointed out that the material objects themselves could not enter sense organs:

...thus when I look at a horse, I do not receive the horse itself into my eye, or a colour belonging to it, but only an image of the colour, which is called spiritual because it is free from all concrete matter.⁴⁵⁵

⁴⁵⁴ E.g. Thauvonius-Eek 1655, VIII. The scholars at Turku did not differentiate between imagination and fantasy, as did most Renaissance philosophers. (See Park 1988.) Fantasy was the mental faculty of perceiving sensory images whereas imagination was capable of creating new images. At Turku, however, these two functions are performed by fantasy alone, to which I shall in the following refer as 'fantasy'.

⁴⁵⁵ Thauvonius-Eek 1655, Th. XIV. "...sic dum eqvum intueor, non ipsum eqvum oculo, aut colorem ei inhaerentem, sed saltem coloris speciem, quae spiritalis

The necessary contact between the object and sense organ was therefore created by particular *species*, which were supposed to be some kind of image of the perceivable objects. Immateriality was one of the most important characteristics of these images. A *species* was defined as an "image spreading from a sensible object, pure and free from matter".⁴⁵⁶ Thus material objects could emit immaterial images or "qualities", which then could be perceived. These *species* needed a substance (usually air or water), called a **medium**, through which to travel to an appropriate sense organ; perception could not take place in a vacuum, because all movement presupposed contact. If all these five constituent parts of perception were ideal and functioned undisturbed, it could not err.⁴⁵⁷ Special characteristics of these requirements in different senses were also studied in the 1690's.⁴⁵⁸ Only insignificant changes had occurred in the accepted dogmas during the succeeding few decades.

This relatively simple picture was complicated by further divisions and definitions of the five central factors. An object could, for example, be *proprium sensibile* i.e. perceivable only by one sense such as taste or hearing, or *communis*, which meant that it was possible to perceive the object by several senses. Rest and movement, magnitude, number and figure were common qualities.⁴⁵⁹ The medium, on the other hand, could be either an external entity between the object and the sense, or an internal one. An internal medium was actually a part of the sense-organ itself, as is touch in the skin or saliva in taste.⁴⁶⁰

Cartesianism took a radically different stance on perception. Ac-

dicatur, ab omni materiae concretionem liberam suscipio." See also Thauvonius-Warelius 1652, Sect. III, Membr. III, Artic. II, passim. Hahn-Bjurbeck 1697, p. 13.

⁴⁵⁶ Alanus-Ketarmannus 1647, Th. X, XII. "...imago ab objecto sensibili sparsa, pura & à materiae concretionem libera". Thuronius-Teeth 1664, Sect. I, Th. V, VIII-XIV.

⁴⁵⁷ Alanus-Ketarmannus 1647, Th. IV-XXVIII. Thauvonius-Eek 1655, Th. IV-V. Thuronius-Teeth 1664, Sect. I, Th. VII, IX, XVI. Petraeus-Ignatius 1673, V-VI.

⁴⁵⁸ Hahn-Ruda 1695, p. 32 ff. Hahn-Widegreen 1695. Hahn-Junholm 1696. Hahn-Boda 1699. Hahn-Wickelgreen 1697, p. 5, et passim. Hahn-Löngreen 1709.

⁴⁵⁹ A typical question in Renaissance Latin psychology was in what sense these common qualities could be said to be objects of perception. See Park 1988, p. 474. Thauvonius-Eek 1655, Th. VI. "Quantitas non per transmutationem ut Qualitates, sed per emanationem agit, sic à quantitate divisibilitas & localitas procedunt, secundo quoque spiritaliter agit quamvis mediata, & hoc sufficit, ut sit objectum commune sensile." Refers to Scheibler's *Disputatio de sensu in genere*.

⁴⁶⁰ Alanus-Ketarmannus 1647, Th. VII-IX, XX-XXIII. Thauvonius-Eek 1655, Th. XVI-XVII, et passim. Thuronius-Teeth 1664, Sect. I, Th. VI-XVI.

cording to the Cartesians perception as a physiological event was not based on quality-like species, but on motion and touch. In fact, all perception, including vision, was in some way based on the tactile sense. The authors at Turku thought this explanation presupposed that material particles would have to enter the sense organs and cause the perceptions directly.⁴⁶¹ The Cartesian attack brought the existence of *species* into discussion, a notion not only defended but also occasionally redefined.

The concept of perceptible species and the idea that "no body will be sensed immediately and as such" (*immediatè & per se*), but only through qualities, are reflected in discussions of certain old questions of scholastic philosophy. In the Renaissance questions had arisen out of disagreements between Averroes and Avicenna over how to interpret particular passages of Aristotle's writings. One of these questions was whether odour would travel through a medium as *species* (Averroes) or as a material vapour (Avicenna). Most authors at Turku took an Averroistic stance, because it was considered absurd for any body to enter the sense organs as such.⁴⁶² A sort of intermediate theory was suggested in 1697 by Johannes Wickelgreen in his thesis on the nature of olfaction.

First of all, a *species* can not be a quality according to Wickelgreen. This is because "...this we usually count among the six absurdities of the Peripatetics; that is, Accident without a proper subject".⁴⁶³ It was known, however, that

It is not to be denied that smells really do often spread through the air in and with their subject matter which is sulphurous particles - sometimes they are subtle and vaporous, sometimes foggy and more coarse. They are released by warmth, fire and other causes and brought to the sense organs.⁴⁶⁴

⁴⁶¹ Hahn-Lundius 1690, p. 4, 8 ff. See also Hahn-Lönqwist 1698, p. 14-15. Hahn-Boda 1699, p. 18-22, 24. Descartes 1973, p. 289-295. See also Hatfield 1992. Wilson 1993.

⁴⁶² See Park 1988, p. 474-475. Thauvonius-Eek XXXI-XXXVI. Hahn-Ruda 1695, p. 40-42.

⁴⁶³ Hahn-Wickelgreen 1697, p. 21. "...inter sex Peripateticorum absurda recensere solet, Accidens scilicet sine suo subjecto proprio."

⁴⁶⁴ Hahn-Wickelgreen 1697, p. 21-22. "Neque negandum est odores non raro etiam realiter in & cum suo subjecto particulis sulphureis, modo subtilibus & vaporosis, modo fumosis & crassioribus à corpore ipso per calorem, ignem, aliasve causas resolutis in aerem spargi & ad sensorium deferri."

Wickelgreen identified this theory as stemming from Heraclitus, Galen and the medical tradition (which of course refers to Avicenna). He could not accept it, however, because in his opinion it mixed up substances and accidents by making an odour a substance. On the other hand, he could not accept the Averroistic, or "Peripatetic" explanation either.

Moreover, we see that many odorous things often gradually dissipate and when the thing itself has disappeared, the smell can often be discerned in the air for a long time afterwards. But mere species cannot explain this because they do not remain when their subject is absent.⁴⁶⁵

Wickelgreen had, however, a solution to the problem. According to him odoriferous species would often join material particles and be carried by them to sense organs, where they would release the species, which in turn cause the perception.⁴⁶⁶

In addition to the more general problems, some questions related to the structure and functions of individual senses were also discussed. Anatomical structures of the eye or the ear could be described, although often in a rather superficial way. In Cartesian dissertations the anatomical and physiological argument played a far more crucial role.⁴⁶⁷ Still most of the problems arose from the Aristotelian tradition of psychology itself. One of the most disputed questions since antiquity had been the nature of vision. Time after time the Platonic conception of vision according to which the eye emits some sort of "visionary rays" was refuted. Seeing was defined as reception of visible images, and in this process the eye itself played a rather passive role.⁴⁶⁸ If the Platonic theory had been followed, seeing would not have occurred in the eye:

⁴⁶⁵ Hahn-Wickelgreen 1697, p. 24. "Videmus insuper res odoratas plurimas paulatim imminui, & re ablatâ, odorem saepe in aëre diu percipi. Qvod species tantum, qvae in absentia objecti non remanent, praestare nequeunt."

⁴⁶⁶ Hahn-Wickelgreen 1697, p. 25-26.

⁴⁶⁷ Hahn-Lundius 1690, passim.

⁴⁶⁸ Alanus-Ketarmannus 1647, Th. XV-XVI, XXXIX-XL, XLVII. Thauvonius-Eek 1655, Th. XIII-XIV, XXVIII, et passim. Thauvonius-Schroderus 1659/1661, Th. III. Thuronium-Teeth 1664, Sect. II, Th. I, III, VI, VIII-X, et passim. Hahn-Wickelgreen 1697, Th. V. Hahn-Junholm 1696, p. 20-21. Hahn-Boda 1699, § VII. Hahn-Wickelgreen 1697, p. 6-12.

But we do more believe in better reasons and experience itself, and deny seeing to happen by emission of rays. Whatever it would then be which is stated to be emitted - be it a *ray, light, spirit* or *atoms* - if the vision occurred the way the Platonists think, certainly seeing would not happen *in the eye* but *in the visible object*.⁴⁶⁹

On the other hand the Cartesians at Turku accepted neither the idea of species nor the Platonic theory. In their opinion, vision was caused by the reception of *radia*.⁴⁷⁰

Whenever special issues such as the nature of vision were not discussed, the descriptions of the act of perception were often in a way very "technical". For example, hearing occurs in the following way:

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The form, or the mode of hearing happens as follows: a sound which has been carried through the medium to the ear, hits the eardrum. This motion makes it take a form of an audible species, which moves through the labyrinth to the innermost cochlea and all the way through the auditory nerves. The sensation of hearing happens when the image has gone through them.⁴⁷¹

In Aristotelian philosophy the theory of perception was the basis on which theories of intellection and knowledge were founded. The images produced by sense perception were the foundation for all abstract thinking. Therefore, the certainty of our knowledge was very much dependent on the ability of our senses to acquire certain unerring perceptions. Indeed, sense perception was accepted with confidence, provided that all requirements for perception were unviolated: "The senses never make mistakes about their proper objects, if the distance

⁴⁶⁹ Thauvonius-Schroderus 1661, Th. III. "Nos rationibus melioribus ipsisque experientiae majorem fidem habentes, visionem emissione fieri pernegamus, quicquid tandem fit quod emitti statuatur, sive radius, sive lumen, sive spiritus, sive atomus, nam si visio ex sententia *Platonicorum* fieret, certè non *in oculo* sed *in objecto visibili* essent."

⁴⁷⁰ Hahn-Lundius 1690, p. 14 "Quocirca visio fit receptione radiorum non emissione. Satis est quosdam radios, non omnes ex objecto prodeuntes visioni inservire..."

⁴⁷¹ Alanus-Ketarmannus 1647, Th. XLVIII. "Forma vel modus auditionis sic se habet: sonus latus per medium ad aurem, pellit tympanum, eoque motu soni speciem excipit & per labyrinthum ad intimum cochlae recessum ac basin nervi auditorij defert, quo cum species perlata est, fit auditio." Alanus and Ketarmannus refer in this to writings of Burgersdijck.

is just, the medium legitimate and the organ has the right disposition."⁴⁷² Although the senses would not err in principle, some failures could happen if all prerequisites for perception were not "normal", e.g. if the object of perception was too distant. For epistemological purposes this interpretation provided sufficient certainty. On the other hand, it was flexible enough to account for the well-known fact that senses - or our judgement of perceptions - are occasionally mistaken.

The senses could not by themselves discern and identify perceptions. Since this was a job done by the so-called internal senses, which were situated in the brain, all perception really occurred in the brain.⁴⁷³ There was some disagreement about whether there were two or three internal senses. At Turku, other writers counted memory among the independent internal senses in addition to common sense and fantasy, while others regarded it only as a contributory faculty of fantasy.

Perception was a passive function of the sense organs up to the reception of the species. However, the process became active in character as soon as the *facultas cognoscens* was activated. Although sensation was a passive process in some respects, perception as a whole was an active one. A perception was perfect only if the received species was appreciated and classified. Unless the rational soul paid attention to the received species, no perception would occur.⁴⁷⁴

A *species* caught by the external senses was transferred to the internal ones for further interpretation. This was done by the *spiritus* residing in the nerves.⁴⁷⁵

The spirit is as if in a guard post in the organs of the external senses. They receive the character or image pressed to the external sense-organs by the object, and transmit it to the common sense.⁴⁷⁶

⁴⁷² Alanus-Ketarmannus 1647, Sicilimenta 2. "*Sensus circa objectum proprium nunquam hallucinatur, si justa sit distantia, medium legitimum & organum recte dispositum.*" See also Thauvonius-Eek 1655, Th. V.

⁴⁷³ Hahn-Widegreen 1695, p. 5. Hahn-Sidbeckius 1698, Membr. I, § III.

⁴⁷⁴ Thuronius-Teeth 1664, Th. XVII.

⁴⁷⁵ Hahn-Lönqwist 1698, p. 9. Hahn-Wickelgreen 1697, p. 8-12. Hahn-Boga 1699, p. 13. Hahn-Junholm 1696, p. 8-11.

⁴⁷⁶ Hahn-Guzelius 1696, p. 12. "Nam spiritus in sensus exterioris organo, velut in statione positi, characterem seu speciem ab objecto impressam in organis sensuum externorum excipiunt, eamque ad sensorium transmittunt commune."

The nature of the *spiritus animales* was somewhat unclear at Turku. Usually they were thought to be incorporeal entities, which were generated in the brain from vital spirits and which moved in the nerves.⁴⁷⁷

The first of the internal senses was the *sensus communis*, which collected and combined all the information coming from various sense organs. It was helped by the *fantasy*, which in its turn retained the perceptions a little longer. Fantasy also examined the *species* more keenly and created totally new *species* or auxiliary images to help the recognition process whenever needed. Whereas fantasy kept the sensible species processed by the common sense longer than the common sense itself could do, *memory* was the faculty which finally stored the images and provided them for later use. It was said to be located "in the uppermost part of the brain underneath the forehead".⁴⁷⁸ However, not all images were transferred from the fantasy to the memory. Whether animals had a proper memory or whether this capacity belonged to the rational soul only was also somewhat controversial. It seems to have been relatively normal at Turku to assume that animals had a so-called sensitive memory which enabled them to remember occasions when they had felt pleasure or pain.⁴⁷⁹

The Cartesians had a different view on how the perceptions were judged and recognized.

*The nerves and animal spirits, which flow in the nerves all the time like a stream, are the most proximate and immediate instruments of perception. This mass of spirits is moved by the slightest impulse by the external objects. They transmit various undulations without delay to the middle parts of the brain. In the cavity of brain there is a certain very small gland, which is called pinealis... It hangs freely and can thus pay attention to all parts of the body equally. And this we consider to be the common sense.*⁴⁸⁰

⁴⁷⁷ On spiritus see also Leikola 1983a, p. 243-244.

⁴⁷⁸ Hahn-Guzelius 1696. "...in ultima cerebri parte sub occipitio". Thauvonius-Eek 1655, Th. LI-LXI. Thuronius-Teeth 1664, Sect. II, Th. XVIII-XXV. Hahn-Junholm 1696, p. 37. Hahn-Gaslander 1707, p. 10-11.

⁴⁷⁹ Thuronius-Teeth 1664. Petraeus-Ignatius 1673. Hahn-Rosendahl 1691. Hahn-Ruda 1695, p. 23.

⁴⁸⁰ Hahn-Lundius 1690, p. 6. "Nervi & spiritus animales sunt proximum & immediatum instrumentum sensationis, qui per nervos, continui instar torrentis, semper fluunt. Haec autem spirituum massa vel minimo impulsu ab objecto externo com-

Once in the brain, the movement of corpuscular "spirits" pressed images on the brain matter. Perception took place, if the soul-substance happened to pay attention to the images pressed by the movement. In order for a perception to become recognized and conscious, this act of judgement was required.⁴⁸¹ It remains unclear, though, how Lundius understood the role of *sensus communis* and the pineal gland in this process.

According to the Aristotelian tradition free movement of the animal spirits in the nerves was crucial for the normal function of the human body. Sometimes, however, the movement of animal spirits was hindered, which caused the *sensus communis* to stop functioning and man to fall asleep. No consensus was achieved on the question of whether it was thick vapours arising from the stomach or something else that blocked the way of the animal spirits.⁴⁸² Sleep was thus a disorder of the sensitive soul, although it was necessary for maintaining health. During sleep fantasy kept on working actively. It created dreams by agitating the residues of sensible species which still remained in the brain. Because the common sense was "switched off" during sleep, even the most weird phantasms would seem real in our dreams. Sometimes animal spirits were blocked into limbs so that they could not communicate with the brain anymore. This would cause somnambulism, a state in which man was not conscious and responsible for his movements and deeds.⁴⁸³

Perception was a faculty of the sensitive soul. Even the processes happening in the internal senses were thus subordinate to the actions performed by the sensitive soul. For this reason even animals could be guaranteed some sort of fantasy and memory. It was well-known,

mota, undulationes varias in momento ad medium cerebrum transmittit. In ventriculo cerebri est glandula quaedam minima, quae dicitur pinealis... libera pendens, aequaliter omnes corporis partes respicere potest, & haec putatur esse sensorium commune."

⁴⁸¹ Hahn-Lundius 1690, p. 4-5.

⁴⁸² Thauvonius-Eek 1655, Th. LIV. Tålpo-Höök 1685, Th. I. Hahn-Wiikholm 1705, p. 13-30, 37, et passim.

⁴⁸³ Hahn-Modeliin 1698, p. 6, 32-33, et passim. Thauvonius-Eek 1655, Th. LVI. Hahn-Wiikholm 1705, p. 63, et passim. Achrelius 1682, p. 366. In Achrelius-Peterejus 1681 more detailed causes of sleepwalking are given, as well as their cures. Th. XII "Sin vero *mali* [angeli causa sunt] antidota caelestis verbi precibusque discrimen illud praecavendum. Noctisurgium naturale ex cupiditate diurnâ, motu phantasiae, cibo vel potu nimio cerebrum fumis opplente proveniens non diu durabile est, sed momentaneum, nisi forte de novo semper causae accumulentur."

for example, that dogs and horses knew their masters, which presupposed memory. The existence of fantasy in animals was also proved by the fact that dogs clearly had dreams, which could be induced from their movements during sleep. The Cartesian theory that animals had no soul at all and that animal movements in sleep were purely mechanical, had no support among the students at Turku, not even from the Cartesians.⁴⁸⁴

The Rational Soul

"The Rational Soul is the form of man, through which it has its essence, special abilities and characteristic operations."⁴⁸⁵ The rational soul was first of all the form of man. In psychology this point of view was also essential, as the particular features of human actions caused by the rational soul in relation to the body were thought to be subject to psychological scrutiny.⁴⁸⁶ The rational soul had two characteristic faculties, intellect and volition, through which man's soul exercised its particular operations - animals could not think. Unlike perception and other functions of the sensitive soul, the rational soul was entirely inorganic and immaterial.⁴⁸⁷ Immateriality was an essential quality of the rational soul, because it made it possible to explain its immortality.

The status of the faculties had been a question of philosophical dispute since the Middle Ages. Was there a real ontological distinction between the soul and its faculties, or did the soul only represent different modalities in different functions? At Turku the question was hardly ever passed over in dissertations discussing the rational soul, and the answers given are similar without exception. As the question was primarily a logical and metaphysical one, the arguments were of the same kind:

⁴⁸⁴ Thauvonius-Warelius 1652, Sect. III, Membr. III, Artic. II, Ax. 6. Hahn-Ruda 1695. Hahn-Modeliin 1698, p. 7. Hahn-Wiikholm 1705, *passim*.

⁴⁸⁵ Miltopaeus-Enebergh 1667, Th. III. "*Anima Rationalis est forma hominis, quā suam habet essentiam, potentias & operationes distinctas*." See also Thauvonius-Anxelius 1655, Th. 6. Thauvonius-Helsingius 1658, Th. 6,8. Thuronius-Stenius 1664, Th. 2-5. Hahn-Collander 1699, p. 4-5. Hahn-Hornaeus 1690, p. 4, 6-7.

⁴⁸⁶ Thauvonius-Anxelius 1655, Th. 7-8. Thuronius-Mathesius 1665, Th. 1. Miltopaeus-Enebergh 1667, Th. VII-VIII. Hahn-Collander 1699, p. 2.

⁴⁸⁷ Thauvonius-Laurbecchius 1653, Sect. III. Thauvonius-Florinus 1656, Quaest. III, V. Thauvonius-Helsingius 1658, Th. 13-16. Thuronius-Stenius 1664, Th. 6, 21. Miltopaeus-Enebergh 1667, Th. IX-XI. Hahn-Collander 1699, p. 6, 12. Hahn-Hornaeus 1690, p. 9-10. Hahn-Bruzelius 1697, p. 20.

Every accident has a real difference from substance. Faculties are accidents. Therefore, they have a real difference from the soul. The major and minor premises are proved because soul is a substance, but the faculties are accidents. It can be added that no created substance is the immediate principle of its own actions.⁴⁸⁸

Not all faculties of the rational soul were not equally important. Intellect and volition were the primary faculties, whereas speech and laughter were placed second.

The prime function of the intellect was to recognize truths.⁴⁸⁹ The intellect was either active or passive in its operations. The **active intellect** would enlighten the *species* as they were expressed by *sensus communis* and fantasy. It also transmuted the sensible species into totally immaterial and spiritual *species intelligibiles*.⁴⁹⁰ Because intellection was an inorganic act, it could not use the species produced by the fantasy as such, but had to transmute them into a form more suitable for thinking processes. Intelligible species were received by the **passive intellect**, which made final judgements on them. The division between active and passive intellect was only conceptual, and the intellect was considered to be a whole in reality. Differences between different "parts" of the intellect could be discerned only by their modes of action.⁴⁹¹ Intellect could thus be regarded as active, because it prepared its tools (i.e. *species intelligibiles*) by itself.⁴⁹²

The other primary faculty of the rational soul was volition, which

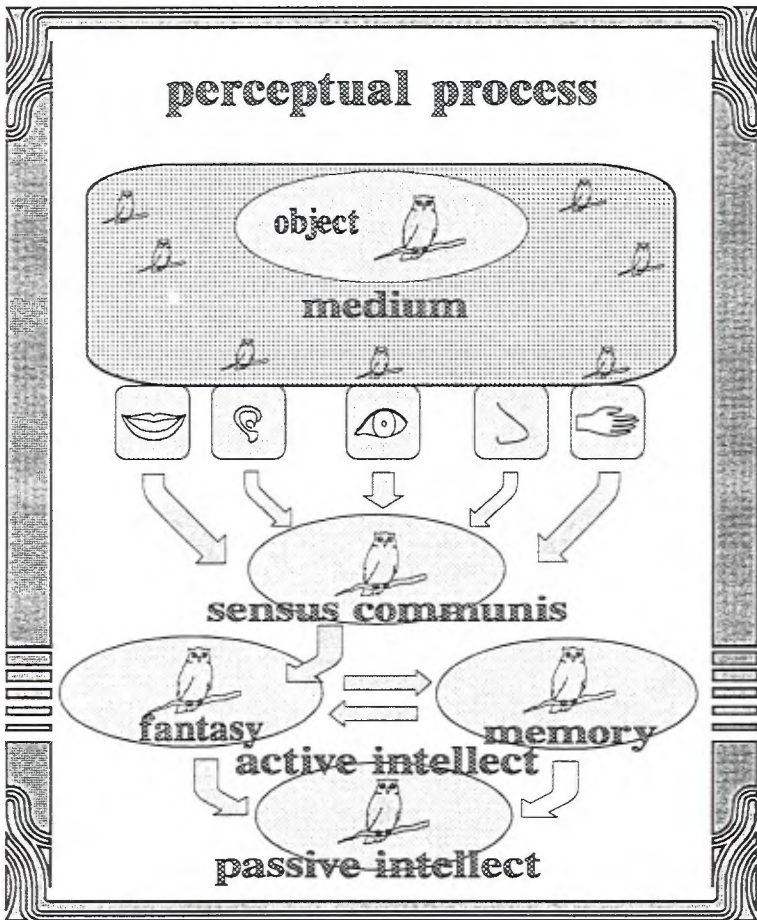
⁴⁸⁸ Hahn-Collander 1699, p. 8. "Omne accidens à subjecto differt realiter; facultates sunt accidentia; Ergo ab anima differunt realiter: & major & minor probatur, quia anima est substantia, facultates vero sunt accidentia: Addi & poterit id, quod nulla substantia creata sit immediatum suarum actionem principium." See also Thauvonius-Anxelius 1655, Th. 9. Thauvonius-Florinus 1656, Quaest. VI-VII. Thuronius-Mathesius 1665, Th. 5. Hahn-Hornaeus 1690, p. 14. Hahn-Bruzelius 1697, p. 7-8. Thuronius 1660, Institutiones Logicae Tractatus Prooemialis, p. 65-69. Flachsenius 1678, Collegium Logicum Prooemiale, p. 131-148.

⁴⁸⁹ Hahn-Collander 1699, p. 8-9. "Intellectus est facultas animae rationalis ad verum cognoscendum ordinata." Thauvonius-Anxelius 1655, Th. 14. Thauvonius-Helsingius 1658, Th. 18. Hahn-Bruzelius 1697, p. 6.

⁴⁹⁰ Thauvonius-Anxelius 1655, Th. 15-17, 25, 28-30. Thauvonius-Florinus 1656, Quaest. IX. Thuronius-Stenius 1664, Th. 18, 20. Hahn-Gaslander 1707. Hahn-Hornaeus 1690, p. 15. Hahn-Bruzelius 1697, p. 14, 17-21, 23-28. On the classical and medieval ideas on *species intelligibiles* see Spruit 1994.

⁴⁹¹ Thauvonius-Anxelius 1655, Th. 18. Thauvonius-Helsingius 1658, Th. 21-22. Thuronius-Stenius 1664, Th. 14, 19, et passim. Hahn-Collander 1699, p. 9-11. Hahn-Bruzelius 1697, p. 23-28. Hahn-Frolander 1692, p. 16.

⁴⁹² Thauvonius-Anxelius 1655, Th. 24-25.



According to Aristotelian theory perception process proceeds as follows: an *object* spreads *sensible species* around it. A *medium* carries the species to a suitable *sense-organ*. Animal *spirits* residing in the nerves move the species to the *common sense*, which combines information coming from various sense-organs. It transfers the species to *fantasy*, which examines them and also creates new images if needed. Fantasy interacts with *memory*, which stores the species. *Active intellect* accepts the sensible species from the fantasy and transmutes them into totally immaterial *intelligible species*. The *passive intellect* makes final judgements on the perception. It remains unclear whether memory can also act directly with the active intellect or must it always negotiate with the fantasy first.

was destined for "reaching for the good and escaping from the bad" (*bonum appetendum & malum fugiendum*). The intellect would show the volition which things were worth reaching for or avoiding. What was not known could be an object neither of desire nor aversion. Volition then governed other faculties, such as speech and locomotion which served the function of achieving the goal set by the volition. The very essence and function of the volition presupposed freedom of the will according to the authors at Turku.⁴⁹³ The very few Cartesian authors at Turku also recognised intellection and volition as the primary faculties of the *res cogitans*, although volition was generally given a much greater role. Man's volition however would not be determined only by the reason, and dependent only on the information provided by the intellect. This was thought to be proved by the fact that sometimes the two opposed each other. Moreover it was for the most part due to volition that man thought at all.⁴⁹⁴

In addition to these so-called primary faculties the rational soul had also secondary faculties. These faculties, speech and laughter, were dealt with only seldom, obviously because they were considered less important than intellect and volition. Speech was the instrument of the rational soul to express the concepts formed in the mind. Thuronius described the act of speech physiologically as follows:

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The act of speaking is speech, which is performed as follows. Air is inhaled into the lungs. It is bounced back from there through the windpipe and the small chinks in the larynx and to the palate. Agitated in this way, the air gives rise to a sound which is collected in the palate. It is then controlled and articulated in various ways by the vocal cords, tongue, teeth and lips.⁴⁹⁵

The ability of speech is limited to humans only, because it presupposes rationality. Although the *faculty* of speech was innate in men,

⁴⁹³ Thauvonius-Anxelius 1655, Th. 32-38. Thauvonius-Florinus 1656, Quaest. XI-XIII. Thauvonius-Helsingius 1658, Th. 29-31. Thuronius-Stenius 1664, Th. 24. Hahn-Bruzeliuss 1700. Hahn-Collander 1699, p. 12-15. Hahn-Hornaeus 1690, p. 16-18.

⁴⁹⁴ Tammelinn-Hiellm 1707, p. 18-27.

⁴⁹⁵ Thuronius-Stenius 1664, Th. 28. "Actio sermonis locutio est, quae hoc modo peragitur. Aër in pulmonis inspiratur: unde per asperam arteriam in laryngis rimulam & palatum resiliit: Aër iste sic agitatus sonum dat, qui in palato collectus, uvulâ, lingvâ, dentibus & labijs postea variè temperatur & articulatur."

no language was natural in the sense of being innate. All languages would have to be learned. The first language of all was created by Adam, when he gave names to animals.⁴⁹⁶ Laughter and its opposite, weeping, were also dependent on rationality. Whatever the reason for laughter was, the faculty was always subordinate to volition.⁴⁹⁷ Certain bodily processes finally initiated laughter:

Laughter occurs in this way: having been stimulated by some joy-causing thing, warm blood and vital spirits start moving from the heart. The muscles of the heart itself and diaphragm, together with those of the thorax dilate, especially the muscles of the cheeks.⁴⁹⁸

The connection between physiology and "psychology" was once again very close. Bodily processes were primarily expressions of the various functions of the soul. In this respect psychology at Turku closely follows the tradition which stems from Aristotle's *De anima* and the *Parva Naturalia*. *De anima* especially held a central position in university curriculums during the Renaissance. The organic conception of soul presupposed combining the physiological aspects with the functions of the soul.⁴⁹⁹

Emotions and Mental Disorders

In addition to cognition and volition, emotions had been a central subject in Aristotle's *De Anima* and the medieval and Renaissance "psychology" which stemmed from it. In Aristotle's view emotional response involved *both* cognitive and bodily aspects. We have in the previous subsection seen that psychology was closely connected with the study of the organic body, but on the other hand it was also important for philosophers as a part of ethics and rhetoric. According to Aristotle the thought of the object of emotion (e.g. a frightening or a

⁴⁹⁶ Miltopaeus-Enebergh 1667, Th. XXXVI. Hahn-Agrell 1697. Hahn-Hornaeus 1690, p. 20.

⁴⁹⁷ Miltopaeus-Enebergh 1667, Th. XXXIV-XXV. Thuronius-Stenius 1664, p. 29-33. Hahn-Hornaeus 1690, p. 18-19. Hahn-Imbergh 1703.

⁴⁹⁸ Thuronius-Stenius 1664, Th. 32. "Fit risio hoc modo: Excitato â re aliquâ gaudio, magna ex corde fit calidioris sanguinis, spirituumque vitalium effusio; ipsiusque cordis, diaphragmatis & musculorum cum thoracis, tum eorum quae â lateribus buccae sunt, dilatatio."

⁴⁹⁹ Park & Kessler 1988. Park 1988.

pleasurable thing, a hateful person) was a prerequisite for the birth of an emotion. Because a thought or belief was thus the efficient cause of emotion, Aristotle thought that emotional response was in a way dependent on the intellect and thus man's behaviour could be affected by reasoning and persuasion, which were central to rhetoric, poetics, ethics and politics. From a wider point of view soul/form was the ultimate source of man's thoughts, emotions and moral actions. In the Renaissance psychology was also studied by medics, who sought in its doctrines help in understanding mental and physical diseases.⁵⁰⁰ However, emotions were not much dealt with in physical theses at Turku.

In Renaissance Aristotelian biological psychology, which was based on *De Anima*, emotions were placed in the realm of the sensitive soul. (This biological distinction between cognitive and perceptual does not directly correspond with Aristotle's ethical and political distinctions between the so-called logical and alogical parts of the soul.)⁵⁰¹ As we remember, the sensitive soul had three faculties: sensitive, locomotive and appetitive. It was the appetitive faculty which produced the emotions, usually further grouped either as concupiscible or irascible ones. Thus, animals were also in a sense able to feel joy or to be sad - a view which Cartesians opposed.

Descartes had aimed to mechanize all of the functions traditionally assigned to the vegetative and sensitive souls. Aristotle had regarded a thought of the object of emotion as the efficient, and the bodily reactions as the *material* cause of emotions,⁵⁰² however physiological processes were given the role of "efficient causes" in Descartes' philosophy. Thus, one of the main ideas in the Cartesian theory of emotions was that all *passions* were excited by corporeal processes, although they had real meaning only as psychic states of the mind.⁵⁰³ If stripped of its dualistic starting-point the Cartesian theory did not necessarily contradict the traditional view, at least if considered as superficially as the authors at Turku usually did: faculties of the sensitive soul were corporeal and hence mortal. According to Miltopaeus, who was one of the very few authors of the Aristotelian tradition who paid any attention to emotions in physical theses, they resided in the heart.

⁵⁰⁰ Park & Kessler 1988, p. 455-457. Fortenbaugh 1975.

⁵⁰¹ Fortenbaugh 1975, p. 26-28.

⁵⁰² Fortenbaugh 1975, p. 12-15, 21, et passim.

⁵⁰³ Alanen 1984.

All emotions were caused by motions of the blood and spirits, and certain physical alterations in some part of the body.⁵⁰⁴

The most far-reaching description of the origin of emotions was given by Daniel Achrelius, who presented a thoroughly Cartesian view of the subject in his *Contemplationes mundi*. Typically the attention is aimed at the physiological part of the Cartesian passion-theory. Achrelius cites Antonius LeGrand's text extensively explaining how the minute corpuscular spirits move from the brain to the heart, dilate the blood and cause an emotion. He then discusses variations of this process, whereby different kind of emotions are generated. To finish his Cartesian episode he aids readers to get more information on the subject by reading Descartes' *De Homine* and *Passiones animae*.⁵⁰⁵ The corporeal explanation of emotions was easily combined with the old dogma of temperaments. Thus, sanguine people were inclined to be joyful, phlegmatics fearful, melancholics sad and choleric angry, because the spirits tended to move in different ways in their nerves.⁵⁰⁶

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Many mental disorders also had primarily physical causes. Although mental illnesses had been a part of the medical and physical repertoire since Hippocrates, it was unusual to discuss the subject at Turku. However, Thuronius describes abnormal phantasies in one of his dissertations: someone thought his nose had changed to a snout, someone else thought he was talking with God, a third lunatic insisted on killing himself. All these hallucinations were caused by the fantasy. Whatever fantasy represented properly to the intellect would be rightly judged by it, but if fantasy did not work in a normal way for some reason, the judgements made by the intellect would produce all sorts of hallucinations. Following Sennert, Thuronius offered three physical causes for the malfunction of the fantasy:

There are three main causes for this, as Sennert teaches us in an accurate manner... 1. When the constitution of brain is defective and melancholic. 2. When the heart generates impure vital spirits, which are the matter of which the animal spirits are formed. 3. When the animal spirits themselves are pure, but some other strange, impure and noxious matter is mixed up with them.⁵⁰⁷

⁵⁰⁴ Miltopaeus-Pryss 1668, Th. V-VI.

⁵⁰⁵ Achrelius 1682, p. 356-359. LeGrand 1679, p. 950-951.

⁵⁰⁶ Achrelius 1682, p. 355. Miltopaeus-Pryss 1668, Th. XIV.

⁵⁰⁷ Thuronius-Kinmundt 1662, Quaest. X. "Hi vero tribus potissimum de causis fiunt,

In the normal scheme of physical psychology discussions of mental illnesses and even of emotions were very rare. Cartesianism was the first new psychology which paid attention to emotions on a larger scale, but at Turku not even this tradition gained a very strong hold. Apart from Achrelius, only Andreas Lundius dealt in passing with various illnesses caused by the malfunction of the nervous system and the corpuscular vital spirits circulating in them. Mental disorders were also caused by diverse derangements of the body.

INSANITY, MELANCHOLY, DELIRIUM, PHRENESIS, STUPIDITY, MANIA, etc. not only corrupt the powers of imagination and memory, but also destroy the ability to make judgements. By wandering here and there without proper order, by raging and rum-maging, jumping and shaking, the spirits seize the fibres of the brain and imprint there unusual images and impressions. These images the mind, as it is intimately united with the body also, connects without selecting and discriminating. It is impossible that certain cogitations in the mind would not respond to certain motions in the body and vice versa. If these motions are enormously unusual and absurd, the cogitations in mind necessarily become unusual and absurd also.⁵⁰⁸

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Outwardly Lundius' description of the causes of mental illnesses resembles that of Thuronius above. However, Lundius arrives at these conclusions from a totally different theoretical background. The full meaning of this passage might open up only after having got acquainted with Lundius' other ideas about perception. However, suffice it to note that Lundius expects that there be a real distinction between

ut accurate docet Sennert... 1. Quando cerebri constitutio vitiosa est & melancholica. 2. Cum spiritus vitalis, qui Spiritibus animalibus materia est, in corde impurus gignitur. 3. Cum spiritus quidem animales sunt puri, ipsis vero materia aliqua aliena, impura & tenebrosa miscetur."

⁵⁰⁸ Hahn-Lundius 1690, p. 25. "INSANIA, MELANCHOLIA, DELIRIUM, PHRENESIS, STUPIDITAS, MANIA &c. non solum imaginationis & memoriae vim corrumpunt, sed etiam iudicium, adeo ut Spiritus huc illuc incerto ordine cursitando, tumultuando, sibi invicem occurrendo, insolita trepidatione saltando, cerebri fibrillas subeuntes insolitas etiam inibi imagines & vestigia imprimunt, quas imagines etiam anima, ut, qui corpori intime unita, sine delectu & discrimine connectit. nam non possunt non certae cogitationes in anima respondere certis motibus in corpore & vice versa, qui motus si insoliti enormes & absurdi fuerint, necessario etiam cogitationes in anima insolitae & absurdae fiunt."

corporeal processes such as imagination and memory, and mind. The former can nevertheless puzzle the mind, which makes the judgments. The solution of this problem of interaction is based on occasionalism. All in all, the main point in Lundius' theory is that the disturbed motion of spirits causes these mental states.

I have here referred to the mind-body problem the Cartesian Lundius had to face. Although Aristotelian philosophy did not face this problem as such, certain ideas concerning the relationship of mind and matter, or form and matter were formulated in Aristotelian philosophy too. Let us now have a look at this aspect of natural philosophical learning at Turku.

The Relationship Between Body and Soul

Despite all their disagreements on the details of the dogma, proponents of the Aristotelian philosophical tradition agreed by and large that the rational soul was the form of man. Unlike all other forms, it was partly immortal and incorporeal. The relationship between the immaterial soul and material body was not seen as very problematic by the scholastic authors at Turku. Body and soul were organically one, the soul being the active part of the pair. No third part or spirit could exist in man:

We shall say these two things only because of the opinion of those who assume a third part or spirit [to exist in man]. If this part existed then the soul would be united with the body by the mediation of something. But in reality (as Thomas says) form is united to matter without mediation. Both the Scriptures and the book of Nature remain silent about the third essential part of man.⁵⁰⁹

It was also strictly denied that any soul could be located in a body in the same sense as material bodies occupied a place. Ontologically, being located presupposed quantity. Quantity on the other hand implied mass, extension and divisibility. But no incorporeal substance such as the soul had quantity or any of the characteristics which having

⁵⁰⁹ Thauvonius-Anxelius 1655, Th. 4. "Tantum dicimus hic duo, ut tollatur opinio eorum, qui tertiam partem *spiritum* sc. constituunt. Si pars ille esset, tum anima mediâ uniretur corpori, verum forma (afferente Thomâ) immediate unitur materiae. De tertia enim hominis parte essentiali tacent Scriptura & Naturae libri."

quantity implied. Therefore the soul could also be claimed to be non-located.⁵¹⁰ There was, however, an intimate relationship between body and soul:

QUESTION III. Is the Rational Soul is inorganic? Affirmed.

...But neither is it mixed up with the body: (because it is not affected by any particular proportion of primary qualities) it does not cease understanding and wanting either, if separated from the body. The soul thinks in the body, but not through body like using an instrument.⁵¹¹

There was a settled formula which expressed the generally accepted relation between the soul and the body: "Every soul is whole in the entire body and whole in each of its parts."⁵¹² This saying also assumes a position on some principal questions within Aristotelian philosophy.

One of the problems widely discussed by the medieval and Renaissance philosophers was whether the entire soul was present in the whole body and in each of its parts. Like many other questions, this one also stemmed from the texts of Aristotle and his early commentators (especially Avicenna and Averroes). The problem was often condensed into discussions on the faculties of the organic soul. Katherine Park has formulated the problem in her article on the organic soul as follows: "Does the cause of the differences between the various operations of the soul lie on the level of form or matter? In other words, do those differences arise in the first place from a distinction in the body or from a distinction in the soul?"⁵¹³

The position held by Albertus Magnus and Thomas Aquinas, which

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⁵¹⁰ Thauvonius-Florinus 1656, Quaest. II. "Quicquid non est quantum, illud non est in loco. At Anima non est quanta. Ergò. Majoris sequela est firmissima. Quod enim quantitate destitutum est, nec extendi, nec dividi potest. Ergo nec partes habet, quae partibus spatij insint." Thauvonius-Helsingius 1658, Th. 10. Thuronius-Mathesius 1665, Th. 6.

⁵¹¹ Thauvonius-Florinus 1656, Quaest. III. "QUAESTIO III. An Anima Rationalis sit inorganica? Affr. ...Haec enim ut corpori commixta non est: (nulla namque certà primarum qualitatū temperie affecta est) ita à corpore separata intelligere & velle non desistet. Intellegit quidem anima in corpore, sed non per corpus, velut instrumentum."

⁵¹² Thuronius-Mathesius 1665, Th. 3. "*Omnis anima est tota in toto corpore & tota in cujuslibet ejus parte.*" Only minor changes in the formulation occurred. Thuronius-Stenius 1664, Th. 7. Miltopaeus-Enebergh 1667, Th. XXIII-XXVI. Hahn-Rungius 1691, § X, et passim.

⁵¹³ Park 1988, p. 477.

was very influential throughout the Middle Ages, was that a real distinction existed between the soul (substance) and its faculties (qualities). Therefore, the different functions of the soul were also caused by different "parts" of the soul. For example the faculty of sight, residing in the eye, would be different from the soul and from its other faculties. On the other hand there was a group of nominalist thinkers, who claimed that the soul was located in the whole body and in each of its parts. The faculty of sight, for example, was an integral part of the soul and present everywhere in the body. The reason why we see only with the eye was that the structure and composition of that particular organ was suitable for sight while other organs were not. The latter view started getting more supporters at the beginning of the 16th century, when the *via moderna* partly joined forces with new readings of Aristotle.⁵¹⁴

The fact that scholars at Turku recognized a real distinction between the soul and its faculties did not otherwise prevent them accepting the nominalist standpoint:

Although the soul is, in accordance with its essence, present in the entire body, it nevertheless could never originate a perception without an organ. And although the essence of the soul is the same in the foot as it is in the eye and the ear, the foot neither sees nor hears. This is because the foot is a proper instrument neither for seeing nor for hearing.⁵¹⁵

It was the final cause of all organs to be structured as they were in order to perform certain actions of the soul. The soul was totally dependent on some bodily organs on certain occasions. For example, an injury in the ear could make a man deaf, although the faculty of audition would remain unhurt.

⁵¹⁴ Park 1988, p. 477-479. Copleston 1985, II, p. 376-378; III, p. 97.

⁵¹⁵ Hahn-Ruda 1695, p. 32-33. "Qvamvis anima secundum suam essentiam in toto corpore praesens sit: tamen nunquam sensus alicujus auctor est, nisi ubi habet organum: & licet eadem animæ essentia, quæ est in oculo & aure, sit etiam in pede: tamen quia in pede neque videndi neque audiendi est instrumentum, in pede nec videt, nec audit." See also Alanus-Ketarmannus 1647, Th. XXIV. Thuronius-Teeth 1664, Th. VI. Even the Cartesian Lundius continues on the same line of thought, although his idea of the soul-body relationship was totally different from these: Hahn-Lundius 1690, p. 7. "*Facultatem percipiendi non esse nisi unam, licet sensus sint diversi; & sensus ipsos non tam ratione naturæ, quam officiorum, & exercitiorum esse diversos ratione non absonum videtur.*"

Related to this problem was the question of the relation between different grades of souls in man. As we know, it was only man who possessed all three types of soul, the vegetative, the sensitive and the rational one. It was asked whether there were three different souls in man or whether they were united into one single soul? If so, how could it be explained that the sensitive soul required the presence of bodily organs in order to perform its functions, while the rational soul could do without any connection with the body? Although these problems were commonly discussed in the Renaissance literature, they attracted only little interest at Turku. It was asserted that the rational soul was one. The sensitive, vegetative and rational faculties of the soul formed an integral whole, the parts of which could be separated only conceptually because of the different functions they performed. The three stages of the soul could be discerned especially during the development of human foetus.⁵¹⁶

The rise of Cartesianism threatened the traditional ideas about the organic connection between body and soul. Discussion of the problem intensified as new ways to explain psychological phenomena in physics were put forward by the Cartesians. We shall come back to these problems in chapter "The Breakthrough of Cartesianism".

6.3. Man, Nature and Supernature

It has been stated earlier that the borderlines between different disciplines were not always very strict in the sense that dissertations dealing with natural philosophical themes could be published in other disciplines too. On the other hand, some theses, e.g. on ethics and politics were published under the guidance of the physics professor, but those theses are not dealt with here. The relationship between man and supernatural powers was also discussed occasionally in physical theses, although the study of spirits was the proper subject-matter of pneumatics. The existing borderlines between sciences mirrored certain conceptions of the state of affairs in nature. Therefore studying the

⁵¹⁶ Thuronius-Mathesius 1665, Th. 4. "Una est re anima rationalis, facultatibus & vegetativis & sensitivis instructa, quae propter diversas functiones diversa sortitur nomina, diversos conceptus." Compare with Thuronius-Allenius 1661. See also Thauvonius-Helsingius 1658, Corollaria 1,2. Thuronius-Kinmundt 1662, Quaest. VI. On the "evolution" of soul see the previous chapter on "The Generation of Man...".

relationship between man and supernature also helped to define his position in the world and the limitations of humanity. For example in medieval philosophy it had been usual not to restrict to explaining the cognition of the embodied human intellect, but to study cognition in disembodied beings also.⁵¹⁷ On the other hand, the relationship between man and nature was not problematised.

It was a self-evident fact that God had given man a position at the top of the hierarchy of living beings. Not only was he created as the image of God, but as a microcosm he also symbolically represented the entire variety of the cosmos.⁵¹⁸ Nature existed in order to provide living for man, and it was his right and duty to rule and exploit it. Man's control over nature was for first achieved by Adam, when he subdued other creatures by naming them.⁵¹⁹ It was recognised, however, that nature also affected humans to some extent. In his study of the causes of the variety of habits and customs among different people Petrus Schefer refers to environmental causes. Certain dispositions of the bodily fluids, i.e. temperaments, were likely to prevail in particular kinds of environments. Each temperament had typical patterns of behaviour, which tended to lead gradually to certain kinds of habits and morals.⁵²⁰ This view is relatively directly derived from Hippocrates, who had proposed that environment (climate, sunshine, winds, geographical location, etc.) affected temperament and thereby health and illness.⁵²¹

Much more common than studying the relationship between man and nature was to discuss the essence of spiritual beings, i.e. angels and demons, and their intercourse with humans. Whereas men consisted of body and soul, angels were pure spirit (pure form). As spiritual beings they were not restricted by the demands imposed by extension and divisibility, for which reason they could act in a way which seemed supernatural to men. In comparison with men, angels had many advantages because of their incorporeality. For example, their acts of intellection were free from sense perception. Angels were created beings, and although they were spiritual, they were nevertheless finite.

⁵¹⁷ Marenbon 1987, p. 117-121.

⁵¹⁸ Hahn-Chydenius 1697.

⁵¹⁹ Achrelus-Hwal 1683, p. 15, § III.

⁵²⁰ Hahn-Schefer 1687.

⁵²¹ Hippocrates 1983, p. 148-169.

On the other hand the incorporeality of angels caused some problems for scholars. How was it possible that angels could sometimes be seen, as if they had a body? How did angels communicate; did they, for example, speak to each other? Although angels could temporarily adopt corporeal form and were able to communicate both by direct intellection and speech, there were certain limits to their powers. God was the supreme ruler over the nature's laws.⁵²² Theories which explained natural events such as the regular revolution of planets by the action of angels or "intelligences" were systematically refuted at Turku. The intervention of supernatural powers in the normal course of nature was supposed to be extremely rare.

The belief in black angels or demons was common even among learned men in the 17th century. Accusations of sorcery were regularly raised at the University during the century. Usually these accusations were of achieving better results by using proscribed arts.⁵²³ It is therefore no wonder that some disputations on the subject were also published. Demonic power over nature was considered to be limited merely to producing false images. For example, man and demon could not procreate:

Changelings are infants which represent human figure, but are formed and produced by the Devil in the womb of witches from blood or some other matter. They are then put in the place of real children, and which he [devil] himself moves and directs in order to deceive people.⁵²⁴

The workings of both *incubus* and *succuba* were fundamentally based on deception and conjuring. Not much more successful were the people who made a pact with the Satan in order to get some advantages. It was, however, a matter of dispute whether the Satan would really give witches and sorcerers the power to fly to orgies with their body or whether it was all eyewash.⁵²⁵ In 1645 Alanus

⁵²² Tålpo-Rodde 1684. Hahn-Ring 1689. Flachsenius-Woivalenius 1684, Quaest. III. See also Hahn-Wargentin 1697.

⁵²³ Heikkinen 1969. Nenonen 1992. Laasonen 1977b, p.

⁵²⁴ Hahn-Montelius 1690, p. 8. "Infantes supposititii sunt foetus, figuram hominis repraesentantes, à Diabolo in sagarum utero ex sanguine vel alia materia efformati atque producti, & loco verorum Infantium suppositi, quos ipse praesentia sua movet ac dirigit, ad alludendum hominibus."

⁵²⁵ Hahn-Almeqwis 1686, Quaestion: "An in potestate Satanae mancipia sua cor-

opined that demons could not loosen even the soul of a witch for nightly orgies - not to mention the body. Alanus argued that if demons could operate with souls in this way, they could also awake the dead, which only God could do.⁵²⁶

Not even Alanus however denied the existence of sorcery and black magic. According to him necromancy, incantation and the use of magical pictures were demonic magic, which was possible only with the help of the Devil. Men could manipulate nature also by lawful means. This natural magic was based on accurate knowledge of both "manifest" and "occult" causes, both of which had nothing to do with the supernatural.⁵²⁷ The difference between men and spiritual beings (both angels and demons) thus formed an essentially unbridgeable gap. Man was to exploit nature for his needs with tools provided by his own skills.

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Seventeenth-century Aristotelianism has, especially in older, whiggish studies, often been presented as the cradle of superstition. On one hand there was belief in God's influence on natural processes, and on the other hand widespread belief in witchcraft, black magic and sorcery. The rise of mechanical philosophy would have abolished these beliefs and made thinking more rational. However, it seems that we have to abandon this notion. In fact, the mechanists' conception of matter as totally barren could also be used to guarantee that supernatural activity - both good and evil - could be ever-present in the universe. Indeed, at Turku we meet the Cartesian professor of physics Johan Thorwöste, who during the 1730's showed a firm belief in the power of popular magic verses.⁵²⁸ On the other hand, some of the most extreme forms of Renaissance Aristotelianism were clearly hostile to the idea of supernatural powers being effective in nature.⁵²⁹ Ideas on supernatural activity are thus better interpreted from inside the philosophical framework of which these theories were in fact part.

In this chapter I have tried to create an overview of seventeenth-century learning at Turku. Although the contents of this learning has

poraliter per aera ad nefaria conventicula sua transportare situm sit? Affir." Hahn-Wargentin 1697, p. 17-18, et passim.

⁵²⁶ Alanus-Munthelius 1645, Th. XLVII. Heikkinen 1969, p. 88-92.

⁵²⁷ Alanus-Munthelius 1645.

⁵²⁸ Thorwöste-Maxenius 1733.

⁵²⁹ Hutchison 1983.

here been very much emphasized, I have also tried to point out what physics was like as science. Our modern categories are seldom efficient in understanding learning e.g. in physics or mathematics, or the typically Aristotelian compound of biological and psychological knowledge. We have seen that learning at Turku was in many ways not purely Aristotelian, but eclectic to some degree of incoherence. On the whole learning at Turku was rather stable throughout the seventeenth century. The element which for the most part was responsible for new ideas was Cartesianism. In this chapter we have already seen some flashes from this "new philosophy", and the next chapter is intended to offer a more concentrated look at the subject.

Cartesianism and the Natural Philosophy at Turku

1. INTRODUCTION

There is no comprehensive study of Cartesianism at Turku, although the subject is dealt with in several smaller articles and touched upon in some monographies. Most studies mention the influence of Cartesian ideas on their respective fields of study. It is nevertheless difficult to form a general picture of the rise of Cartesianism at Turku from them.¹ The most profound analyses of the subject until now can be found in two articles by Seppo J. Salminen.² His research concentrates mainly on the relationship between the orthodox Lutheran theology and Cartesian philosophy from the theologians' point of view. This approach quite understandably puts less emphasis on the fact that Cartesianism was not only a problem for theology, but that it played an important role in the development of natural philosophy, too. Moreover, Salminen handles "philosophy" as a whole without distinguishing between various disciplines within philosophy: metaphysics, logic, natural philosophy, moral philosophy, etc. All of these branches of philosophy were important for theology, but not all in the same way and to an equal degree. Therefore they also had partially different approaches to Cartesianism as well.

In this chapter I intend to offer a general analysis of Cartesianism at the University of Turku. The main emphasis will be placed on the

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¹ See e.g. Slotte 1898, *passim*. Fagerlund & Tigerstedt 1890, *passim*. Sandblad 1945, *passim*. Knuuttila & Niiniluoto 1986, p. 26, *et passim*. Leikola 1987, p. 561-563, 572-573.

² Salminen 1981 & 1983.

influence of Cartesianism on natural philosophy, although theology naturally plays an important role as background. In history of science situations in which conflicts occur between different traditions are generally regarded as very interesting. Because Cartesian philosophy was often involved in controversies with Aristotelianism, many studies of Cartesian science and philosophy have tended to concentrate on the Cartesian disputes. This is especially true for the studies of Cartesianism in Sweden.³

In this study we shall also look at the four best known occasions at Turku when these two philosophies supposedly clashed. But was Cartesianism the main cause of these controversies? If we look more closely at these occasions, it becomes evident that other factors were involved as well. I shall argue that non-Cartesian factors contributed to the birth of the disputes in question. It is also important for us to see which particular features of Cartesianism were the most sensitive? Which Cartesian arguments were most strenuously rejected? However, concentration on controversies easily creates the false illusion (as in my opinion it has done in most Finnish studies on the subject) that there was hardly any Cartesianism except the controversial cases. Certainly many Cartesian ideas were discussed and even accepted at Turku, which should not be ignored simply because they were tacitly accepted. It has been shown recently that in fact many European universities were ready to open their doors to at least some of the Cartesian dogmas.⁴

This leads us to my main argument concerning the study of Cartesian science. When we talk about the confrontation between Cartesian and Aristotelian ideas, we have to take into account in which discipline and at which level of importance the ideas discussed are found. Obviously fewer divergences of opinion were tolerated in metaphysics and theology than in natural philosophy. But even in natural philosophy some subjects were more sensitive than others, depending on what kind of dogmas the new ideas challenged. In this chapter I shall try to answer the question of how these various degrees of sensitiveness were established. What made it possible for Cartesianism to develop in peace and quiet as well? One of the most important aspects of this chapter is to see what kinds of strategies were used

³ Lindborg 1965. Salminen 1981, 1983. Klinge 1987, p. 416-428.

⁴ Gascoigne 1990, p. 215-220. Ruestow 1973. Heyd 1982. Brockliss 1987, 1981.

both for dispelling Cartesianism and for introducing Cartesian ideas.

Interest in Cartesian science and philosophy has been revived recently among historians of science, and it is a much-discussed topic in philosophy of science as well. It can therefore be expected that the *candide lector* is not altogether unfamiliar with this philosophy. However, it might be sensible to begin with by recalling some general characteristics of Cartesian natural philosophy. The following survey is not intended to be a systematic and comprehensive presentation of Cartesianism, but it is only intended to create a background for the forthcoming discussion. It will then be appropriate to look at the corresponding developments at the main university of the Swedish empire, the University of Uppsala. The course of events at Uppsala differs in many important respects from Turku, although we could expect to find similarities in reasoning as well. Therefore, in order to see what kind of connections and resemblances there might be between these two universities, it seems fitting to summarize Cartesianism in 17th-century Uppsala.

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Cartesianism in a Nutshell

Both in Descartes' own time and later too Cartesian philosophy has been seen as radically breaking with the scholastic tradition which preceded it.⁵ However, Descartes' project for renewing philosophy inherited many characteristics from the parent philosophy against which it revolted. Although Descartes himself tried to soften the reception of his ideas, Cartesianism was nevertheless a radical new philosophy, and it was reacted to accordingly.⁶

In which matters did Cartesianism differ most from Aristotelianism and which were the most usual causes of controversy? Certainly theologians - Catholics, Calvinists and Lutherans - saw Cartesianism as threatening some of their most fundamental religious views, although the objections raised by these churches differed in details.⁷ However,

⁵ Although interestingly enough some contemporary critics of Cartesianism accused it of unoriginality. Jolley 1992, p. 407-412.

⁶ Ariew 1992.

⁷ Clarke 1989, p. 22-34 has analysed the reasons why e.g. the French Catholic church found Cartesianism suspicious, but why, on the other hand, some catholic sects such as Jansenism took a more positive view of the philosophy. On the Jesuits' attitudes towards Cartesianism see Ariew 1992, p. 93-69. Jolley 1992, p. 399-403.

even the theological opposition was based on divergences in philosophy. There were discrepancies between Aristotelian and Cartesian philosophical theories both in metaphysical and physical ideas. In epistemology there were two main reasons why Cartesianism met with resistance. First of all the methodical doubt of Descartes awakened the mistrust of theologians. Applying any doubt to the Bible or to the existence of God was thought to be blasphemous as such, and doubt in general was feared to lead to atheism.⁸

Descartes was regarded as seriously challenging the fundamental concepts of Aristotelian epistemology. Whereas all Aristotelians regarded sense perception - at least in principle - as our only source of reliable knowledge about the world (*nihil est in intellectu quod non prius fuerit in sensu*), Descartes developed a system based on rigidly rationalistic principles.⁹ He claims we could never be sure whether our sense perceptions really did represent reality. Therefore, reliable knowledge should be based on innate and rationalistic principles which were not contaminated by the senses. Hence Descartes claimed to have derived his entire physics from metaphysical principles.¹⁰ Moreover, the ideal model for all sciences would be mathematics precisely because it could be independent from sense perceptions.¹¹

Although Descartes often emphasized the rationalistic elements of his philosophy, we should also see that he was far from negative towards experimental science either. Indeed, any one-sided view of Cartesianism, which only takes into account its rationalistic side renders it rather embarrassing to know how for example his allegedly metaphysical physics could so often follow a clearly experimental programme in practice. At the University of Uppsala Cartesianism was defended expressly because of the advance it made in empirical and experimental philosophy and medicine.¹²

It was at the metaphysical level that probably the most serious of-

⁸ E.g. Lindborg 1965, p. 38, 144-145, et passim.

⁹ Clarke 1992, p. 259.

¹⁰ According to Clarke 1979 Descartes in fact does deduce his physics from metaphysical principles, but his understanding of "deduction" is so far from ours that this causes most of the obscurity in the matter. On the other hand the problem of innate ideas or conceptions occupied the minds of many 17th-century Cartesians, who generally were reluctant to accept the concept of innate ideas (at least in the naive Platonistic sense). Clarke 1989, Ch. 2.

¹¹ Descartes 1973, p. 92-94, et passim.

¹² Lindroth 1975, p. 463. Lindborg 1965, p. 300-306.

fence against traditional Aristotelianism was encountered. Cartesian dualism was in conflict with the Aristotelian understanding of substance. It was particularly important for Aristotelians to retain "the right" interpretation of substance, because some of the most fundamental concepts of both theology and natural philosophy were closely connected with it. Descartes declared invalid the Aristotelian idea according to which a substance consists of form and matter together in such a way that their existence is constantly dependent on each other. In an Aristotelian world there were as many substances in the world as there were independent compound entities. For Descartes a substance was not the unit of individual entities, but a more universal category of being. To be a substance meant to be able to exist by oneself. Thus, only two kinds of substances in the world existed (except God). They were according to Descartes mind and matter, which by definition were totally independent of each other.¹³ The Aristotelian way of defining the relationship between the ontological status of substance and accident fell together with the concept of substance. Philosophy operated now with new concepts such as primary and secondary qualities such as number, quantity and motion versus sensible qualities.¹⁴

Naturally Cartesian dualism clashed especially with the traditional views of man. One of Descartes' aims was to develop a philosophy which would provide a rational and sufficient proof of the immortality of man's soul. In Descartes' view mind was so closely bound with matter in the Aristotelian hylemorphic system that it would be almost impossible to explain how any psychic functions could survive the separation from body.¹⁵ Descartes' answer to this problem was a hard-line separation between the mortal body and the immortal soul. Lutheran Aristotelians regarded Cartesian dualism as guaranteeing matter a far too independent role. How could pure matter - passive as it was by nature - perform all the various operations discernible in all living beings without the help of the active principle, soul? Descartes had denied the existence of any soul-substance in animals, because the soul was immortal and could exist in man only. Aristotelians could not accept this reduction of animals to machines. There was a fear - a well-founded and sometimes also a declared one - that if the living

¹³ Descartes 1973, p. 239-241.

¹⁴ See e.g. Clarke 1989, Ch. 2-3.

¹⁵ Cottingham 1992b, p. 237-241.

functions of an animal could be reduced to mechanical causes, it would be only a matter of time before the same would be done with human minds.¹⁶

Not only did Descartes despise the Aristotelian concept of form, but he could not accept its definition of matter either. Therefore the differences of opinion were no less bitter at the physical level. When the metaphysical concept of substance had gone, some of the most fundamental questions in Aristotelian physics were no longer relevant in the context of Cartesian philosophy. Because Aristotelian physics was based on the theory of the four elements, it also presupposed qualitative argument as an integral part of the element-theory. Descartes stripped all other qualities except extension away from the material substance. The physical world would consist of minute particles of three different sizes, small enough to fill every place in the universe so that no vacuum would exist. This Cartesian matter was entirely inert, and it could thus be moved only by some external agent. The ultimate cause for all motion and its preservation was God, who had set these particles in constant motion. However, science should not seek to explain the acts of God but to look only for the intimate causes of all kinds of physical processes and mutations occurring in nature. These causes were the various movements of the particles themselves.¹⁷

Cartesian physics strove to explain natural phenomena by mechanistic theories, whilst the Aristotelians would accept a wider range of efficient and final causes. It was very much exactly these "occult" attractive and repulsive forces in nature and qualitative explanations which Descartes sought to get rid of in his physics.¹⁸ Moreover, Aristotelian physics distinguished both between linear sublunar and circular supralunar motions, and between natural and violent ones. As is well known, according to the Aristotelians the natural motion of bodies was caused by their striving towards their own "natural" place, which was determined by their qualities of heaviness and lightness respectively. Descartes however regarded extension as the only characteristics or accident of the material substance: motion was just another state of being for them. Although motion was *not* an inherent property of matter for Descartes, the various movements of matter

¹⁶ Clarke 1989, p. 27.

¹⁷ Descartes 1983, p. 40, 49-50, 52, 57-58, 110. Hatfield 1979.

¹⁸ Hatfield 1979, p. 113-115. Clarke 1989, Ch. 4.

were of crucial importance in explaining all natural processes. The whole indefinite-sized universe had evolved when the movements of matter had gradually settled into the form of vortices, one of which was our solar system. For example, what we feel as light and warmth was actually caused by the pressure of particles coming from the Sun. This systematically mechanistic physics was something which simply could not be fully understood by scholars brought up in the Aristotelian "paradigm".

Both the Aristotelian and Cartesian views as posed above are some sort of "standard philosophy". Individual differences did occur between different religious or geographical schools of Aristotelianism. The concept "Cartesianism" is somewhat problematic as well. There were differences between Descartes' and his disciples' ideas and between the disciples' theories as well - not to mention the fact that Descartes himself was not always very clear about what he meant. Those scholars who became Cartesians often modified Descartes' theories instead of accepting them as such.¹⁹ Promoting Cartesian ideas was seldom easy, because often the Cartesians lacked institutional support. There were two main strategies which were adopted by Cartesian scholars at different European universities. Either one took up a role as an extreme Cartesian, or tried to present Cartesian ideas by utilizing Aristotelian concepts. The latter strategy was perhaps more commonly used. Sometimes it was accompanied by the claim that Cartesianism actually was the genuine form of Aristotelianism. In Sweden for example Petrus Hoffwenius, who was an eminent figure in the Uppsala disputes over Cartesianism, made use of both of these strategies.²⁰

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Cartesian Disputes in Sweden

René Descartes spent the four last months of his life in Sweden, where he died on the 11th of February 1650. He was the jewel in the collection of famous learned men, whom Queen Christina had imported to her court. The scholars and artists brought there were supposed to teach the Queen and create a cultivated atmosphere. Christina's interest in philosophy was a part of the new kind of a court culture which had spread around Europe from the end of the sixteenth century on,

¹⁹ Brockliss 1987. Heyd 1982, Ch. IV. Clarke 1989. Westman 1980b, p. 91, 97-99.

²⁰ Clarke 1989, Ch. 1. Lindroth 1975, p. 454, 542. Lindborg 1965, p. 116-121, 141 ff.

and Christina also wanted to show off her own learning and the well-being of scholarship at her feet. For philosophers and scientists this system offered new chances. In the protection of their non-clerical patrons philosophers, astronomers and other scholars could achieve social and intellectual positions which sometimes offered them opportunities to create different kinds of knowledge than the traditional learning system had been willing to allow them.²¹ It seems that around the mid-seventeenth century this kind of a court culture was in Sweden very much dependent on the personality of Queen Christina. Its influence did not so readily affect the Swedish Universities, in any case not in the case of Cartesianism. Cartesianism did not really arrive in Sweden and at the University of Uppsala through the court. It was the medical students' and professors' contacts with Leiden, which played a crucial role in dissemination of Cartesian ideas in Sweden.

As in many other Universities Cartesianism was vehemently opposed at the University of Uppsala. There were two periods which usually are referred to as those of the Cartesian disputes. The first covers the years 1662-1668, and the second 1686-1689. It is problematic, however, in what sense the period between 1662 and 1668 can be labelled as an epoch of *Cartesian* dispute.

In 1662 the recently-appointed professor of medicine, Petrus Hoffwenius, started publishing a series of dissertations called *Artis medicinalis parvae exercitationes*.²² The first part of the dissertation series had already made the theological faculty suspect it of heresy. Hoffwenius was accused of supporting Socinian views, according to which man himself had the ability to turn towards God for grace. Put in more medical terms it was stated that corpuscular vital spirits caused soul and the whole body to turn to God (*spiritus sistit membra Deo*), whilst the orthodox Lutheran dogma stated that the salvation of man was entirely dependent on God's mercy.²³

Only the third part of Hoffwenius' dissertation series, printed in 1665, included clearly Cartesian ideas. Although the academic world was at that time seething with theological disputes, mainly over syncretism, Cartesianism had also gradually become involved in the dispute. Because Cartesian philosophy was seen first of all as a threat

²¹ On court politics and the patronage system see e.g. Biagioli 1993.

²² The work was actually an abridged version of Johannes Antonides van der Linden's *Meletemata medicinae hippocraticae*. See Lindborg 1965, p. 79 ff.

²³ Lindborg 1965, p. 85, et passim.

to religion (also because of its supposedly Socinian connotations), the questions in dispute in Hoffwenius' thesis also concentrated on theological subtleties. Theologians, eager to keep their dogma pure, were suspicious about every philosophical trend divergent from the Aristotelian ideas which had been adapted and revised to support theology. Fearing the influence of non-Lutheran confessions allegedly implicated in syncretism, the theologians at Uppsala strove to limit the freedom of philosophy. At the 1664 Diet the clergy went as far as to demand new restrictions on the freedom to travel abroad.²⁴

Although philosophical questions of substantial forms, mechanistic philosophy and Cartesian and Aristotelian epistemologies were to some extent at stake at Uppsala, the most burning problems were caused by dogmatic aspects. Hoffwenius was, for example, accused of discarding the theory of the propagation of soul *per traducem*, which was essential to the Lutheran theory of original sin. On the other hand, the Cartesian professor of medicine, Olof Rudbeck Sr. in 1665 defended the idea that the mystery of the Christ's presence in the Eucharist could be explained by Cartesian philosophy. This question had for a long time been disputed in Central European universities too.²⁵ Theologians at Uppsala also accused the Cartesians of not accepting Aristotelian logic and other important parts of traditional philosophy. Cartesians were said to present views which were totally contrary to "sane" philosophy. For example, they dismissed the concept of substantial forms. The general principles of logic, metaphysics and natural philosophy were important as the basis of learning for all disciplines, but especially for theology.²⁶ Hoffwenius' answer to all these accusations presented against him was that his meaning was not to throw out the old principles but to show that the philosophy of Descartes was compatible with them.²⁷

The dispute was finally settled in 1668, after the clergy had made its last attack on Cartesians at the Diet. No final solution was achieved, though. Petrus Hoffwenius had already agreed in 1665 not to lecture on Cartesian philosophy any more. It was, however, precisely because

²⁴ On syncretism see Göransson 1952; on attempts to control foreign travels Göransson 1951. The attempt to make all students (including the arts' students) study certain courses in theology was connected with this controversy.

²⁵ On the Jesuits' worries on this question see e.g. Jolley 1992, p. 400.

²⁶ Lindborg 1965, p. 128 ff.

²⁷ Lindborg 1965, p. 130.

of Hoffwenius' natural philosophical lectures (begun anew in 1673) that Cartesian philosophy really made a breakthrough at Uppsala. In 1678 Hoffwenius published his famous *Synopsis physica*, a series of theses which presented Cartesian physics in its entirety. In the same year, another thesis was published, in which Cartesian dualism was thoroughly examined. It is typical of Swedish Cartesianism that Hoffwenius did not refer directly to *Principia Philosophiae*, but to texts of other Cartesians such as Johann Clauberg, Johannes de Raei and Louis de la Forge.²⁸

By the end of the 1670's theologians saw that the threat posed by syncretism to orthodox Lutheranism had receded. This made them more relaxed and less watchful for philosophical purity, which gave Cartesianism a chance to strengthen its position. A couple of talented young Cartesians trod in Hoffwenius' footsteps. Andreas Drossander followed Hoffwenius as the professor of medicine after the latter's death in 1683. An even more enthusiastic Cartesian was Johan Bilberg, who was appointed professor of mathematics in 1679. Little by little the natural philosophers and even metaphysicians turned to Cartesianism during the first few years of the 1680's. Rolf Lindborg has noted that by the mid 1680's it was more difficult for an Aristotelian to criticise Cartesian philosophy at Uppsala than *vice versa*. However, important aspects in the relationships between theology and philosophy, such as the relevance of the Bible as an arbiter of truth in natural philosophical questions, remained taboos at Uppsala.²⁹

The clergy's dissatisfaction with the growing influence of Cartesianism burst out at the Diet of 1686. Only smaller incidents had taken place at the University in 1679, when Nils Celsius defended a thesis on Cartesian astronomy, and in 1685, when theologian Petrus Ljung attacked the Cartesian idea of the knowledge of God.³⁰ The clergy demanded a denial of the entire Cartesian philosophy and of every other kind of "new" philosophy. Although the success of Cartesian mathematics and of the "experimental" philosophy in medicine were conceded, the development of these disciplines should not be allowed to disturb the general worldview. Nor should it shake the authority of the Bible or deprive logic of its position as the principal discipline in sciences. All in all, the clergy's propositions aimed at a

²⁸ Lindborg 1965, p. 135, 141-183.

²⁹ Lindborg 1965, p. 136, 191-222.

³⁰ Lindborg 1965, p. 136, 183-191.

total control and excessive censorship of philosophical thought.³¹

All faculties of the University of Uppsala were asked to reply to the proposition of the clergy. Although the professors of theology by and large stood behind the proposition, not even the position of theologians was unanimous. Censorship and radical changes in the schooling system which had been proposed by the clergy gained little support. The University wanted to retain its autonomy in respect to the church, too. During the 1660's the professors in the Faculty of Philosophy had been as eager to oppose Cartesianism as the theologians. Now the situation had changed. According to many philosophers Cartesianism was safe for theology. Moreover they claimed that the old-style theology was no longer valid but should be reformed. This radical stance was strengthened by the claim that theology and natural philosophy should generally be separated from each other. It should come as no surprise that the Faculty of Medicine demanded freedom for "experimental" philosophy. Even the Faculty of Law ended up defending Cartesiansim.³²

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After many bureaucratic phases, the dispute was settled by the King. On the 17th April 1689 King Carl XI sent a letter to the chancellor of the University, stating that no freedom of philosophy should be allowed at the University as would be aimed against the Christian religion and dogma. Nor should the Bible be submitted to any philosophical criticism. However, in all other matters except the religion and Holy Scriptures, a free use of philosophy should be allowed. The King's statement did not specify which philosophies could be studied freely, nor did it set any criteria for the question of what was to be regarded as criticism of the Bible. In any case neither Cartesianism nor Aristotelianism were denied. The resolution did not end all quarreling about Cartesianism, because both parties had different readings of it. In the interpretation supported by Cartesians the "new philosophy" had won.³³ What ever the "right" interpretation may then be, it is sure that the Cartesians were very effective in applying theirs. For a few decades Cartesianism dominated natural philosophy at the University of Uppsala.

As we have seen, the Cartesian debates in Sweden were not restricted to the University of Uppsala only, other institutions like the

³¹ Lindborg 1965, p. 226-259.

³² Lindborg 1965, p. 259-307.

³³ Lindborg 1965, p. 321-338.

church and the state (King and the Diet) becoming involved too. Elsewhere, for example in the Netherlands, the disputes on Cartesianism had largely remained inside the walls of the Universities.³⁴ But there were differences even between various parts of the kingdom of Sweden. The Cartesian debates never spread to the University of Turku as such. It is not that Cartesianism would not have been known at Turku. At least the theological circles at Turku were well aware of the essence of the new philosophy. For example professor Enevaldus Svenonius actively took part in the church political discussions on syncretism at Uppsala. He was nominated in 1664 to the clerical committee, which was supposed to prepare a circular for the Swedish universities against Cartesian philosophy. Another professor of theology, Petrus Bång, played a crucial role in starting the Cartesian disputes anew in 1686.³⁵ Politics at Turku was to keep battles over Cartesianism away from the home ground. However, there may be tendencies in which developments at Uppsala influenced Turku, too. These parallels have not been studied before, although claims to have done this exist.³⁶ Unfortunately we do not have the opportunity to look at the question either, except at a very general level only. Having created a wider view of Cartesianism, let us now have a look at the discussions on this topic in 17th-century Turku.

³⁴ Ruestow 1973, p. 34-60, 140-141.

³⁵ Salminen 1978, p. 350. This idea of the clergy was baffled by the chancellor of the University of Uppsala, Magnus De la Gardie. On Bång see Salminen 1981, p. 100.

³⁶ Salminen 1983, p. 59 claims that in his previous article (Salminen 1981) he has "shown how the Finnish discussions depended on the Cartesian Disputes in Uppsala". In fact, Salminen has done no other than present some chronological comparisons. He has not proved any causal connections between Swedish and Finnish discussions.

2. THE FIRST SOUNDS OF THE NEW PHILOSOPHY

Laurbecchius Against the Revival of "Copernico-Cartesianae"

On the 8th of June 1661 the assistant of the Faculty of Philosophy, Petrus Laurbecchius, ascended to the lecturer's desk of the Auditorium Major of the University of Turku to defend his thesis, written under the direction of the professor of mathematics Simon Kexlerus and solemnly named: *Dissertatio Tripartita, cumprimis De Circuli Qvadratura et Vero Mundi Systemate, Adversus Copernicum Redivivum*.³⁷ A great part of the contents was mathematical, dealing with the problem of how to draw a square equal to a circle of a given size. The first, geometrical part deals with the use of geometry and the general conditions for the validity of a geometrical theorem.

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Just as some previous studies have stated, Laurbecchius' thesis was to a great extent polemics both against Copernicanism and Cartesianism.³⁸ Its title indicates that it was a response to Daniel Lipstorp's book *Copernicus redivivus sive de vero mundi systemate liber singularis*. Lipstorp had been born in Lübeck in 1631. He first studied astronomy at the University of Rostock, and in 1652 he matriculated at the University of Leiden to study mathematics. While at Leiden Lipstorp took part in the controversies over Cartesianism, which were the hottest issue at the University at that time. In his main work *Specimina philosophiae cartesianae* Lipstorp claims the excellence of the Cartesian and Copernican philosophies. The superiority of the Cartesian system was the reason - as he claimed - why, desperately seeking for the truth, he had finally converted to Cartesianism. He praises the Cartesian mathematical method and mechanics. *Specimina*, as well as his other book, *Copernicus redivivus* were both published in 1653.³⁹ In the latter Lipstorp discusses both the biblical and philosophical arguments against Copernicanism. According to Lipstorp, all counte-

³⁷ We do not know whether the work was actually written by Laurbecchius or by Kexlerus. Although it seems to me reasonable to suppose that this work was done in co-operation, I shall in the following refer to it as Laurbecchius' work.

³⁸ Salminen 1981, p. 93. Salminen 1983, p. 59-60. Slotte 1898, p. 18.

³⁹ Lindborg 1965, p. 77-78.

rarguments could be disproved by Cartesian natural philosophy.

We do not know what caused the dramatic turn in Lipstorp's life, but he seems to have abandoned his main subjects of study (astronomy, mechanics and mathematics) soon after the publication of these books. No sign of Cartesianism can be found in his later works. He begun studying law at the University of Leiden, and in 1656 he published a book in canon law. In 1662 Lipstorp was finally appointed professor of law in the University of Uppsala.⁴⁰ Rolf Lindborg has shown that Lipstorp was appointed professor mainly on the recommendation of the influential Olof Rudbeck Sr, who also was inclined to Cartesianism. Lipstorp did not, however, receive a friendly welcome from the officials of the University, probably because his actions at Leiden during the 1650's were known. Although the Senate did not directly try to prevent his nomination, it was certainly delayed from the date Rudbeck had planned.⁴¹ Lindborg also wonders whether it is a coincidence that the "Cartesian" disputes at Uppsala began in 1662 when Lipstorp was appointed, and they ceased in 1665 when he left the University.

It would be tempting to connect the strong attack by Laurbecchius on Lipstorp to his election as the professor of law at Uppsala. This is impossible, however. Laurbecchius' thesis was already published in 1661 whereas Lipstorp's predecessor, professor Bringius, died suddenly at the end of January 1662.⁴² What is remarkable, though, is that the first attack on Cartesianism was made at Turku *before* any polemic began at Uppsala.⁴³ The fact that Laurbecchius' work was the first thesis so clearly directed against Cartesianism alone makes the incident worth closer study. Let us now first turn our attention to what Laurbecchius actually had against Lipstorp's book.

To begin with Laurbecchius states the "real state of things" in cosmology by asserting that the Earth stands still in the middle of the

⁴⁰ Lindborg 1965, p. 78-79.

⁴¹ Lindborg 1965, p. 79. The excuse used to delay Lipstorp's nomination was the year of grace of the previous professor Bringius' widow. In itself this does not necessarily include any action against Lipstorp, since it was quite usual to guarantee the widow the right to her deceased husband's salary during the "year of grace".

⁴² Uppsala Universitets Akademiska konsistoriets protokoll VI 1661-1663, p. 101. 5.2.1662 "Efter nu M. Bringius i hastigheet ähr hädan ryckt worden, skall hwar och en af Consistorio för sig hemma betänkia om en duglig kaarl i stället."

⁴³ In spite of this Salminen claims that the discussions of Cartesianism at Turku were dependent on those at Uppsala. Salminen 1983, p. 59.

cosmos, and the Sun and the stars revolve around it. He was forced to defend the Ptolemaic worldview, because there was a constantly spreading movement which claimed otherwise.

...Ptolemy confirmed that it would be absurd if the Earth was carried along the ecliptic in a great yearly orbit, as was claimed *long ago* by Pythagoras of Samos, Philolaus of Croton, Timaeus Locrus, Aristarchus of Samos, Cleanthes, Leucippus, Plato the old. In *recent* times no fewer scholars have stated the same: Martianus Capella, Guilielmus Gilbertus, Petrus Peregrinus, Maricurtius Gallus, Nicolaus de Cusa, a Cardinal, and Copernicus with his innumerable followers (none of whom regards himself sufficiently learned unless he imagines the Earth to move while the Sun stands still), Galileans and Cartesians...⁴⁴

Many scholars who supported the Copernican system were named. This showed that the problem of Copernicanism was serious. More "recent" authors were linked to names from antiquity. On one hand it mirrors the idea that all wisdom - even the unacceptable - derived ultimately from antiquity. On the other hand it is curious to see how by putting the matter in this way Copernicus was deprived of the status of an innovator. Many other rejected ideas were attacked by calling them "novelties", but not Copernicanism.

Laurbecchius presents many arguments derived from the Bible in support of the geocentric system. Salminen has shown that it was exactly this thesis of Laurbecchius which really established the Bible as the final criterion for philosophical truth and introduced biblical arguments into astronomical discussion at Turku.⁴⁵ It is true that Laurbecchius argues for the centrality and immobility of the Earth, and the motion of the stars, the Sun and the Moon by referring frequently to the Bible. It seems, however, that there is also something more

⁴⁴ Kexlerus-Laurbecchius 1661, Cap. III, 1. "...sancit Ptolemæus, quod absurdum sit; tum ut Terra per Eclipticam in orbe annuo & magno ferri queat, sicut id statuere *olim* plurimi, Pythagoras Samius, Philolaus Crotoniates, Timæus Locrus, Samius Aristarchus, Cleanthes, Leucippus, Plato senex: *recentiùs*, nec pauciores, Martianus Capella, Guilielmus Gilbertus, Petrus Peregrinus, Maricurtius Gallus, Nicolaus de Cusa Cardinalis, Copernicus quoque cum asseclis innumeris (quorum nemo se satis doctum æstimet, nisi Terram, quiescente Sole, fingat mobilem) Galilæanis & Cartesianis..."

⁴⁵ Salminen 1983, p. 60.

important at stake than merely an acceptable interpretation of an astronomical system. The problem was that the "Copernico-Cartesianae" had called the absolute authority of the Bible into question. According to Laurbecchius they claim that "...this is to be understood only in accordance with our mode of understanding, not because the things themselves are really so."⁴⁶ Thus the question of whether the authority of the Bible was valid in the field of natural knowledge and not only in matters of faith, is connected with the question of the right way of interpreting the Scripture. Laurbecchius uses biblical argument as much as he does partly because he wants to show that the Bible *does* give relevant information about nature. Because the two books of revelation complement each other, the information in them concerning each other cannot be contradictory.

Immobility of the Earth and the movement of the stars can rightly be construed from the sacred texts. And this is quite appropriate. Because God wanted us to know the book of nature, there are many things [concerning the book of nature] which are revealed [in the Bible], although it principally contributes to greater aims.⁴⁷

In Laurbecchius' opinion the blasphemous "Copernico-Cartesianae" not only questioned the authority of the Bible in natural philosophy, but had also more than once interpreted the Bible falsely.⁴⁸ For the orthodox Lutherans the right way of interpreting the Bible was a literal reading - this procedure was of course in practice guided by certain preconceived principles. Hence, it was not enough for Laurbecchius just to cite the Bible, but the real meaning of its words had also to be made clear. In order to argue for the correctness of his interpretations Laurbecchius uses etymological and other philological methods. It is, for example, the "the order and context of words" (*verborum*

⁴⁶ Kexlerus-Laurbecchius 1661, Cap. III, 2. "...haec solum secundum rationem concipiendi nostram intelligenda, non quia reapse ita sint, ausu improbo asserere occipiat, id studiosius advertendum erit."

⁴⁷ Kexlerus-Laurbecchius 1661, Cap. III, 4. "*Quies terrae motusque astrorum*, è sacris, nec minus recte, adstrui debet. quod neque est inconveniens; cum Deus ex libro etiam naturæ cognosci voluerit, atque ideo permulta inde in alterum Revelatum, etsi ob finem magis præcipuum... contulerit."

⁴⁸ Kexlerus-Laurbecchius 1661, Cap. III, 3 "*Sed Copernicéi*; prætermisso illo de Chizchijâ, cum laciniam suo solemnî assuere ei nequeant; hoc alterum Iosuae prodigium, nefandum in modum, detorquent glossis, nec theologicè, nec mathematicè veris.", et passim.

ordo & contextus), which showed him the true meaning of the words in the Bible.⁴⁹

Resisting the heliocentric system is of course an essential aim in Laurbecchius' thesis. The main fault in Cartesian authors' (such as Lipstorp's) texts was, according to Laurbecchius, that they claimed a physical reality for the Copernican system.

This would be enough of these, unless, as mentioned, Lipstorp had not defended the Copernican opinion as a Physical truth and not as an Astronomical hypothesis (which is what Copernicus most likely did), and unless he had not considered these two as equal in his 'Revived Copernicus'. This book is otherwise full of things which are pleasant to the intellect. However in the same book he defends the Copernico-Cartesian opinion with arguments derived from revelation and from reason, and rejects the Ptolemaico-Tychonic system.⁵⁰

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Although Laurbecchius conceded that Lipstorp's book contained many things which were "pleasant for the intellect", the claim for physical truth of the Copernicanism was to be refuted. Compared with most other theses aimed against Copernicanism Laurbecchius' thesis contains relatively little physical argument.⁵¹ He prefers to attack the metaphysical and epistemological premises of the Copernicans. In my opinion, this type of argument is not the mere refutation of a new physical theory, but constitutes a more severe criticism of the philosophical premises on which the pro-Copernican thought was based. Among several arguments against the Copernicans/Cartesians, two are especially noteworthy.

⁴⁹ Kexlerus-Laurbecchius 1661, Cap. III, passim.

⁵⁰ Kexlerus-Laurbecchius 1661, Cap. III, 4. "Poterant hic ista sufficere, nisi, qui allegabatur, Lipstoriopus, Copernicéam sententiam, non ut Astronomicam *hypothésin* (quod verisimile est fecisse Copernicum) sed ceu veritatem Physicam defendisset; eoque comparasset *Copernicum* suum *Redivivum*, Librum alioqui multiplici rerum copiâ, quae scitu jucundae sunt, refertum: in quo id agit, ut argumentis, tam è revelatione, quàm ratione, sententia, Copernico-Cartesianam stabiliat, & Ptolemaico-Tychonicam evertat."

⁵¹ I count here as physical argument only those claims made by Laurbecchius which he bases on the ideas concerning the properties of a sphere. Kexlerus-Laurbecchius 1661, Cap. III, 5-6. (G2): "neque enim astra, aut primo Mobili, aut vehiculo materiae caelestis raptantur, ut qui motus eorum necessariò tum foret violentus; sed vi insitâ, ab internòque principio, ipsa sese in alia aliâque loca promovent."

First of all, Laurbecchius refutes the Copernican argument that because the heliocentric system was more simple, it was more likely to be true. In the Tychonic system the orbits of the Sun and Mars crossed each other, which did not happen in the more simple and elegant Copernican system. Moreover, the apparent movements of the planets could more easily be "saved" if the Earth was conceded to move on the ecliptic. Although Laurbeccius agrees that the Copernican system is indeed simpler than the other planetary models, he cannot accept simplicity as the criterion for physical truth. By doing this Laurbecchius attacks the very core of the metaphysics of the new natural philosophical thinking. "But really, natural things are not to be construed from ease of explanation or understanding, but on the contrary these things are to be derived from nature."⁵² There would be neither logical nor any other kind of necessity to believe that God would have created the world in a way which was most easily understood by human reason.

Secondly, it was the differences about the idea of legitimate methods for scientific ratiocination which divided the parties. Descartes and his disciple Lipstorp are accused of mixing up the methods of invention and disposition. Lipstorp is said to demand the use of geometry outside the boundaries of mathematics.⁵³ It was one of the most central points in the Cartesian program for renewing sciences that all sciences would ideally have to be based on geometrical reasoning. In Descartes' opinion this branch of mathematics offered the most secure form of ratiocination. Although the Cartesians could only seldom apply the mathematical method in physical sciences in practice, the ideal remained and was loudly promoted as an actual achievement of the new philosophy.⁵⁴ Laurbecchius was a child of the scholastic age, in which the hierarchy of sciences was followed by a hierarchy of appropriate methods. In his opinion the Cartesian method was absurd.

...a *thing* is different from its *exposition* or *representation*, which only seeks to express a thing through the senses (as Hobbes wisely

⁵² Kexlerus-Laurbecchius 1661, Cap. III, 4, 6. "*Verumtamen, non ex facilitate, sive delineandi, sive intelligendi, rerum natura effingenda erit, sed illa altera hinc potius derivanda.*"

⁵³ Kexlerus-Laurbecchius 1661, Cap. III, 6. "...*geometriae vim usumque crepat, non in mathesi solùm, sed in disciplinis quoque ceteris*".

⁵⁴ Clarke 1989, Ch. 5-7.

deduced in *Elem. Phil. sect. I.c.12*). In respect to the *System of the world* Geometry can only give the *Exposition*, i.e. the Figure, not say anything about the *Thing* itself.⁵⁵

The Cartesian geometrical method and its scope was dealt with in a more detailed manner in the first section of this same dissertation. Thus far Finnish historical research has been so keenly concentrated on discussing Laurbecchius' refutation of Cartesianism in connection with Copernicanism that it has passed over his other attainments in silence. It is evident that in his criticism of Cartesian geometrical method Laurbecchius also refers to the other book by Lipstorp, the *Specimina philosophiae*.

Starting from the very basics, Laurbecchius explains what a geometrical problem or a theorem is. Regarding their uses it becomes evident that there must be different methods for problem-solving (*methodus inveniendi*) and teaching (*methodus docendi*).⁵⁶ The gravest accusation he makes against Lipstorp is that he confuses the one with the other. Laurbecchius finds nothing to complain about in the Cartesian synthetic and analytic methods in themselves, but only opposes the misunderstanding of their applicability.⁵⁷ Another claim closely related to this is that mathematical reasoning could be used only in the category of quantity. Thus no operations arising from form, for example, fell in the field of mathematics. This principle was of crucial importance in the dispute over the "real" world-system too:

Neither Galileo nor Lansbergius have used the proper form of argument. They draw conclusions about the *radius* and *dimensions* of the stellar spheres from the motions of the Fixed stars and the Planets. The slowness or velocity of the movement of the stars is not dependent on the size of their orbs, but stems from their inherent natures.⁵⁸

⁵⁵ Kexlerus-Laurbecchius 1661, Cap. III, 4. "...res est aliud, aliud ejusdem *expositio* seu *repraesentatio*, quae exprimere rem sensibus queat (ut doctè Hobbes *Elem. Phil. sect. I.c.12*. deducit) & in *Systemate mundi* solam modò *Expositionem* h.e. *Figuram Geometria* dare potest, *Rem* non potest." Here the reference to Hobbes is quite incidental; Laurbecchius does not otherwise support Hobbes' ideas.

⁵⁶ On seventeenth-century conceptions of inventive and teaching methods see Reif 1962, p. 270-278.

⁵⁷ Kexlerus-Laurbecchius 1661, Cap. I, 5-6.

⁵⁸ Kexlerus-Laurbecchius 1661, Cap. I, 7. "Quare, neque Galilæus, aut Lansbergius,

Thus, the movement - or the immobility - of planets was dependent on their form or "nature", and only the knowledge of that provided information on the real physical state of things. Geometry could add nothing to this except demonstration (in the sense of being a sort of illustration and explication of the theory). Laurbecchius says that the Cartesians such as Lipstorp distort the words of Aristotle when they claim that according to him mathematical principles were also valid in physics. Lipstorp relies on a basic statement in Cartesian metaphysics when he claims that mathematics is suitable for studying *corpora naturalia*, because as material entities their only characteristic is extension. On the other hand Laurbecchius defends Aristotelian physics by arguing that a discipline which did not consider colour, hardness, etc., as real properties of a natural body, was more statics than physics proper.⁵⁹ The strongest argument was derived from theology, however. Claiming that extension is the only property of a natural body was, according to Laurbecchius, a Calvinistic error.⁶⁰ Indeed, the Cartesian concept of matter as extension was successfully used by some Calvinist Cartesians to defeat the Lutheran dogma of the ubiquity of Christ.⁶¹ Laurbecchius' fear was thus not entirely groundless. Aristotelian and Cartesian conceptions of method and substance were fundamentally incompatible. Anybody watching through Aristotelian lenses was bound not to be able to accept Cartesian views.

It was noted that Lipstorp was far from the only Cartesian in the history of science who supported Copernicanism. From the point of view of more traditional scholars this was a monstrous combination. Lumping together Copernicans and Cartesians was an efficient rhetorical deterrent to any Aristotelians planning to adopt Cartesian or Copernican ideas. Laurbecchius had possibly received the core of his counter-arguments from foreign sources, though his exact sources cannot be traced here. Although his criticism of these two "isms" did undoubtedly greatly affect the future fortunes of both at the University

genuino argumentandi genere sunt usi; cum è Fixarum Planetarumque motu, sphaeræ astri cujusque *semidiametrum* & *capacitatem* concludunt: quandoquidem tarditas velocitasque, motus siderum, non abs capacitate orbium, sed ingenitâ astrorum naturâ, cuique suâ, proveniunt."

⁵⁹ Kexlerus-Laurbecchius 1661, Cap. I, 10.

⁶⁰ Kexlerus-Laurbecchius 1661, Cap. I, 10. "...quippe cum inde sit consequens, aut Christum non habere verum corpus, siquidem Extensionem aliquando cohibeat, aut eum non esse omnipræsentem, cum, ipso remanente, essentia sua tolli è corpore nequeat; eoque nec Extensio, si ipsa Corporis essentia esset."

⁶¹ Heyd 1982, p. 72-75.

of Turku, it was, however, the criticism of the Cartesian method, which was philosophically more important and interesting. The depth of Laurbecchius' criticism is remarkable, especially as it has been written before the Cartesian disputes at Uppsala began. Laurbecchius also pinpointed the spot where the two philosophies clashed fundamentally.

Laurbecchius was a talented young man and his thesis was given the respect it deserved, as we see from the fact that he was the *primus* in the master's promotion only three days after the disputation.⁶² This attack on Cartesianism did not, however, lead to any wave of similar dissertations, although Cartesian ideas were refuted in occasional theses. Most probably there was no need for intense opposition either against Cartesianism or Copernicanism.

Other Attacks On Cartesianism

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Petrus Laurbecchius' anti-Cartesian thesis in 1661 was the first, but not the last attack on the new philosophies during that decade. Laurbecchius condemned Cartesianism as a proponent of the heliocentric philosophy, and discarded the use of mathematical method in physics. We are told by some of the reference literature that the next person to refute Cartesian views at Turku was the professor of physics as well as logic and metaphysics Andreas Thuronius in a thesis published in 1665.⁶³ Thuronius is here seen as "formulating the Cartesian problem" for the academic public at Turku. In my opinion, however, this view is somewhat misleading.

Salminen writes that the three main problems in Cartesianism according to Thuronius were methodical doubt, the rejection of the Aristotelian theory of substance and heliocentrism.⁶⁴ Whilst this is true, Salminen does not consider the context in which Thuronius advances his criticism of Cartesianism. One suspects Salminen of exaggerating both Thuronius' talents and the originality of his discussion: "...Thuronius had read Descartes himself. He cites Descartes' ideas in an original way and takes only those questions into consideration, which were truly relevant for the Finnish practice of theology and philosophy especially."⁶⁵ The same themes were discussed all over Europe and

⁶² Lagus 1891, p. 55.

⁶³ Salminen 1981, p. 93-94.

⁶⁴ Salminen 1981, p. 94-94.

⁶⁵ Salminen 1981, p. 94. "...Thuronius luki itse Cartesiustaan, referoi hänen ajatuk-

there is nothing particularly Finnish in them. In his article published two years later Salminen praises Thuronius' account of Cartesianism as particularly objective. In Salminen's opinion it is also noteworthy that Thuronius rejected Cartesianism on purely philosophical reasons (contrary to Laurbecchius' theological argument).⁶⁶ In the following I shall argue that this general interpretation of Thuronius-Sutthoff's thesis needs to be corrected.

The thesis in question considers the nature of physics as a science. First of all, the usefulness of the study of physics is argued for, and the origins and devotees of the discipline are then surveyed.⁶⁷ Finally, Thuronius gives a profound definition of physics, which according to the established practice meant the exposition of the nominal and practical definitions of "physics", its four causes, etc.⁶⁸ In the second *inquisitio* Thuronius discusses the origins of physics. Knowledge of nature was innate in Adam when he was created.⁶⁹ Adam's knowledge was perfect, but after the Fall only minor residues of it could be communicated to the antediluvian Patriarchs. Through Noah and his sons, the Chaldeans, Egyptians and the Greeks physical knowledge finally reached Pliny. Since then the knowledge of nature had been subject of study for an increasing number of scholars. In addition to these ancients there were a good many modern authors in physics. It is in dealing with the modern traditions of physical science that Cartesianism is called into question.⁷⁰

Thuronius classifies "the more recent Physical Authors" (*recentiori Auctori Physici*) into three groups: the disciples of Aristotle, *novatori* and the "surveyors of nature".⁷¹ Aristotelians receive severe criticism from Thuronius:

siaan omaleimaisesti ja otti tarkasteltaviksi sellaiset kysymykset, joilla oli nimenomaan suomalaisen tieteenharjoituksen kannalta merkittävä teologis-filosofinen relevanssi."

⁶⁶ Salminen 1983, p. 60. "Hänen [Thuroniuksen] kartesiolaisuutta koskeva selontekonsa oli ajan oloissa harvinaisen objektiivinen ja - mikä merkittävintä - uuden filosofian hylkäämisen perustelut olivat yksinomaan filosofiset."

⁶⁷ Thuronius-Sutthoff 1665, p. 1-6. By reference to St. Augustine, Seneca, Cicero and Ovid it is claimed that man is not set on the Earth only to live there but also to admire and study the wonders of nature. Moreover, the study of nature leads to acknowledging the majesty of God.

⁶⁸ Thuronius-Sutthoff 1665, p. 29-48.

⁶⁹ Thuronius-Sutthoff 1665, p. 6-7. "Sapientiam naturalem, eamque exactissimam, primo Homini in ipsâ creatione à Deo fuisse inditam, nemo facile negaverit."

⁷⁰ Thuronius-Sutthoff 1665, p. 7-29.

⁷¹ Thuronius-Sutthoff 1665, p. 17-18. "Recentiores porro Auctores Physicos triplicesprehendimus: Aristotelis sectatores, Novatores & Naturae venatores."

...they enslaved their minds to Aristotle to the extent that they respected his Physical dogmas as much as they revered the Holy Scriptures in Theology, and they used more time and effort in presenting and explaining his texts than investigating the mysteries of nature. They put together useless questions, in addition to these long and pointless theses, by which the understanding of the students was disturbed, and the familiarity with things was in a strange way obscured and hidden.⁷²

Thus the disciples of Aristotle have considered the authority of their master equal to the Bible. They spend their time in pointless hair-splitting so that they forget to study the mysteries of nature and concentrate on the obscurities of the books instead. Moreover, Thuronius seems to be irritated with the self-confidence of "Aristotle's slaves".⁷³ He does not name any of the alleged disciples of Aristotle, but claims that "almost all Scholastic Physicists and members of several other schools" (*Physici Scholastici ferè omnes, & plerique alij sectarij*) are such. Thuronius' distrust of Aristotelians is hardly a sign of embracing new philosophy of nature, but is probably based on the sort of anti-scholastic attitude which had been typical of Lutheranism since the Reformation.⁷⁴

According to Thuronius it is typical of the *novatori* that they despise all true principles of philosophy recognized by the old authors. One of the most successful and popular of these innovators was "*Renatus Des Cartes*", whose philosophy had caused quarrels in many places. This would not have happened, Thuronius says, if Descartes had honestly sought the truth.⁷⁵ Thuronius' refutation of the "monstrous physical opinions" of Descartes is not so long so that it could not be quoted in its entirety here. It shows well how the Aristotelians' reading of Descartes' ideas was sometimes rather cursory and occasionally removed far from what many Cartesians actually promoted.

⁷² Thuronius-Sutthoff 1665, p. 18. "...ita tamen Aristoteli sua manciparunt ingenia, ut ipsius dogmatibus non minus tribuant in Physica, quam ipsi Scripturæ Sacræ in Theologia, indeque plus temporis & operæ insumunt, in textibus ejus enarrandis & explicandis, quam ipsis naturæ mysterijs investigandis. nectuntque quæstiones inutiles, & super ijs prolixas & otiosas disputationes, quibus ingenia discentium turbantur, rerumque ipsarum cognitio mirum in modum obscuratur & involvitur."

⁷³ Thuronius-Sutthoff 1665, p. 19. "...ipsum denique nihil ignorasse & in nullo errasse clament."

⁷⁴ On this anti-scholasticism see Kusakawa 1990.

⁷⁵ Thuronius-Sutthoff 1665, p. 20-21.

Descartes stated that: all things must be doubted at least once, and everything which is acquired through the senses is to be held false. The prime principle from which the truth of all things can and should be deduced is this: I (Descartes) think, therefore I am. There are neither substantial forms nor real qualities. The essence of corporeal substances consists of extension into length, width and depth. The world has no limits to its extension. The matter of the heavens is not different from the matter of which the earth consists: therefore only one kind of matter in the entire universe exists. The Earth is one of the Planets and the Moon, when it is new, is illuminated by the Earth. The Sun is a fixed star. The Sun obtains new matter every day for its substance and loses it. There are three visible elements in this world (created by Cartesius and lacking names), and of these three all bodies are composed. The Sun and the stars consist of the first element, the heaven of the second, the Earth, planets and Comets of the third element. The Earth can better be said to be light than heavy. Light, colours, odours, savours and tactile qualities are nothing else but certain kinds of dispositions, consisting of magnitude, figure and motion.⁷⁶

Despite some standard misunderstandings of Cartesianism (such as the infinite as against indefinite size of the world) Thuronius' description is accurate, managing to summarize the main features of Cartesianism. However, it is a simplified presentation of the philosophy, which hardly can be called altogether objective. The absurdity of these ideas is made manifest by its being in the conditional mode. Unless the passage really was composed by Thuronius himself, the text could

⁷⁶ Thuronius-Sutthoff 1665, p. 21-22. "Statuit autem Cartesius: de omnibus rebus semel ad minimum dubitandum, & quaecunque sensibus hauriuntur pro falsis habenda esse. Primum principium unde omnium rerum veritas deduci debet & potest hoc esse: Egò (Cartesius) cogito, ergo sum. Formas substantiales & qualitates reales nullas dari. Extensionem in longum, latum & profundum substantiæ corporea naturam constituere. Mundum nullos extensionis suæ fines habere. Non aliam esse materiam coeli quam terra: imò materiam in toto universo unam: eandem existere. Terram esse unum è Planetis, Lunam, cum nova est, à terrâ illuminari. Solem esse stellam fixam. Solem quotidie novam materiam substantiæ suæ assumere & deperdere. Tria esse hujus mundi spectabilis elementa (apud Cartesium nata & nominibus carentia) & ex his tribus omnia corpora componi: nempe solem & stellas fixas ex primo, coelos ex secundo, & terram cum planetis & Cometis ex tertio. Terram non gravem, sed potius levem dicendam esse. Lumen, colorem, odorem, saporem & tactiles qualitates nihil aliud esse, quam dispositiones quosdam in magnitudine, figura & motu consistentes."

have been compiled from almost anywhere: from Descartes' followers texts, or even from some anti-Cartesian text. We do not know whether any of Descartes' books were available at Turku in the middle of the 1660's. However, in the 1682 library catalogue *Meditationes de Prima Philosophia* is mentioned.⁷⁷ Thuronius simply states that Cartesian principles are wrong, and he hopes to be able to examine the subject more closely in some later thesis.⁷⁸

It is by no means only Cartesianism which is rejected by Thuronius. A Hungarian scholar, Johannes Bajerus and Francis Bacon are exploded as much as Sperling and Sennert are praised. The list of Bacon's sins is a long one:

He makes physics a practical discipline, or confuses it with manual arts which are derived from physics. This is against Sennert and Sperling. He [Bacon] presupposes natural bodies to have strange principles, this with Comenius and against Sennert and Sperling. Against Sennert and Sperling he presumes all natural bodies to be living, and against Sennert and Sperling he expresses new notions and concepts and new terms never heard of, and mixes up a new method and a mode of teaching with all this. He wants the substantial form to be nothing other than a coordination and disposition of corpuscles, as if in other aggregates. This is also against Sennert and Sperling.⁷⁹

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The gravest mistakes made by Bacon seem to have been introducing new ideas into philosophy and contradicting Sennert and Sperling, the authorities revered at Turku. Of course, these accusations would be appropriate to the other "innovators" too, including Descartes. On the whole this criticism is, however, directed against Bacon.

⁷⁷ BRAA 1682.

⁷⁸ Thuronius-Sutthoff 1665, p. 22. "Quas veritates (ut ipse appellat) & plures alias, soli cogitationi Cartesianæ fictisque hypothesibus & conjecturis superstructas, suo tempore, bono cum Deo, pro re natâ examinabimus, nec veritates eas, sed vanitates & meras imposturas esse sigillatim ostendemus."

⁷⁹ Thuronius-Sutthoff 1665, p. 25. "Physicam disciplinam facit practicam, aut illam cum artibus ex ea fluentibus confundit, contra Sennertum & Sperlingium: peregrina ponit corporum naturalium principia cum Comenio, contra Sennert. & Sperl: vitam omnibus corporibus tribuit, contra Senn.& Sperl: novas & inauditas cudit notiones, novos terminos, novam docendi comminiscitur methodum modumque, contra Senn. & Sperl. Formam substantialem nihil aliud esse, quam, velut in aggregatis alijs, coordinationem & dispositionem partium, contra Senn. & Sperlingium..."

Having rejected the Aristotelians and the *Novatori* Thuronius proceeds to define the right way to study nature. The *Naturae Venatori* do not commit themselves to Aristotle's name, but follow him as a guide in natural philosophical inquiry. The opinions of classical authors are respected, and if they are not harmonious with the Book of Nature, they are discreetly passed over.⁸⁰ The need to find the happy mean was also mentioned by the Wittenbergian logician Johannes Scharfius, although his classification of the two extremes differed from that of Thuronius.⁸¹ According to Thuronius a *venator naturae* proceeds without "unnecessary" hair-splitting and subtleties. Hence, Thuronius' description of the right way of scrutinizing nature is in line with the 1645 edict which prohibited introducing any new ideas into philosophy. No matter how badly Bacon is told off by Thuronius, the program for the proper use of philosophy he offers is such as it would meet Bacon's approval.

...having abandoned all pointless subtilities of disputations they spend all their efforts in turning and opening the pages of the great book of nature. And they bring to light many secrets of nature with care, they use trustworthy experiments and the truths of things which follow are not at all conjectural or hypothetical.⁸²

In Thuronius' opinion this kind of research has best been done by the "leader of the nature's surveyors", Iulius Caesar Scaliger.⁸³

All in all, Thuronius' criticism of Cartesianism is only a passing remark in the thesis, covering only a good two pages of a 48-page

⁸⁰ Thuronius-Sutthoff 1665, p. 26-27. "...terminos & notiones veterum, quatenus quidem absque veritatis dispendio usurpari possunt, retinent, sententias quoque eorum ad veritatis trutinam appendunt, & cum magno Naturae libro conferunt: cui si conformes deprehendantur, eas cum gratâ Auctorum commemoratione suscipiunt; sin minus, modestè, cum excusatione illorum, praetereunt."

⁸¹ Scharfius 1646, p. 6. "...libere quidem veritati studet, & res ipsas scrutatur, prout in se sunt, aliorum tamen auctorum dogmata & dicta simpliciter non rejicit, potius omnia probat, &, quae vera bonave sunt, eligit, amplectitur, & constanter retinet." Scharfius groups philosophers into *libera*, *sectaria* and *mediae*, whereof the first and revolutionary ones were not necessarily modern authors.

⁸² Thuronius-Sutthoff 1665, p. 27. "...missa disputandi subtilitate inutili, omnem operam volvendis ac revolvendis magni naturae libri paginis impendant, multa naturae arcana sensim in lucem proferunt, suffultique haud fallacibus experimentis, veritatem circa res adsequuntur minimè conjecturalem aut hypotheticam."

⁸³ Thuronius-Sutthoff 1665, p. 27. Thuronius has Scaliger's *Exotericae exercitationes* (1557) in mind.

work. Aristotelianism, Cartesianism and Baconianism are all attacked to as contradictory to the proper way of studying physics. The attention paid to Cartesianism in this thesis should therefore be placed in its proper context and its importance should be neither exaggerated nor undervalued.

In the 1660's and 1670's the opposition to Cartesianism was for the most part provided by the theologians. It was especially methodical doubt and some other problems connected with theology which were discussed. For example, the claim which was allegedly made by Petrus Hoffwenius at Uppsala that the corpuscular "spirits" in blood turn the man's mind towards God was refuted.⁸⁴ However, from the beginning of the 1680's on the Faculty of Theology quickly started to close itself off from philosophical discussions. It was a normal viewpoint in 17th-century science that theological problems should not be discussed in philosophy - not even in the framework of Aristotelian philosophy. Whereas theology was omniscient, philosophy could produce only a limited amount of truth. The first professor of theology especially, Enevaldus Svenonius, had from the 1660's on encouraged the view that the Faculty of Philosophy ought to be some sort of vanguard of orthodox theology. Philosophers were supposed to defeat Cartesianism on their own ground before it strengthened sufficiently to threaten the true religion. Therefore it was considered proper to discuss problems related to theology even in philosophical disputations, but only if the views expressed supported the orthodox Lutheranism.⁸⁵

The fear of Cartesianism the theologians felt was with no doubt inspired by the course of events at Uppsala. It is more doubtful, however, how much the individual events at Uppsala influenced Turku. It has been claimed, for example, that Flachsenius' and Grimsteen's thesis on the astronomical hypotheses would have been directed against Hoffwenius' *Synopsis physica*, published a year earlier.⁸⁶ It is hard to find support for this interpretation, because Grimsteen's thesis shows no special interest in opposing the Cartesian version of the heliocentric theory. In one chapter of the thesis Lipstorp is cited frequently⁸⁷, but I regard this as rather natural because Grimsteen here follows Laurbecchius' thesis very closely. Laurbecchius' work against

⁸⁴ Salminen 1981, p. 95-97. Gezelius 1672, p. 362-364.

⁸⁵ Salminen 1981, p. 98-99. Salminen 1978, p. 268-269, 411.

⁸⁶ Salminen 1981, p. 99.

⁸⁷ Flachsenius-Grimsteen 1679, Membr. III, Th. 10.

Lipstorp was, after all, one of the most profound studies at Turku in which Copernicanism was refuted. Referring to the "strange" Cartesian principles involved in the heliocentric theory was an effective way to refute both of them. Why does Grimsteen not use this powerful argument as Laurbecchius had done, if the thesis really was inspired by Hoffwenius' *Synopsis physica*? Looking for possible "influences" between two series of events is always a tricky business, and we should be careful when making claims about it. A mere coincidence is not enough, and we must also consider the actual contents of each thesis and the context in which the arguments belong.

The theologians' demands for opposition to Cartesianism were undoubtedly known in the Faculty of Philosophy. The task set for the Faculty by Svenonius was taken seriously especially by those scholars who either for personal reasons or because of the nature of their discipline were close to theology.⁸⁸ In physics, however, the problem of Cartesianism was tackled only from the 1680's on.

3. THE 1680'S: SHARPENING CRITICS AND THE FIRST PROPONENTS

Juhana Cajanus and His Never-Achieved Professorship

Whereas the 1670's had been a quiet time as regards Cartesianism, the new decade began with an incident which more or less had to do with the new philosophy. The case of Juhana Cajanus can be seen from several different viewpoints. In a way, it probably was a conscious attempt to keep Cartesian influences away from the University, but other reasons for the rejection of Cajanus' applications for a professorship at Turku can be pointed out. These other reasons may actually be so forceful that the suspicions of Cajanus' Cartesianism turn

⁸⁸ Salminen 1981, p. 99-100.

out to be more excuses than reasons.

Juhana Cajanus (1655-1681) was the eldest son of the pastor of Paltamo in the North of Finland. Juhana Cajanus Sr. was a particularly active pastor considering the very distant location of his congregation. He even represented the clergy at the Diet of 1672. It is therefore no wonder that he sent his eldest son to study at the University of Uppsala. Cajanus Jr. seems to have been a clear-headed and industrious student, and he managed to gain the approbation of influential patrons.⁸⁹

In August 1680 Juhana Cajanus applied for a professorship at the University of Turku. His application was supported by letters of recommendation from His Majesty King Charles XI and the revered old Chancellor Per Brahe. Cajanus' application was not aimed at any particular professorship, but at a so-called expectancy. Whenever a professorship became vacant at the philosophical faculty, Cajanus would be appointed. Despite his great references Cajanus' career ran into difficulties. The professor of poetry, Petrus Laurbecchius, resisted the application at the Senate of the University. He claimed to have talked with Cajanus, and although he indeed praised him as a hard-working man, Cajanus was according to him "addicted to the principles of Cartesian philosophy".⁹⁰ After a lengthy discussion Cajanus' application was passed over and the expectancy was given to the secretary of the University, Andreas Wanoehius.

What reasons did Laurbecchius have to suspect Cajanus of Cartesianism? Laurbecchius claims to have talked with Cajanus, but we do not know how well he actually knew a man not resident in Turku. It is certain, however, that Laurbecchius was well aware of the main features of Cartesian philosophy; nineteen years earlier he had written a profound thesis refuting Cartesian astronomical ideas. Cajanus' reputation as a Cartesian was based on his wide-ranging two-part thesis *Meletematum In Mundi Animam*, published in 1679. Salminen has described Cajanus' sincere intention to sail between the Scylla of the Cartesian universe and the Charybdis of Aristotelianism. Cajanus respects Descartes highly, but he takes a scornful stand against the Cartesian and Calvinist theologian Christopher Wittich.⁹¹ Salminen does

⁸⁹ Svensk Biografiskt Lexicon 1927, p. 207-208. The first great biographical lexicons published in Sweden (1837 and 1858-59) do not mention Cajanus.

⁹⁰ CAAP V, 30.8.1680, § 5.

⁹¹ Salminen 1983, p. 61-62.

not probe further into how closely Cajanus' rhetoric mirrors what he actually writes.

The first thing to separate Cajanus from the Scholastic tradition is his method and style of writing. In neither part of *De anima mundi* does the argumentation follow Aristotelian patterns, in which the concepts form and matter, the four causes and the categories of being usually played a major role. In the first part of the thesis Cajanus first describes different ideas about the world-soul, discussing ancient and Scholastic proponents of the idea, and assessing the correctness of other authors' interpretations of these views. He classifies the proponents of the idea of a world-soul into four major groups. Firstly, there are those who consider world-soul to be pure mind,⁹² secondly, there are those who think that *anima mundi* is something between mind and matter.⁹³ Thirdly, there are authors who equate world-soul with the divine,⁹⁴ and fourthly there are philosophers who regard the world-soul as consisting of pure fine matter.⁹⁵ Descartes, whom Cajanus sees as copying Sebastian Basso's ideas, is only one of these. He also refers approvingly (!) to Christopher Wittich and seems to agree with him that the idea of world-soul can be accepted in the sense of subtle, all-pervading matter which is the cause of many natural events.⁹⁶ The second major chapter of *De anima mundi I* seeks causes by which the variety and particularly the falsity of these ideas can be explained.⁹⁷ Cajanus seems by no means to promote either Cartesianism or the existence of world-soul in the first part of the thesis.

The tone in the second part of *De anima mundi* is strikingly different. Cajanus' argument is now clearly and elegantly Cartesian. He proceeds from the claim that God is the only entity which can exist with the sole power of its own perfection.⁹⁸ He is careful not to pro-

⁹² Steuchius-Cajanus 1679, Cap. I, § IV-IX.

⁹³ Steuchius-Cajanus 1679, Cap. I, § X-XXX. These are classified into two sub-groups; those who regard world-soul as partly mind, partly matter and those who do think it to be either of these, but of a third, intermediate nature.

⁹⁴ Steuchius-Cajanus 1679, Cap. I, § XX-XXIV.

⁹⁵ Steuchius-Cajanus 1679, Cap. I, § XXV-XXXII.

⁹⁶ Steuchius-Cajanus 1679, Cap. I, § XXXII.

⁹⁷ Steuchius-Cajanus 1679, Cap. II.

⁹⁸ Arrhenius-Cajanus 1679, Cap. III, § VI. "Solus Deus existit vi naturæ & perfectionum suarum, quæ tantæ ac tam plenæ sunt, ut earum, adeoque & Dei, existentia non aliunde sit arcessenda." This follows Descartes' definition of a substance. Only God can be a substance in the perfect sense of the definition, since both

claim dualism aloud, but stresses repeatedly that mind and matter are very tightly connected to each other.⁹⁹ Can we presume that in saying this Cajanus also indirectly presupposes the validity of Cartesian dualism? An Aristotelian would certainly refer to the metaphysical relation between the concepts of form and matter, which Cajanus does not do. Now all these created entities (Cajanus does not use the word substance) are dependent on God in two ways: He has not only created them, but also maintains them continuously in existence. Besides mere existence, things are dependent on God in all of their actions:

The conservative act of God is not enough for moving and agitating natural bodies, which remain in their state of being. Another act of God is required, without which the bodies could neither move nor function in any other way.¹⁰⁰

Normally the effective cause of motion would be attributed to form in Scandinavian scholastic philosophy. Emphasizing God's role as the mover in ordinary physical processes was much more common in Descartes' thought and among the British Protestant physicists.¹⁰¹ Cajanus states that God produces motion in the world by his mere will. He describes the two theories of how God could be understood as the prime mover. According to the "peripatetic" interpretation God gives natural bodies some capacity to move by themselves. The Cartesian view was that natural bodies were not able to move by themselves, but God was the actual cause of all movement. Cajanus humbly denies being able to solve such problems as determining the correct view and he complains about the difficulty of choosing between two unsatisfactory explanations.¹⁰² The problem of whether material bodies had a principle of motion in themselves or whether they were moved entirely by an external agent, is very much a theological question for Cajanus:

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mind and matter are dependent on God.

⁹⁹ Arrhenius-Cajanus 1679, Cap. III, § III, et passim.

¹⁰⁰ Arrhenius-Cajanus 1679, Cap. III, § XIV. "Scilicet ut moveantur & agant res naturales, non sufficit actum Dei conservativum, quo in esse suo permanent, sed requiritur præterea actus Dei alius, sine quo nec moveri, nec vel tantillum operari possunt."

¹⁰¹ Garber 1992, p. 303-322. Deason 1986.

¹⁰² Arrhenius-Cajanus 1679, Cap. III, § XXI, XXIV.

When Descartes called God an assistant soul (because he addressed no motion at all to corporal bodies themselves) ...he meant it as appropriate as no other way can be. Now when we say with the Peripatetics that natural bodies move themselves with God, the nomination of assistant soul is nevertheless equally suitable for Him in that case too.¹⁰³

Without giving a definite answer on the question Cajanus proves, however, that God is the *primum movens* in the sense that all movement ultimately depends on him as the Creator. Cajanus then proceeds to prove his main argument that God is *anima mundi assistens*. Cajanus' argument is very complicated and we cannot go into details here. In order to prove his point Cajanus draws upon more Aristotelian ways of defining concepts. He claims that an assisting form would not define the essence of an entity like the substantial form does. The assistant form is, however, present all the time and is a source of actions.¹⁰⁴

An assistant form... does not unite with this or that matter essentially, but only externally or, in other words it confers motion on it, or it directs its motion or, as is peculiar to God only, maintains its substantial being. If the aforementioned definition is referred to God in this sense, everything goes together exactly.¹⁰⁵

Because God is omnipresent, maintaining the cosmos continuously and being the primary cause of all motion and other operations in the world, the definition of an assistant form suits him. On the other hand God can even more appropriately be called *anima mundi adsistens*, because a spiritual God can exist voluntarily without the material

¹⁰³ Arrhenius-Cajanus 1679, Cap. III, § XXI. "Equidem Cartesius, dum corporibus ipsis in motione sui partes nullas tribuit, Deo animae adsistentis vocabulum ...ita appropriat, ut ratione nulla appropriari possit magis: Sed annon, si cum Peripateticis corpora naturalia cum Deo se movere dicamus, in Deum nihilominus ut formae ita animae adsistentis appellatio quadrabit?"

¹⁰⁴ Arrhenius-Cajanus 1679, Cap. III, § XXVII.

¹⁰⁵ Arrhenius-Cajanus 1679, Cap. III, § XXVII. "Forma adsistens... ipso ipsiusve materia essentialiter non cohæreat, verum solummodo extrinsecus vel motum conferat, vel actionem dirigat, vel, quod solius Dei est, ipsum tò esse potenter sustentet. Quo sensu si ad Deum referatur definitio modo exhibita, conveniunt exacte omnia."

world he has created.¹⁰⁶ All in all it is Cajanus' aim to consider in which way the material world is dependent on God the creator and how this can be expressed in Cartesian and Aristotelian terminology. His discussion therefore has a very theological character.

The scholars at Turku would hardly have accepted Cajanus' ratiocination. First of all the concept *forma adsistens* was not generally in use and it is doubtful whether it would have been approved of. Secondly, the main point of Cajanus' thesis was theologically more than suspicious. The idea of a world-soul was plainly refuted in some dissertations written at Turku.¹⁰⁷ Whereas Cajanus tried to prove that all action in the world was at some point ultimately dependent on an external actor, God, the view favoured at Turku was explicitly the opposite.

...there is no discernible action in the world which would have its origin in a soul common to the entire universe. But all operations are caused by peculiar and distinct forms. Since every part of the universe has a peculiar form of its own, there is no need for a common form to connect them, even though the individual forms could still exert their actions in it.¹⁰⁸

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The existence of any kind of uniting form or soul was usually refuted because it was thought to lead to severe metaphysical difficulties. Accepting this view was also thought to be an easy way to pantheism, and should therefore be banned. Of course, Cajanus' argument for the *anima mundi* was based on a different notion, and he also refuted the classical proponents of the idea.¹⁰⁹ Probably no less unacceptable for the scholars at Turku was the way Cajanus combined

¹⁰⁶ Arrhenius-Cajanus 1679, Cap. III, § XXXII-XXXIV.

¹⁰⁷ Thauvonius-Forsenius 1650, Corollaria 2. "An detur Anima mundi, vel Spiritus universi creatus? Neg." Thauvonius-Miltopaeus 1653, Porismata I. "Coelum non est animatum, sive coeli forma non est anima." Thauvonius-Lilius 1656, Th. 7-11. Cf. also Gezelius 1672, p. 242. "Forma mundi est unicus ille mirabilis & perfectissimus ordo, quo res ille inter se connexae & sapientissimè inter se collatae sunt & distinctae."

¹⁰⁸ Thauvonius-Lilius 1656, Th. 9. "...nulla conspicua in mundo apparet actio, quae proficiscatur à communi totius universi animâ: Sed omnes operationes peculiaribus ac distinctis formis debentur. Quare cum omnibus universi partibus peculiaris forma insit aliqua communis eas connectens non requiritur, quippe quod in eâ singulae formae operationes suas exsequi possint."

¹⁰⁹ Arrhenius-Cajanus 1679, Cap. III, § IV.

somewhat Cartesian arguments and theories of motion with Copernicanism and the idea of world-soul, all based on theological reasoning.¹¹⁰

It seems that from the viewpoint of the professors at Turku Cajanus was even more dangerous than they knew or said. It is unlikely that Cajanus' theses were known at Turku, because in that case the opposition to his dogmatic views would probably have been still stronger than it was. Mere rumors of the applicant being Cartesian-minded was enough to scare the philosophers at Turku.

But what had the reception of Cajanus' thesis at the University of Uppsala been like in the first place? It did indeed cause some stir and it seems that the professor of metaphysics, Matthias Steuchius, rather disliked it. Steuchius did not himself support Cartesian ideas. Lindborg thinks it probable that Steuchius had not had time to read Cajanus' thesis beforehand or had not bothered to do so, thus permitting ideas which he did not approve of. When the second part of *De anima mundi* was about to be ventilated, Steuchius opposed the publication. It is revealing that the matter was handled in the Council of the Faculty of Theology three times from November 1679 to June 1680.¹¹¹ In the protocols of the University Senate Cajanus was mentioned only once, on the 30th April 1679, when he was given an imprimatur.¹¹²

It seems thus that the fuss about Cajanus' thesis remained relatively minor and was limited to theological circles. It has been suggested that it probably was the Cajanus case which six years later inspired the proposition made by the clergy that the maximum length of philosophical dissertations should be four pages. Even the busiest professors would then have time to censor the writings thoroughly.¹¹³

¹¹⁰ Arrhenius-Cajanus 1679, Cap. III, § VI, XV, XVI, et passim. Cajanus uses theological argument in several ways and on many levels. It is not, however, within the scope of this study to deal with the subject more deeply. Just as Salminen 1983, p. 61 claims, Cajanus disapproves of the theologian Christopher Wittich. This is understandable not only because Wittich was Cartesian, but especially because he was a Calvinist.

¹¹¹ Lindborg 1965, p. 234. Lindborg calls part one of Cajanus' thesis one of the most beautiful Cartesian theses ever published at Uppsala. Lindborg's reasoning here is somewhat obscure, because he does not refer to the contents of the thesis at all, and seems not to know the really Cartesian part of *De mundi anima*, published in the *presidium* of Arrhenius.

¹¹² Selander 1974, p. 312. "30. Aprilis 1679. ...IV Bewilliades Johanni Cajano att disputera de anima mundi."

¹¹³ Lindborg 1965, p. 234.

It is probable that the main reason for rejecting Cajanus for the professorship was not his Cartesianism after all.¹¹⁴ Obviously the contents of his Cartesian thesis was not even known at Turku. At the meeting of the Senate on the 30th August 1680 Cajanus' application for a professorship had been rejected and the secretary of the Faculty of Arts had been given an expectancy. At the beginning of 1680 the professorship of history and politics became vacant. The meeting of the Senate on the 21st of January 1680 considered Abraham Wanochius the best applicant for the professorship. The Constitutions of the University decreed, however, that in the election of a professor there should be more than one candidate. In this situation, the application of Cajanus "was remembered", because the King's references "could not totally be ignored".¹¹⁵

The situation was obviously very painful. Everybody agreed that Cajanus should be taken into account in some way, but nobody seems to have wanted to appoint him professor. Cajanus' possible Cartesianism was not used as an argument against him, although some suspicions about his philosophical preferences may have existed. The only criticism was expressed by the professor of theology Enevaldus Svenonius, who stated that "none of us knows Cajanus and whether he is good or bad. And he has not studied enough either."¹¹⁶ There were more reasons which spoke for Wanochius. In addition to his academic merits (disputations, lecturing) his present office as Secretary made him "automatically" professor according to the constitutional rules which regulated advancement. Besides - it was mentioned twice - Wanochius was about to marry the daughter of Svenonius, the influential prime professor of theology.¹¹⁷ The King actually appointed Wanochius, placed at the head of the list of nominees, professor of history and politics. Cajanus was given an expectancy for the professorship of physics, which was to become vacant soon.¹¹⁸ He never became professor, however, because he died by 1681.

It is evident that the professors at Turku preferred to nominate their own students to important posts. Dogmatic divergences could be in-

¹¹⁴ Some older research especially claims the opposite. See e.g. Hultin 1902, p. 113-114.

¹¹⁵ CAAP V, p. 129.

¹¹⁶ CAAP V, p. 131. "ingen af oss känner Cajanum om han är ond eller godh, har icke heller studerat."

¹¹⁷ CAAP V, p. 130-131.

¹¹⁸ CAAP V, p. 131, 135-136.

tertained with the question, and they usually were good weapons to beat opponents with. However, in the case of Cajanus his dogmatic deviations were not brought to light in any detailed and emphatic manner. Considering the weirdness of Cajanus' views both in religion and in physics it is striking that his beliefs were not used against him. The most probable explanation is that his views were not known well enough at Turku. There may also be a good deal of truth in the prickly comment made by professor Laurbecchius in the meeting of the 21st January, that it seemed that the Finns wanted to displace all Swedes from the University.¹¹⁹ All other professors naturally denied having any such intentions; those with a guilty conscience easily take offence. Be that as it may, the nepotism of the age played an important role in this nomination.

Criticism of the Cartesian Concept of Substance

During the 1680's the criticism aimed at Cartesianism by the scholars of natural philosophy concentrated mainly on one theme - the concept of substance. The new philosophy was seen through very Aristotelian spectacles and all judgements made on it were based on the Aristotelian metaphysical principles. Of course, the falsity of Cartesian philosophy was evident already by the notion that it was regarded as contradicting the Holy Scriptures and "all other recognized authorities".¹²⁰

First of all the mere definition of physics in the Aristotelian tradition made Cartesian philosophy incompatible with it. According to the often-repeated formula "Physics is a science of natural bodies, as far as they are natural."¹²¹ Physics was also knowledge of the universal characteristics of individuals of a certain class or group. The proper subject of study, *corpus naturalis*, was any entity consisting of matter and form. Only then could substances be considered to be *quatenus naturale*. For Cartesians, who rejected the notions of matter and form in the Aristotelian sense, the whole project of physics was something different. It was supposed to discover the causes of phenomena by constructing a mechanical model which would employ only such con-

¹¹⁹ CAAP V, p. 129.

¹²⁰ Hahn-Häf 1685, p. 3-4.

¹²¹ See e.g. Thuronius-Suthoff 1665, p. 29. "*Physica est scientia corporis naturalis, quatenus naturale est.*"

cepts as extension and motion,¹²² so that the incommensurability of these two philosophical systems started from the very concept of science. The question of what natural philosophy or physics ought to be like was not taken up explicitly in discussions at Turku. However, this question undoubtedly lies in the background of the discrepancies between the two philosophies.

Descartes was accused of rejecting the notion of substantial forms and of defending the view that all forms were accidental. In this Descartes was said to have revived the dogmas of classical atomists Democritus and Empedocles. The Aristotelians thought it absurd to guarantee matter an ability to form a substance, because in that case matter would hold a more noble position than the form.¹²³ In Aristotelian philosophy the ontological categories were placed in a hierarchical order. Because a substance was superior to its accidents, no accident could be a cause of a substance. Therefore, neither quantity nor extension could be the cause of a material substance. Of course, Descartes never claimed that extension was the efficient cause of the material substance, stating rather that it was its only property. It was also evident for Aristotelians that one accident could not dominate a substance and determine its nature. For this reason it was also claimed to be impossible that extension could be the sole property of matter.¹²⁴ The Cartesian views of a substance were thus labelled as a confusion between the categories of substance and accident.¹²⁵

Antonius Le Grand's argument that quantity was a property which could by no means be separated from the material substance was refuted too. The claim was considered blasphemy, because it belittled the power of God, who could preserve a body even if its extension was abolished.¹²⁶ Theological arguments were also otherwise widely used against Cartesianism. Bolhemius, for example, wanted to maintain the real distinction between the substance and the accident for the following reason: if there was no difference between these categories, then sin would be a part of man's nature and not only one of

¹²² Clarke 1992.

¹²³ Flachsenius-Lund 1681, Art. II Th. VI, Art. IV Th. I-II. Hahn-Häf 1685, p. 2.

¹²⁴ Hahn-Bolhemius 1688, p. 2-8.

¹²⁵ Hahn-Bolhemius 1688, p. 10. "Dicimus confundere ipsum notionem substantiae cum notione Accidentis, & statuere: substantiam & Accidens esse unum & idem, quod nunquam a novis concessum est, nec potest evinci."

¹²⁶ Hahn-Bolhemius 1688, p. 11. "Qvemadmodum sublatâ qvantitate, non statim in-terit corpus, qvia Deus illud absque aliquâ Extensione conservare potest."

his characteristics. If man was sinful by nature, this would mean that God had created something depraved, which was against His nature and the word of the Bible.¹²⁷

Cartesian mechanistic philosophy denied the existence of soul-substance in animals. All vital functions were explained by purely mechanistic principles. In the 1680's, students at Turku interpreted this view in a way which Descartes would hardly have agreed with. It was claimed that according to Descartes motion was the main cause of life. This would lead to animism: "Now if Motion were the cause of Life, and I shoot an arrow with a bow, the faster the arrow flies the more I should assume it to be alive."¹²⁸

Of course it was not Descartes' intention to attribute life to all moving things. Nevertheless, his idea was interpreted in this way, and the view thus achieved was considered contrary to the Bible. Moreover, it was thought to be the form's task to provide a substance with its typical functions. Mere figure, movement, magnitude and place were inadequate properties for differentiating between things. This caused certain problems: "in what way, on what criteria do the Cartesians think they can distinguish an eagle from a bull and a sparrow from a stag."¹²⁹ The other side of this question was that if all matter was homogenous, how was it possible that all motions and processes were not identical.¹³⁰ Other characteristics of matter were also thought to be unacceptable in Cartesianism. Bolhemius attacked Le Grand's notion that all extended matter could be infinitely divided. In mathematics the notion of infinity was perfectly acceptable. According to Bolhemius Le Grand falsely introduced a mathematical concept into physics, where there were both the upper and lower limits of size in divisibility.¹³¹

¹²⁷ Hahn-Bolhemius 1688, p. 20.

¹²⁸ Flachsenius-Lund 1681, Art. IV Th. II(-III). "Nam si Vitam Motus efficit, emisam de arcu sagittam, quæ citatissimo fertur cursu, etiam maximè vivere assere-rem."

¹²⁹ Hahn-Håf 1685, p. 10, 25. "...quâ ratione, quovè modo aqvilam à bove, passerem ab alce discernere velint Carthesiani." See also Flachsenius-Lund 1681, Art. IV Th. IV.

¹³⁰ Hahn-Håf 1685, p. 25. "Nam eadem anima seu forma si omnibus inesset animalibus, ut illi volunt, cur non easdem virtutes, motus, inclinationes, vires & operationes causat, atque univocà planè ratione producit æque in hujus ac illius speciei individuïs?" Flachsenius-Lund 1681, Art. IV Th. IV.

¹³¹ Hahn-Bolhemius 1688, p. 11-13. "Dicimus... Ant. Le Grand... introducere etiam in Physicam principia sua Mathematica".

Occasionally other features of the Cartesian philosophy were criticised during the 1680's. For example, Flachsenius and Lund opposed the theory of clear and distinct ideas as a guarantee for certain knowledge. On the one hand, mere clear and distinct perception of an idea would not guarantee that our idea still was right. On the other hand, a clear and distinct idea was equated with a simple idea. It could be further asked why simplicity would be a better criterion for truth than complexity?¹³²

Similar arguments to those advanced for the defence of substantial forms had been argued at the University of Uppsala from the 1660's on. A thesis written by the professor of Greek Martin Brunnerus in 1664 became a standard model for the arguments favouring substantial forms.¹³³ The arguments would thus have had about two decades to travel over the Gulf of Bothnia from Uppsala to Turku and so they probably did, although no Swedish authors were specially referred to. This kind of argument was so to speak common property between most Aristotelians and circulated widely in the literature. Now is there something in the developments at Uppsala in the 1680's specifically which would have launched the defence of substantial forms at Turku? It is true that Cartesianism had strengthened its foothold at Uppsala at the end of the 1670's and the beginning of the 1680's. Theses defending the Cartesian concept of substance were published there. We can suppose that this development might have been watched with concern at Turku and in this way a need for something like preventive criticism against the spreading of these dogmas at Turku might have arisen. On the other hand we are now talking about only three theses from the 1680's. There is nothing in them which would indicate that they were aimed against some specific thesis or a particular incident at Uppsala.¹³⁴

All in all, the picture offered of Cartesianism was seldom fair to the new philosophy. The scholastics' objections were based on the presupposition that Aristotelian metaphysics was the only correct system to be relied on. Any explanation which failed to employ the con-

¹³² Flachsenius-Lund 1681, Art. IV Th. V.

¹³³ Lindborg 1965, p. 97-115, et passim.

¹³⁴ Once again it has to be said that no Uppsala theses or authors were mentioned. On the other hand Hahn-Häf's thesis in 1685 was printed six months before Johan Bilberg's thesis promoting dualism was published. Lindborg 1965, p. 192, et passim.

cepts of matter and form in an adequately acceptable way was doomed as absurd. When the Aristotelians rejected Cartesianism, they actually opposed Aristotelian-coloured interpretations of the Cartesian theories. This kind of discussion would necessarily lead to an irreconcilable controversy, because there was no mutually agreed way of reasoning. These philosophies spoke two different languages and it was therefore easy to categorize the language of the alternative system as absurd and incomprehensible. Moreover, it was typical of the dissertations to present a very fragmentary picture of the philosophy under attack.¹³⁵

The First Proponents of Cartesianism: the Case of Physiology

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By now it should be rather clear that although there were no real disputes caused directly by the Cartesian philosophy at the University of Turku at this time, some Cartesian ideas were nevertheless strenuously resisted. However, Cartesian ideas were not always discussed in a negative tone. The 1680's saw the first theses at Turku in which Cartesianism was favoured. In this subsection we shall survey those theses published in physics which either supported Cartesian ideas or at least adopted a neutral attitude towards them.

The first conspicuous appearance of Cartesian ideas at Turku was in Achrelius' natural philosophical textbook *Contemplationes mundi*. There is a persistent rumour that the incident which followed the publication of the first parts of the book would have been motivated by the Cartesian principles in Achrelius' book.¹³⁶ Achrelius had begun to publish his work in 1678 as a series of disputations. On the 5th of December 1678 the professor of Hebrew and Greek Ericus Fallander demanded at the Senate that the publication of Achrelius' disputation series should be suspended. According to Fallander the reason for this was "because a part of it is against the dogmas of other, more sane philosophers, and moreover it introduces new principles, and other things which seem to be against the Faculty of Philosophy".¹³⁷ The

¹³⁵ This is true especially of Hahn-Hâf 1685 and partially of Flachsenius-Lund 1681.

¹³⁶ This view originated from two articles written by different persons (K.F. Menander and Gjörwell) in 1773. Although this view has already been rectified by Rein, the stigma of once having been accused of Cartesianism still dogs Achrelius. Rein 1908, p. 132-134.

¹³⁷ CAAP IV, p. 476, 5. Decemb. 1678. "...efftersåsom een dehl deruthi repugnerar alijs saniorum philosophorum dogmatibus, hand och der iämpte införer nova prin-

professors of theology, Petrus Bång and Enevaldus Svenonius and the professor of medicine Elias Til-Landz favoured the further publication of Achrelius' work, because it did not contradict the Holy Scripture and it was considered to be useful for young students.

However, the "*nova principia*" do not in this case refer to Cartesianism. Those parts of *Contemplationes mundi* which present some ideas of Descartes and Le Grand were published nearly four years after this incident, in 1682 (in the same year the dissertations were printed anew in book form). At the time the accusations were raised, only three theses had been published. It was probably Achrelius' informal style, which did not follow the traditional method of presentation very closely, and his claim for the homogeneity of the world which caused irritation among the members of the Faculty of Arts. Besides, the two best experts on Cartesianism available at Turku, Petrus Bång and Petrus Laurbecchius, were present at the meeting of the Senate. If Achrelius' work had been suspected of Cartesianism, they would surely have smelled a rat. Achrelius was allowed to carry on with his work, and it was never attacked again.¹³⁸

It has already been stated in chapter "The Body of Knowledge" that Achrelius was the first scholar at Turku to present the theory of the circulation of blood in its Cartesian version. He also adopted the Cartesian theory of the origin of emotions. The most crucial differences between Harvey's theory of the circulation of blood and the version of it adopted by Descartes were on the questions concerning the origin of blood and the causes of the movement of the heart. According to Descartes blood originated from food through a complicated process of digestion - a Galenic view, which Harvey had rejected. On the other hand, in Descartes' opinion the heart was dilated (not contracted) by blood, which was warmed up by the fire residing in the heart. This view was also faithfully presented by Achrelius.¹³⁹

It is possible that Achrelius had not read Descartes' books at all but only one of his disciples, Antonius Le Grand. At least Achrelius' account of the emotions is based on extensive citations of Le Grand.

cipia och mehr sådant som synes facul. philosoph. wara emot..." On the course of events see Leikola 1987, p. 562. Hultin 1902, p. 271-273. Salminen 1981, p. 98.

¹³⁸ Vallinkoski 1966, p. 1. Bång played an important role at the beginning of the "Second Cartesian Dispute" in Uppsala in 1686. See Lindborg 1965, p. 227, et passim.

¹³⁹ Achrelius 1682, p. 363. Leikola 1983, p. 196-198. Hatfield 1992, p. 342-343.

Achrelius is not quite consistent here, stating on consecutive pages that emotions originate first in the brain from various "impressions" found there, and then in the heart from where the emotions would surge to the brain through nerves.¹⁴⁰ In any case Achrelius agrees that *glandula pinealis* was the organ in brain which was the "information-managing centre" of man.¹⁴¹ At Turku there had been very little interest in the study of the emotions of man in traditional psychology (in the form in which it was a part of physics). If emotions were discussed at all, it was done in connection with the *facultas appetens* of the sensitive soul.¹⁴² But the Scholastic and Cartesian theories of emotions - especially as Achrelius' by no means represents a mechanical explanation - do not necessarily contradict each other if considered from a sufficiently general point of view. As faculties of the sensitive soul, emotions were fundamentally based on matter. Because they were common both to men and animals they could not be a part of the rational soul, which alone was immortal. The physiological if not mechanical explanation of the origin of emotions as presented by Achrelius is, therefore, in a sense only an extension of the old theories.¹⁴³

No matter how openly Achrelius presented these Cartesian theories, he was by no means a Cartesian. Achrelius did not support dualism, nor did the use of these theories presuppose it. On the whole Achrelius' thinking rejects the main ideas of Cartesianism, but as a self-proclaimed eclectic he made use of suitable parts of the philosophy.¹⁴⁴ In fact, some later proponents of the theory of the circulation of blood seem to be more devoted adherents of Cartesian philosophy than Ach-

¹⁴⁰ Achrelius 1682, p. 355-356. "Sequentur nunc *passiones animae, quae mentem humanam commovent & agitant, per ipsos spirituum motus*: oriuntur in cerebro è variis impressionibus, quae fiunt absque voluntatis concursu." "Observamus, *passiones in corde perceptas surgere in cerebrum per nervorum scalas, ibi residere, illud etiam turbare.*"

¹⁴¹ Achrelius 1682, p. 356. "...ubi *glandula* quaedam stabulatur, quae alias spiritus animales excipit, & imagines ex corporeis rebus venientes, in se unit: in ista vero, animam specialius functiones suas exercere, *percipiendo & volendo*, existimant eruditi." Achrelius (p. 359) also urges reading more of Descartes' *Passiones animae* and *De Homine*.

¹⁴² See e.g. Gezelius 1672, p. 296-297.

¹⁴³ Cf. e.g. Miltopaeus-Pryss 1668, passim. Th. VI "Affectus enim cum motione sanguinis, spirituum & alicujus partis corporeae alteratione fiunt. Motus vero voluntatis vel mentis nullus cum mutatione corporis primo fit..." On Descartes' mechanical physiology and psychology in general see Hatfield 1992.

¹⁴⁴ Achrelius 1682, Cordate et Candide Lector, b3.

relius could ever have been. In his *De sensibus* Andreas Lundius presented perhaps the most thorough-going apology ever for the Cartesian physiology at Turku. The contents of Lundius' theses will be dealt with in the next section of this study, so that it is enough only to mention it here. A year after Lundius' theses another proponent of Cartesian physiology emerged.

Laurentius Gezelius was himself the author of his dissertation on blood published under Hahn's direction.¹⁴⁵ He readily boasts his preference for the new philosophies:

As in the following I shall be studying the movement of blood, I can see how wide open is the road to error. Therefore I prefer to follow a guide on this expedition than to start off without any direction. I shall listen to the new Philosophers, who say this [circulation of blood] occurs by the virtue of an innate fire. Cartesius shall show us the way, and I shall put much stress on his opinions or illustrations or exclusions, as stands in his peculiar book *De Homine*.¹⁴⁶

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As I have shown previously in this work, Gezelius' views on the circulation of blood are in fact less directly Cartesian. On the question of the different colours of arterial and venal blood Gezelius also proclaims his reliance on the Cartesian theory of colours. The "man of intellectual sharpness, Cartesius" claims that colours are nothing but "various modes in which the objects send their images and are received by the eyes".¹⁴⁷ Achrelius had in his *Contemplationes mundi* given a slightly broader explanation of Cartesian colour-theory, but he dismissed it as false in its fundamentals.¹⁴⁸ Gezelius on the other

¹⁴⁵ On Gezelius see also Leikola 1983, p. 203.

¹⁴⁶ Hahn-Gezelius 1691, p. 8. "In successionis ordinem circa sanguinis motum inquisituro, video quam lata pateat errandi via. Quicunque ergo sit, duces potius in hac expeditione sequor, quam ut sine duce ovans incedam, audio novos Philosophos, qui beneficio ignis innati fieri hoc ajunt, edocti viam ab ipso Cartesio, cujus verba in majorem opinionis sive illustrationem sive exclusionem adduco, prout habentur in peculiari ejus *De Hom.* p.m.4."

¹⁴⁷ Hahn-Gezelius 1691, p. 13,15. "*vir ingenio ac acumine inclutus Cartesius*" "*diversos modos, quibus hoc illos [species] recipit & remittit ad oculos*".

¹⁴⁸ Achrelius 1682, p. 282-284. The question was about the colours of plants, and several colour theories are weighed, among them those of e.g. Willis and Paracelsus. Sennert's "chemical" theory is accepted, but Cartesius' theory rejected as follows: "Ita Chartesiana, accidentia cum substantijs, abstracta cum concretis, cau-

hand applies the Cartesian theories much less than he claims to do and the Cartesianism included in his work is far more vague than one could expect. What is notable is that the name of Descartes is invoked quite explicitly and positively.

Other psychological processes such as emotions could also be explained by referring to physiology. In December 1697 Jacob Hildeen disputed on the causes of differing philosophical opinions. One wonders if he did not get inducement for this work from the quarrels concerning Rudeen's theses earlier in the same year. According to Hildeen the causes for diverging opinions were partially in the different function of peoples' intellects. One factor which heavily influenced the constitution of blood, spirits and brain - and thus the function of the intellect - was changes in the atmosphere. These changes, says Hildeen, had been verified by Cartesius and de la Forge with the help of the barometer.¹⁴⁹ In his search for the causes of varying opinions in philosophy Hildeen refers very often both to Descartes and other Cartesians, and to Bacon. Although the contents of Hildeen's thesis are otherwise not particularly Cartesian, and in some aspects it is also very critical of Cartesianism, it is remarkable that Cartesian authors were willingly referred to. The same holds true for Petrus Wiikholm's thesis on sleep, which he claims is caused by a relative defect of animal spirits in the brain. These spirits are material particles, and their movements are described in Cartesian terms.¹⁵⁰

Medicine and physiology were strong fields of Cartesianism. At the University of Uppsala especially it was the Faculty of Medicine which from the outset was very active in promoting Cartesian philosophy. By the time Achrelius presented the theories of the circulation of blood and of the origin of emotions it had been established as a medical philosophy. At Turku, however, where the Faculty of Medicine was a mere formality without proper content, and only a few dissertations on physiology or other medical subjects were published in Physics, Cartesianism did naturally not gain such a strong position - not even in medicine.

It is typical of those medical dissertations in which Cartesianism played an important role that they do not presuppose engaging in the more sensitive tenets of Cartesian philosophy. Lundius, whom we shall

sam principalem cum instrumentali confundit."

¹⁴⁹ Hahn-Hildeen 1697, p. 14-16.

¹⁵⁰ Hahn-Wiikholm 1705, passim.

briefly meet, was the only physiologist openly to proclaim dualism. Some subjects, such as the question of the role of the pineal gland in the transactions between the soul and the body, came closer to the boundary line between the acceptable and the refutable. During the 1690's, the problem of dualism was more widely discussed.

4. THE BREAKTHROUGH OF CARTESIANISM

In 1689 the king ordained a statute which allowed the free use of philosophy at Universities unless religion was harassed. Many Cartesians seem to have understood this as supporting their own practices. It was only after this date that Cartesian tendencies at the University of Turku became more and more overt. Cartesianism was not embraced without strong opposition, though. In this chapter we shall have a look at the time during the 1690's and after, when Cartesianism slowly but steadily made its way through the barricade of Aristotelianism.

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Brawly Lundius' Cartesian Enthusiasm

Only one year after the publication of the king's statute the academic peace at Turku was shaken by a young student from Uppsala, Andreas Lundius. He got into a fistfight soon after the publication of his strongly Cartesian thesis. The trial following the incident was long discussed in the Senate. It was not formally aimed against Lundius' Cartesian views, although they played a role in creating the conflict. Lundius' thesis *was* strikingly Cartesian, and it is of course tempting to see this in a causal relation to the fact that soon after the ventilation of his dissertation he got involved in a serious fight. However, I shall claim that even here other factors than Cartesianism also played a role. The main features of this incident have been discussed recently, so we shall only briefly discuss the outward course of events later in this subsection.¹⁵¹

Lundius arrived in Turku from Uppsala in 1688, and he defended his thesis (obviously written by himself) on the senses of man on the 16th May 1690 in physics. Although Lundius praised Descartes vo-

lubly, he emphasised his own independence from any dogma and denied wishing to break the highly-valued academic peace.¹⁵² In his *gratulatio* professor Daniel Achrelius also mocked the scholastic method and declared that when seeking for the Truth a scholar must not depend on any philosophical sects. Achrelius was not a Cartesian, but he was perhaps more ready to criticise various forms of scholasticism than many other scholars at Turku were. He had himself been eager to adopt ways of thinking which differed from the scholastic traditions.

Lundius declares Cartesian dualism in explicit terms in the very preface of his thesis. This passage is the first at Turku where this standpoint was stated positively, and hence worth quoting at length. Lundius wants to define man's nature by comparison with angels.

This [man's nature] is composed of two entirely different essences and thus it is not one thing by nature like an Angel is, because an angel does not need anything else to its angelic nature except spiritual being and negation of extension. It is the unity of the composite of soul and body which together constitutes a man. I trust that nobody who has a judicial mind denies that these two substances really differ from each other, because it belongs to the nature of a corporeal body to have three dimensions, that is to be extended in length, width and depth. It is divisible into parts, it has magnitude, figure, place, motion and so forth. The soul also has in profusion those features which constitute its nature, and nothing which pertains to the nature of a body can be discerned in soul. Soul is a thinking thing, or a thing armed with intellection and volition, and I cannot think of the essence of the soul without cogitation for the slightest moment. Its attributes are intellection, volition, perception, apprehension, immortality, indivisibility, negation of extension into length, width and depth, and so forth, and if the diversity of these essences is weighed in the balance of free judgement, it cannot be anything but clear to everyone that these substances are farther away

¹⁵¹ Klinge 1987, p. 419-421, 426. See also Salminen 1983, p. 66-67.

¹⁵² In Hahn-Lundius 1690, *Apologia Ad Lectorem*. "Aristotelicae servitutis jugum meae cervici non imponetur. Cartesius etiam esto Philosophorum omnium princeps, sapientiae in nubibus aquila, literarum Hercules & abstrusioris naturae summus imperator; ejus tamen mancipium minime me dico: semper sollicitus fui quomodo è sentibus & tricis praëjudiciorum pedem expediendo, viam ad sapientiae ac Aesculapii Templum mihi munirem. Ex communi pleraque hausi fonte; vasculo tamen meo."

from each other than the heaven is from the earth, and that they differ from each other more than fire differs from water, and the hardest stone from the most tenuous air.¹⁵³

Lundius divides man's attributes into three classes: firstly there are those which pertain only to the soul, secondly those belonging to the body only, and thirdly, a class of properties which are common to mind and body. It is this third class of sensations and appetites which Lundius wants to turn his attention to.¹⁵⁴

As far as the basic traditional elements demanded for the formation of a perception are concerned, Lundius' account agrees with the Aristotelian theory. Sensible objects, medium and sense organs all play an important role both for the traditional Aristotelians and for Lundius. At this stage it is more or less a question of just providing an alternative, mechanical explanation to the established theory. Lundius states that each sensible object produces an image of itself by emitting a subtle *effluvium*, which reaches our sense organs by local motion so that the necessary contact between the object and the sense organ is established.¹⁵⁵ This idea seems very Democritean, and Lundius indeed refers at this point to the ancient atomists Democritus, Epicurus, and the 17th-century philosopher Kenelm Digby. Descartes discerned three stages in the perception process depending on the extent to which

¹⁵³ Hahn-Lundius 1690, Adsertum Prooemiale. "Hic compositus est è duabus diversissimis essentiis, & sic non est res una, scilicet unitate naturae, sicut Angelus est unum quid, utpote, qui ad essentiam suam angelicam nihil requirit praeter spiritualement esse, & negationem extensionis; sed unitate compositionis ex anima & corpore organico, quae duo unum constituunt hominem. has autem substantias realiter inter se differre, neminem sani iudicii inficias iturum confido. nam corpori ad sui naturam corpoream nihil deest, ejus a natura est, habere trinam dimensionem, in longum, latum & profundum esse extensum, esse in partes divisibile, habere magnitudinem, figuram, situm, motum, &c. Anima etiam omnia, sui naturam constituentia, abunde habet, nihilque in ea concipi potest, quod corporis naturam redolet. haec nihil aliud est, quam res cogitans, seu res intellectu & voluntate praedita, cujus essentiam ne minimo quidem momento absque cogitatione concipere possum. Ejus adtributa sunt: Intellectus, voluntas, perceptio, apprehensio, immortalitas, indivisibilitas, extensionis in longum latum & profundum negatio &c. Et sic harum essentialium diversitate ad stateram liberioris iudicii adpensa, non poterit non cuius in aprico esse hasce substantias longius inter se, quam coelum & terram distare, magisque quam ignem & aquam, lapidem durissimum & aerem tenuissimum inter se differre."

¹⁵⁴ Hahn-Lundius 1690, Adsertum Prooemiale.

¹⁵⁵ Hahn-Lundius 1690, p. 3.

different substances participated in it.¹⁵⁶ Lundius adopts this view, which also corresponds to the order in which a sensation proceeds physically.

The first phase in the birth of sensation is entirely physical. To begin with, a motion of the sense organs and "animal spirits" in the nerves is required. This motion is excited by external sensible objects. However, the motion of the material particles in the sense organs is usually so slight that we cannot experience it as movement. Here we can see a radical difference with the Aristotelian theory. Whereas the Aristotelians could accept only immaterial forms or species entering the sense organs, here we have a real contact caused by the activity of material particles stimulating the organ. The second stage in sensation, perception, involves both substances, mind and matter. It is also caused by local motion of the spirits, which run through the nerves to the *sensorium commune*, situated in the pineal gland. The spirits print certain characters into the brain and thereby offer the mind "an occasion" to inspect the information produced by the sense organs. If mind "pays attention" to the "occasion", the perceived information reaches the final stage, which is purely dependent on the soul-substance. In reality these stages could not be discerned in the process of sensation, although conceptual divisions could be made. Approaching again the Aristotelian concepts Lundius also stresses the point that the faculty of perception is only one in man, although the senses might be different.¹⁵⁷ Like the scholastics, Lundius trusts the ultimate ability of perception to produce reliable knowledge. It is our mind which is susceptible to erraneous judgements.¹⁵⁸

The second stage of the perception process was notoriously difficult for Cartesians, because it presupposed interaction of the two radically different substances. Descartes himself did not see his dualism causing any problems in this respect. According to him the whole problem arose from the false supposition that two different substances could not interact. In other words we could know *that* they interacted, but

¹⁵⁶ Hatfield 1992, p. 350-353.

¹⁵⁷ Hahn-Lundius 1690, p. 7-8. It was in accordance with the Aristotelian dogma accepted at Turku to claim that there was only one sensitive faculty in man, although the organs were different.

¹⁵⁸ Hahn-Lundius 1690, p. 4-6. "Et sic nunquam error nisi in 3. gradu deprehenditur. ...Quinimo sine ulla ratione erroris sensus inculantur, nam si objectum, medium & organum sint, justo & debito modo disposita, nullus sensus decipitur."

not how *they* did it.¹⁵⁹ Nevertheless the problem continued to occupy many other 17th-century philosophers. Lundius evades the question in a way not dissimilar to many other Cartesians.

*The soul and the body work alternately, so that certain movements which originate in the body border on the soul. Certain ideas in the soul correspond to these movements, but the ideas in mind limit themselves to the point where they meet the body. In the same way certain movements in the body correspond to these ideas. We cannot explain this mutual reaction in any other way except that the Creator wanted to connect these two extremely different essences in this way, between which there is no other connection and proportion.*¹⁶⁰

The mind-body problem is briefly dealt with by Lundius from an entirely different point of view also, which illustrates the ultimate difference between the substances. Lundius remarks that the mind or soul has no absolute power over the body. This is evident from various illnesses such as epilepsy, which was according to Lundius caused by an uncontrollable flux of spirits. Lundius also notes that many basic physiological functions were quite independent of our thought.¹⁶¹

After the general discussion of the nature of perception Lundius moves on to study the senses one by one. He first turns to discover the physiological properties of the tactile sense, explaining how it consists of a net of small glands and nerves spread everywhere on the skin. For Cartesians the sense of touch was the most important of all senses, because all sensation was based on the motion of particles. As Lundius puts it, "There is no sense, which would not presuppose the existence of tactile sense."¹⁶² Lundius regards sight as the next

¹⁵⁹ Wagner 1993.

¹⁶⁰ Hahn-Lundius 1690, p. 5-6. "*Anima & corpus agunt in se invicem, adeo ut certi motus in corpore excitati terminentur in anima, quibus motib. certae ideae in anima respondent, & animae ideae desinant in corpore, quibus ideis parili modo certi corporis motus respondent. Et hanc mutuam reactionem non aliter explicare valemus, quam quod conditor ita voluit adeo diversissimas essentias, inter quas connexio & proportio nulla, connectere.*" Lundius refers here to Le Grand, Heereboord and Clauberg.

¹⁶¹ Hahn-Lundius 1690, p. 7. "*Motum etiam intestinorum peristalticum, cordis systolen & diastolen, circulationem sanguinis non novit, multo minus impedire potest [anima].*"

¹⁶² Hahn-Lundius 1690, p. 9. "*Nullum namque datur sensus qui non praesupponat tactum.*"

most important sense, and he describes the anatomy of the eye in an exceptionally detailed manner. Lundius had obviously been present at the dissection of a bull's eye, performed by the professor of medicine Andreas Drossander at Uppsala.¹⁶³ Anatomical details of the number of nerves and the composition of the eye's humours merge with optical speculation in Lundius' text. The Cartesian theory of sight agreed with the intromission theory, which had been the mainstream optical theory among scholastics.¹⁶⁴ The rest of the senses, hearing, taste and smell are caused by various movements of tiny material particles as well.¹⁶⁵

The third part of Lundius' thesis deals with the "internal senses" of man. In practice this part consists of a description of the anatomy of the brain, which is considered to be the centre of the nervous system. Contrary to the Aristotelian tradition, which asserted that memory, fantasy and common sense were separate entities, Lundius discerns only one internal sense in man which expresses itself in three kinds of functions: *sensus communis*, imagination and memory. All these are corporeal in the sense that they are caused by various motions of the spirits, which impress images upon the brain matter. But according to the definition Lundius gave at the beginning of the thesis, perception was a process which pertained to both of the substances, mind and body. It remains a little unclear from Lundius' text, in which way mind is supposed to participate in sense perception. Presumably the only connection is implied in the occasionalist theory, according to which the faculties "give occasion" for the mind to inspect the various images impressed on the brain. Without the inspection of the mind we would be unconscious of any perceptions handled by the body.¹⁶⁶

One of the main points of the Cartesian theory of perception was that it invalidated the traditional understanding of sensible qualities. According to the Cartesian theory a distinction had to be made be-

¹⁶³ Hahn-Lundius 1690, p. 9, 12.

¹⁶⁴ Hahn-Lundius 1690, p. 11-14. Hatfield 1992, p. 351.

¹⁶⁵ Hahn-Lundius 1690, p. 14-18. "Fit igitur sonus ex aëris concussione & agitatione, ex qua subtilissimae aëris particulae segregantur, quae peculiarem motum tremulum & undulationes varias accipiunt, quae ad auditus organum deferuntur atque inibi variis modis praeparatae & temperatae ad sensorium demum per nervum auditorium deducuntur." (p. 15-16) "Et sic sapor nihil aliud est quam convenientia atomorum rei sapidae cum poris seu papillarum linguae, salem imbibentius." (p. 17) "Fit igitur odoratus hoc modo: Effluvia illa subtilissima e corporibus odoriferis promanantia membranam percellunt, ubi fibrillae nervae olfactoriae illa excipit & per os cribriforme ad sensorium commune deducit." (p. 18)

¹⁶⁶ Hahn-Lundius 1690, p. 18-23.

tween the objects which caused our perceptions and the experiences we have of them. Sense experience could not give us any information about the real properties of physical bodies. All that was really present in the external world were variations of motion and figure, but our senses nevertheless give us ideas of sound, colour, and so on. Qualities like colour, taste and sound were only secondary, i.e. they had certain existence only in our experience but not necessarily in the outside world.¹⁶⁷ In addition to his scepticism on the ontological level Descartes tried to abolish the Aristotelian qualities in his physics too. Although no real qualities as such existed, our sense perceptions were not merely hallucinations in so far as all sensible "qualities" could be reduced to the movements of tiny material particles. This aspect was thus essential for the entire Cartesian system. What kind of a stand did Lundius adopt on the question of the reality of qualities? He deals with the question only in passing when discussing vision. Although he agrees with the Cartesians about the cause of perception, the conclusion he draws is ostensibly contrary to the Cartesian one.

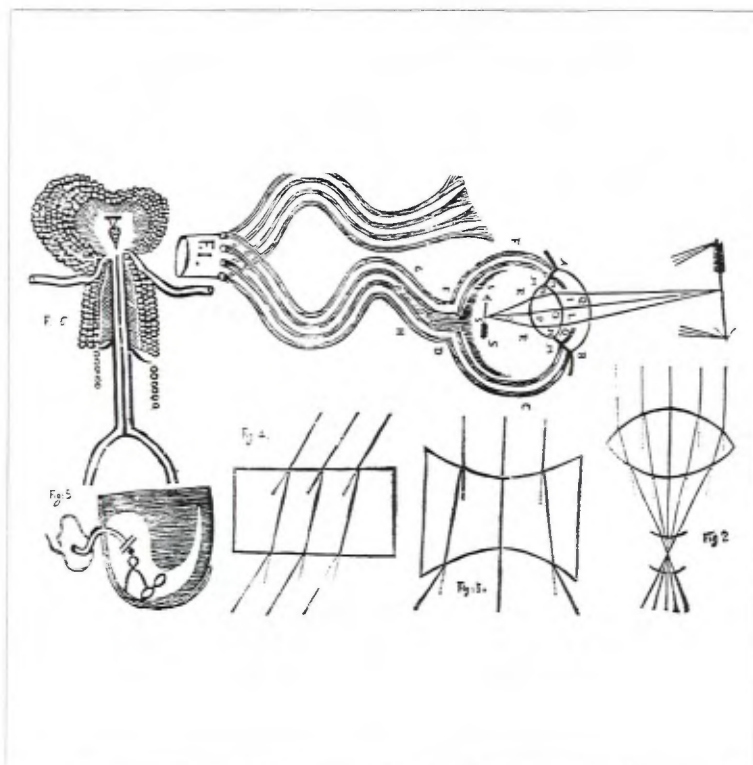
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Vision does not occur by emission of rays but by reception of them. It is enough for vision to receive some rays, namely those which cross the pupil, and it does not need all rays which proceed from the object. It is here in the vestibule where all the colours have their origin. They are caused by various reflexions and refractions, which are modifications of light conforming with the object according to certain laws. *From here it also follows that all colours are equally real, and not some real and some others apparent and false, as it is generally believed.*¹⁶⁸

It is difficult to say whether Lundius really wants to conclude here that all qualities are real in the traditional meaning of "real" which supposes them to be certain characteristics of an external body. On the other hand Lundius here certainly does what Descartes also did

¹⁶⁷ For discussion of Descartes' primary and secondary qualities see Hutchison 1982, p. 242-243. Clarke 1989, p. 48-51, 71, et passim. Wilson 1993.

¹⁶⁸ Hahn-Lundius 1690, p. 14. "Quocirca visio fit receptione radiorum non emissione. Satis est quosdam radios, non omnes ex objecto prodeuntes visioni inservire, nempe illos qui pupillam trajiciunt. Hinc in propatulo est omnes colores originem debere variis reflexionum & refractionum legibus, quae iterum modificatio luminis objecti conformationi debetur. unde etiam patet omnes colores esse aequae reales, non quosdam apparentes & falsos. ut vulgò creditur."



Andreas Lundius' Cartesian dissertation on the senses is also exceptional for its illustration. Traditionally a picture was more or less just for ornamentation or simply presented the object discussed. Lundius however uses illustration as a part of his argumentation, as can be seen e.g. from his discussion on the vision. Capital letters in the text refer to corresponding letters in the picture. This practice so to speak geometricises the argument and creates an impression of exactitude.

❧ II ❧
CAP. II. De Visu.

§. I.

Hic ceteris ut dignitate & usui, ita etiam ordine prior censeri debet. Quocirca primum oculi artificiosissimam structuram & partes, (quæ sunt: tunica 3, humores 3, nervi 7. quorum unus est visorius, 6. motorii, musculi 6. quorum iidem 4. recti, 2. obliqui) dein modum visionis oculorum & animi judicio paucis subijcere animus est. videatur etiam in hujus rei meliorem perceptionem fig. 1. utut ruditer delineata.

§. II. 1. FIGURA oculi est orbicularis ABCDEF cujus pars antica FABC a quovis potest videri, postica pars CDEF priori major, intra os capitis lateat. 2. Tunicæ 3. numerantur, quæ ex nervo optico oriri vulgo creduntur ad eum ut nervus in varias diductus membranas oculi globum constituat. Quarum prima CORNEA, quæ nihil aliud est quam duræ matris propago, & omnes cerebro exeuntes nervos tegit, totumq; oculum ambit, cujus anterior pars AB diaphana instar cornu, CORNEA dicitur; posterior pars BCD EFA opaca & densa est, & vocatur SCLEROTICA. Alia membrana pericranio orta, & ad pupillæ usq; foramen extenta, ADNATA dicta, seu ALBUM OCULI, ob album colorem, Corneam orbitæ ossibus adligat, nam est ex musculorum tendinibus contexta: Hæc sua opacitate hoc præstat, ut justo plus lucis per corneam in oculum non penetrat. Cornea aliquantulum antrorsum prominet, ut radii refractione collecti pupillam subeant; alias si plana esset & depressa, solum illa, quæ a fronte sunt, videremus, non etiam illa, quæ a lateribus. SECUNDA AILB UVEA seu choroides dicitur & est pizæ matris propago, in anteriori parte IL perforata, quod foramen PUPILLA dicitur. In hac notamus LIGAMETA CILIARIA MNMN, seu filamenta quædam nigra, quæ humorem crystallinum suspensum tenent. Pu-

B 2

pilla

in assuring all perceptions a similar status. Lundius' remark that some colours are not apparent and some real refers in any case to the distinction which was traditionally made between colours caused by particles of sulphur (real colours) and the apparent colours caused "only" by reflections of light.

Lundius' thesis was in many respects a forerunner of the new philosophy at Turku. First of all it of course showed relatively profound knowledge of the latest anatomy and physiology. Lundius refers extensively to such authors as Antoine Le Grand, Adriaan Heereboord, Johann Clauberg, J.-B. Du Hamel and Jacques Rohault. In anatomy his most respected authorities were Marcello Malpighi, Nicholaus Steno, Thomas Willis and Andreas Drossander, to name just a few of his most important sources.¹⁶⁹ All in all, Lundius was relatively up-to-date. But his thesis differs from the others in another respect too. He does not follow the scholastic order of presentation at all, but builds up a way of presentation of his own.

One would expect that if something was about to meet resistance among more traditional scholars, this kind of exposition of Cartesianism certainly would. However, instead of any public opposition to his ideas it was Lundius' own pugnacious behaviour which led him into difficulties. In the early hours of the 1st of June 1690 Lundius was injured. When the combatants were questioned by the Senate of the University, the following chain of events was reconstructed. Late that night Lundius had started making offensive remarks to his fellow students. He had allegedly claimed that the majority of professors at the University of Turku were uneducated and therefore the students were not much better than grammar school pupils. Lundius had boasted that he would from then on oppose every thesis *extraordinarie*. The angry Lundius had thrown some ashes in a fellow student's face, swords were drawn and consequently Lundius got a bad wound on his head.¹⁷⁰

The Senate of the University handled the case as a mere disciplinary matter. The accusations that Lundius had disparaged professors were

¹⁶⁹ Lundius' profound knowledge of anatomy may be partly credited to his acquaintance with professor Til-Landz. Lundius thanks Til-Landz in the preface of his thesis, and in the row he also mentioned him as the only professor at Turku who understands his ideas.

¹⁷⁰ CAAP VI, p. 590-597, 2. Junii 1690. Lundius seems to have entertained the slightly paranoid idea that other students had conspired against him. p. 593, 597.

considered unsubstantiated.¹⁷¹ Although the incident itself was only indirectly linked with Cartesianism, Lundius' person still represents a violent outburst of the new philosophy at Turku. Being an adherent of Cartesianism he was scornful of the forms of thought he regarded as outdated. Professor Matti Klinge has in his *History of the University* brought up the interesting idea that the row which Lundius caused was considered particularly dangerous, because there were actions afoot against some religious dissidents at the same time. A small group of radical pietists had caused severe disturbance at Turku during the same summer Lundius came from Uppsala to Turku.¹⁷² It was not so much Lundius' Cartesian ideas which were regarded as dangerous. Even more serious was his obvious rebellion against the established academic order and authorities. Just as Ulstadius had questioned the spiritual status of the clergy, Lundius now questioned the learning of the professors.

All in all, the blissful ignorance of the University of Turku of the changing world of learning had started to be sullied. The Chancellor of the University, G.A. de la Gardie was at that time consciously trying to modernise it; it is very characteristic of Turku that the pressure for change came from above. In the 1690's two of the professors nominated were Cartesian. One of them was the professor of medicine, Laurentius Braun (Braunerskiöld having been knighted), who had studied in the Cartesian Faculty of Medicine at Uppsala. The other one was Torsten Rudeen, appointed professor of poetry in 1692.¹⁷³ As a third person the professor of eloquence, Christiern Alander, could be mentioned as a Cartesian arriving from Uppsala. But it was Rudeen's theses that caused one of the real disputes about Cartesianism at the University of Turku. Let us however have a look at the anti-Cartesian discussion of this period first.

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¹⁷¹ CAAP VII, p. 6-8, 10. Julii 1690.

¹⁷² Klinge 1987, p. 426. For example, Laurentius Ulstadius had in 1688 appeared naked in the Cathedral, cursed the Lutheran religion and claimed that the Lutheran clergy lacked touch with the Holy Spirit. Two students, both of whom had studied at Uppsala, shared Ulstadius' views.

¹⁷³ Klinge 1987, p. 421. Klinge mentions that Braun was active in spreading Cartesian ideas at Turku. While this may be true from his other activities, in his only published dissertation he retained old Galenic views. This does not necessarily invalidate his alleged Cartesianism, however, because Descartes adopted quite a lot of Galenic views on physiology. Hatfield 1992, p. 341.

Cartesian Theories Refuted

In the 1690's the emphasis in the criticism of Cartesianism shifted from the notion of substance to the mechanistic explanations of nature. Cartesian epistemology, rationalism and methodical doubt also acquired its first critics in natural philosophy. Let us first turn our attention to Descartes' mechanization of nature. The concept of a mechanistically functioning nature was, of course, based on Descartes' dualistic theory of substance. For Descartes the mechanistic model was the the best way of explaining the phenomena produced by matter. Notoriously Descartes applied this model of explanation to living organisms as well. We cannot here go into details, but obviously Descartes had both theological, metaphysical and physical reasons for rejecting animal souls.¹⁷⁴ The fact that Cartesian philosophy denied animals any kind of a soul was found utterly unacceptable by the Aristotelian scholars at Turku.

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During the previous decade Cartesian mechanistic philosophy had been supposed to lead to animism. In the 1690's, the theory began to be understood the other way round: it would make animals machines by leaving no space for a soul.¹⁷⁵ The first theses asserting this had been published by the very end of the 1680's. Descartes was not the only one to have a mistaken view of the nature of animal soul:

I shall only say that the forms of animals are not rational souls as Pythagoras [claimed], and they are not, as Cartesius claims, blood warmed in the heart and thinned out as spirit. The movements of animals would then arise from the various movements of this spirit. And it is not a kind of small flame, or a more tenuous species of fire, as Gassendi suggests. I strongly refute that they would be created directly by God, be induced from the heavens or arise from matter. These forms are rather of a mediate nature between matter and spirit.¹⁷⁶

¹⁷⁴ Garber 1992, p. 302-303. Clarke 1992, 1989, p. 174-181.

¹⁷⁵ This objection to Cartesian mechanistic philosophy was of course much more common. See e.g. Clarke 1989, p. 27.

¹⁷⁶ Hahn-Ulholm 1689, p. 54. "Hoc solum dicimus, brutorum formas nec esse animam rationalem, ut pythagoras... nec sanguinem in corde calefactum, & in spiritum attenuatum, a cujus motu varii illorum motus proficiscantur, ut Cartesius, nec flammulam quandam, seu tenuissimi ignis speciem, ut Gassendus, nec a Deo immediate nunc creari, a coelo induci e materia educi, pernego, sed illas formas

It was stated that according to Cartesians the material form of animals was made of elementary fire, the material of organic body or subtle blood.¹⁷⁷ Whatever type of corporeal substance the Cartesian "animal soul" might consist of, it was considered unacceptable, because matter was by nature a passive principle and could not organise and inform itself.¹⁷⁸ The argument runs thus on a similar track as the criticism of Cartesian substance had done in the previous decade. The existence of animal soul was also thought to be proved by the great number of different functions performed by the animals, which had emotions and moved voluntarily. Moreover, the Cartesian idea that the material "soul" was located in the pineal gland was considered absurd.¹⁷⁹ Physiological functions could not be the efficient cause of all the actions perceived.

At least two interrelated things were at stake here. The existence of animal souls was of course an ontological question. For the Aristotelians the animal souls were something essentially belonging to the order of nature, and the elimination of their existence meant a radical change in the way the world looked to them. But the existence of animal souls - or substantial forms in general - was also in another way an important question. According to the Aristotelians a form was a central explanatory principle, because all the qualities and functions of, say an animal, were produced by the form. Descartes, who saw the form as attributing "thinking" even to such non-living bodies as stones, strove to expunge substantial forms from all relevance to scientific explanation.¹⁸⁰ Thus we approach the question of what "science" should be like and what kind of explanations would be acceptable. In the scholastic natural philosophy this explanatory model was so deeply rooted that it was indeed impossible to think about proper explanations without the substantial forms. Moreover, much of the theological dogma was dependent on substantial forms in its presentation and explication. The rejection of the animal souls thus threatened a large number of concepts vital to the Aristotelian philosophy and world-view.

esse mediae naturae inter spiritum & materiam."

¹⁷⁷ Hahn-Ruda 1695, p. 6-7. "ex quo hujus mundi elemento sit composita forma brutorum."

¹⁷⁸ Hahn-Ruda 1695, p. 9.

¹⁷⁹ Hahn-Linstorpius 1688, p. 6-7. Hahn-Rungius 1691, §III, et passim. Hahn-Ruda 1695, p. 18-39. Hahn-Hacks 1700, p. 26, et passim. Hahn-Nidelström 1704, p. 10-18, et passim. See also Miltopaeus-Pryss 1668, Th. XIII.

¹⁸⁰ Clarke 1989.

Opinions like those presented by the scholars at Turku reveal how difficult it was to view things in a conceptually new way. Of course, we might suspect that in most cases there was not even willingness to do it. Both mechanistic philosophy and heliocentrism were opposed when the Cartesian vortex model was refuted. We meet the vortex theory for the first time in Jonas Ekedahl's thesis *On Comets* in 1695. Descartes is integrated into the discussion as one of the the scholars who support some form of the theory that comets are actually planets. Ekedahl has a simplified vision of Descartes' theory, but he quite rightly sees it explaining comets as suns/planets moving from one vortex to another. Ekedahl, who considers comets to be extraordinary stars lit by God in order to scare and warn people, does not approve of this view. In Ekedahl's text, the description of Descartes' vortex theory seems to argue for its own impossibility.

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He knowingly tries to draw his conclusions from mere suppositions and Mathematical hypotheses. He then tries to affirm that GOD has impressed motion onto this certain and peculiar Chaos, which as such is immobile. The three elements which he has assumed to exist would then have been formed by this motion, and not only that, the celestial bodies have developed from those very elements, particularly from the first element, which would constitute peculiar orbs or vortices, carrying along and rotating the planets. This most praiseworthy Author says, that it is due to this gyration that Comets move from one vortex to another, and that comets are as old as the entire creation, not in respect to their essence but to their matter.¹⁸¹

Once again we witness a clash between the two different ideas about science proper and scientific explanation. Cartesian theories were implausible because they were based on "mere mathematical hypotheses". Whatever proofs were not based on demonstration, i.e.

¹⁸¹ Hahn-Ekedahl 1695, p. 14. "...ex meris suppositionibus & hypothesibus Mathematicis suas educere conclusiones sedulo conetur, idoque adfirmat DEUM certum atque peculiarem Chaoti, ex se alias immobili, impressisse motum, ut non solum tria illa, quae statuit, generata sint Elementa, sed etiam ex illis Elementis, & quidem praesertim ex primo, corpora coelestia provenerint, quae peculiare nacta sunt orbis seu vortices, quibus circumferrentur atque rotarentur; in qua gyratione, dicit laudatissimus Auctor, quod transeant Cometæ ex uno vortice in alium, sintque temporis creationis, si non quoad totam suam essentiam, tamen quoad ipsam materiam coaevi."

sylogistic reasoning based on indemonstrable premises, were scant opinions or "hypotheses" in the Aristotelian understanding of ideal science. Descartes, on the other hand, tried to give a different kind of status to hypothetical explanation. In his opinion certain knowledge in the sense of Aristotelian *demonstratio* was not attainable from nature. All we could arrive at were hypotheses whose status would nevertheless be more probable than simple guesswork. Part of Descartes' problem of explaining his stance was that in the earlier part of the seventeenth century the concept of probability itself was just emerging.¹⁸²

On the physical level of his argument Ekedahl seems to grasp the elements in their Aristotelian sense and therefore finds a theory, which assumes elements to exist in the supralunar region absurd. His refutation and ridicule do not, however, prevent him from referring positively to Descartes when arguing for the location of comets in the heavens.¹⁸³ Whereas Ekedahl bases his arguments on natural philosophy, Johannes Tålpo prefers to show the incompatibility of the vortex theory with the Bible. His *Qvies coeli*, printed in 1699, saw the Cartesians as the main proponents of the adverse heliocentric system. Nothing in the Bible would support the vortex theory, nor was there any necessity of nature for it. Teleological arguments were not as common in Aristotelian discourse as one might expect, but Tålpo presents one: "Whose benefit would these vortices then serve?"¹⁸⁴ The Bible also produced the best arguments in Tammelin's and Nidelström's thesis where the Cartesian form of heliocentrism was refuted. Neither of these authors accepted Descartes' definition of motion, according to which the Earth would be at rest, because it did not change its position in respect to other particles around it.¹⁸⁵

All in all, no coherent picture of Cartesian astronomy and physics can be formed on the basis of the theses at Turku. Criticism was mainly directed against heliocentrism and the theory of elements in Cartesian natural philosophy. For example, the different concept of motion (not caused by the form) or the plenum theory were discussed only incidentally.¹⁸⁶ There were also themes which were dealt with

¹⁸² Clarke 1989, Ch. 5, 7. Shapiro 1983, Ch. II. Hacking 1978, p. 18-30.

¹⁸³ Hahn-Ekedahl 1695, p. 35-36.

¹⁸⁴ Hahn-Tålpo 1699, p. 15, et passim. "*Cui denique usui inservirent hi vortices?*"

¹⁸⁵ Tammelin-Nidelström 1706, p. 15-17. Hahn-Tålpo 1699, p. 22-29.

¹⁸⁶ Hahn-Tålpo 1699, p. 28. Tammelin-Frostman 1710, p. 27.

even more sporadically.

Although theologians had regarded dualism and methodical doubt as the main problems in Cartesianism for decades, it was only at the very end of the 1680's that these problems were tackled in physics dissertations. In December 1689 Petrus Ring opposed certain views held by some Cartesian theologians about the cognition of angels. Considering the criteria of truth Ring accuses Le Grand and other Cartesians of asserting man's own cognition as the highest criterion. Truth, according to Ring, was not dependent on the cognizing subject, but on the object of cognition. Having a clear and distinct idea would not guarantee certainty.¹⁸⁷ Ring cannot accept the Cartesian view that our mental states (perceptions, judgements) do not necessarily correspond to the entities outside the mind-substance.

Methodical doubt was thus also refuted by Ring. He did, however, make a difference between *methodical* and *hyperbolic* doubt:

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Descartes however differs from the Sceptics in that whereas they remain in their doubt, he tries to use doubt for achieving a better understanding. Whereas doubt is the aim for the Sceptics, for Descartes it is a means for Philosophising. Nevertheless this kind of doubt does not find a place among the legitimate methods, because nothing which is contrary to conscience, such as doubt, cannot decently be used for acquiring scientific knowledge.¹⁸⁸

The threat of atheism was latent in every doubt. Dualism was also criticised sometimes, mainly in connection with questions related to sense perception processes. In addition to this, the location of soul in the pineal gland was still seen as a problem.¹⁸⁹ Although Descartes

¹⁸⁷ Hahn-Ring 1689, p. 40-41. "Hinc errat nobis quam maxime *Ant. le. Grand* cum suo Antesignano Cartesio *Institutionibus Phil.Reg.4.p.11.* dum asserit omnis veritatis regulam ac normam esse propriam cogitationem, adeo, ut id demum pro vero habendum, quod clare & distincte percipitur. ...Idcirco rectissime statuimus, quod pendeat veritas non a subjecto, quod cognoscit, sed ab objecto, quod cognoscitur, quia nullus homo potest esse alicujus scientiae, aut sententiae norma..."

¹⁸⁸ Hahn-Ring 1689, p. 43-44. "Cartesium quidem in hoc a Scepticis differre, quod hi in dubitatione acquiescant, ille intendat ea uti ad meliorem cognitionem, adeo ut dubitatio Scepticis sit finis, Cartesio autem medium Philosophandi: nihilominus autem hujusmodi dubitatio inter legitima media locum non invenit, nihil enim quod est contra conscientiam, sicut dubitatio, potest de jure adhiberi ad scientiam acquirendam."

¹⁸⁹ Hahn-Ruda 1695, p. 26-27, et passim.

did not strictly speaking locate soul in the pineal gland, this naive reading of his theory became common during the 17th century. Locating some particular function of the soul, such as *sensus communis*, to the pineal gland was nevertheless in no way repugnant to the Aristotelians. The opinion expressed by the student Guzelius was typical of solutions of this dilemma: it was the common sense which was the route of sense perceptions into intellection proper, which was located in the pineal gland. The soul itself could remain unlocated.¹⁹⁰

Outright opposition to Cartesianism was by no means an overwhelmingly dominant attitude at Turku. The majority of theses did not comment on Cartesianism in any way.

Cartesian Meteorology

During the 1690's there was a considerable increase in references to Cartesian authors, which did not, however, cause any reactions from the more conservative scholars at the University. This situation raises several questions for the historian of science. First of all, how widely did Cartesian influence spread at Turku and to what extent did it affect learning? How deeply had those authors who frequently refer to Cartesian writings, really adopted the new philosophy? In this subsection we shall bear these questions in mind while at the same time taking a look at Cartesianism in theses on meteorology. Meteorological theses are interesting in respect to Cartesianism, because it was here that the new philosophy gained perhaps most ground at the theoretical level. In this subject Cartesian citations almost overwhelmed some theses.

I have discussed Cartesianism in meteorological dissertations at Turku in a previous article,¹⁹¹ which shows that positive or neutral reference to Cartesian authors does not automatically mean adopting Cartesian ideas. What I find interesting, however, are the several "strategies" which were used in respect to Cartesian theories. At one extreme we have the cases in which Cartesian authors are cited incidentally, with no necessary connection whatsoever to Cartesian philosophy.¹⁹² A more complicated strategy was used e.g. by Magnus Widebeck, who combined pieces of Cartesian and traditional philosophies

¹⁹⁰ Hahn-Guzelius 1696, p. 18-19.

¹⁹¹ Kallinen 1993.

¹⁹² See e.g. Hahn-Heurlin 1702, p. 15, where Le Grand is cited as an authority against the view that a laurel crown could protect man from being hit by lightning.

without ever really committing himself to either view. It was typical of Widebeck to argue against a Cartesian view using a citation from another Cartesian author, and to mix Aristotelian and Cartesian references in a way that they seem to agree where in reality they contradict each other. Cartesian, Aristotelian and Paracelsian theories could be expressed without ever saying, which theory was the right one. One sign of Widebeck's vagueness is also the fact that he very seldom makes any negative judgements either.¹⁹³

What does Widebeck's woolliness reveal? We may ask how much he really understands about the main ideas of Cartesian natural philosophy. Or can we expect his vagueness to be a (semi-)conscious strategy for introducing at least some mechanical explanations? An example shows Widebeck discussing the problem of how the vapour which causes meteorological phenomena rises.

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...and these vapours are (b) not light by their nature, because a propriety of one thing does not become a characteristic of another thing. But this evaporated water rises into the heights because of the fire which it contains, and which really is light. So also *Cartesius* (c) calls vapour water mixed with fire... [(b)= Sperling *Institutiones* 1.5.c.8., (c)= c.4. *Meteora*.]¹⁹⁴

Sperling's view of the question was actually the one which was generally embraced at Turku: the watery vapour rises, because naturally light particles of fire are conjoined to it. On the other hand, Descartes also seems to think that evaporation is caused by minute particles which penetrate the pores in water.¹⁹⁵ The difference between Descartes' and Sperling's views, which Widebeck is either unable to see or does not want to see, is as follows. Sperling's theory is based on the qualitative conception of matter: fiery particles rise because they are light by nature. On the other hand, Descartes' particles of homogeneous matter just move around in the filled-up universe according to the mechanical laws and without any natural goal what-

¹⁹³ Hahn-Widebeck 1702, p. 6, 8-11, 13, 22, 31, 40, et passim.

¹⁹⁴ Hahn-Widebeck 1702, p. 13. "...sunt hi vapores (b) leves non tamen sua natura, propria enim unius non fiunt propria alterius; sed propter ignem quem continent qui verè levis est, hic resolutam aqvam in sublime vehit, ideo etiam *Cartesius* (c) *vaporem aqvam igni commistam adpellat*... [(b)= Sperl. Inst. 1.5.c.8., (c)= c.4. *Meteor.*]"

¹⁹⁵ Sperling 1663, p. 508. Descartes 1644, p. 215, et passim.

soever. However, the second law of motion in the *Principles* shows that particles tend to preserve their motion in straight lines. Thus, there is a tendency for a body in curvilinear motion to recede from the center of rotation; a phenomenon which was later to be called centrifugal force.¹⁹⁶ It is in this sense that the particles from the surface of the rotating Earth "tend" to rise upwards.

If Widebeck's views were in the most cases close to the traditional theories (at least as far as it can be judged from his text), there were other authors who were more eager to adopt Cartesian theories. Still it is true that despite the frequent citations of Cartesian authors the Cartesian ideas do not strike the eye. It is only in small details of the theories that one can pick up the scent of Cartesianism. However, very fundamental questions concerning the nature of motion and nature's laws lie disguised in these cursory questions. In Sveno Melander's¹⁹⁷ thesis on lightning Cartesianism was once again involved in the question about the nature of the power which draws the vapours and exhalations upwards. Melander writes:

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...it can be judged that exhalations, which blow from the subterranean caverns into the heights, conjoin there [under earth] with a most subtle matter, which Descartes calls matter of the prime element. And it is natural for this element to move very rapidly...¹⁹⁸

It seems that Melander has now replaced the traditional fiery particle with a Cartesian, rapidly moving "first element". According to Melander it was an inherent property of fine matter to move upwards. Once again Descartes' theory of quickly moving "first elements" has been wrongly understood to be inherently movable. The attractive force of the Sun had so often been favoured as an explanation for the rising of vapours by the more traditional commentators. Relying on Du Hamel's text Melander claims that this was mere fiction, because

¹⁹⁶ Garber 1992, p. 312-316.

¹⁹⁷ Of the three students discussed in this subsection only Melander had studied for a while at Uppsala. Lagus 1890, p. 241 mentions that Melander had gone through deposition ceremonies there. The same roll by no means implies that Widebeck and Pryss would have studied there. See Lagus 1890, p. 230, 302.

¹⁹⁸ Hahn-Melander 1693, p. 15-16. "...existimandum est, exhalationes, quae ex cavernis subterraneis in altum transpirant, ibi conjungi cum materia subtilissima, quam Cartesius materiam primi elementi appellat, eique innatare, quae celerrimae est agilitatis..."

attraction could not be explained physically. It was more probable that the Sun's rays extract vapours mechanically, by some kind of percussive force.¹⁹⁹ Melander thus does not have an unambiguous explanation, but proposes several theories. It remains unclear whether they were alternative or mutually complementary. Although Melander preserves the Sennertian understanding of matter, the attractive forces do not appeal to him any more.

Melander prefers mechanical explanations in other theories also. According to the traditional view, thunderstorms were generated by the fraction and inflammation of certain "chemical" substances ("nitre" and "sulphur") in the air. Melander's view of the question is a simplified Cartesian one: there are clouds at different heights from the surface of the earth. The upper clouds are surrounded by a warm mass of air, which condenses the cloud. (It is said that this happens in the same way that snow condenses before it melts away.) The thicker cloud gets heavier, and it falls onto the clouds below it. This - according to Melander - causes lightning and often also a downpour. The varieties in the sound of thunder would be caused by the different densities of the colliding clouds and their different speeds. This crudely mechanistic collision theory and the idea of the condensing effect of warmth have both been derived from Descartes. Melander's text even partially follows Descartes' (or some of his disciples') text.²⁰⁰

A third example of the mechanistic explanations adopted by Melander characterises the attitude of Cartesian natural philosophy towards older theories. Since antiquity there had been a theory according to which very hard stones could be generated by a thunderstorm and then fall down to earth. In 17th-century science the existence of these *lapis fulminaris* was still generally acknowledged, although there were differences of opinion about the way the generation was presumed to take place. Descartes did not dispute the existence of these stones, but explained them on his own premises. In fact, the theory of thunderstones was an excellent paradigmatic case for the Cartesians: if stones could be generated mechanically in the air, why would it not be possible that over a much longer time the whole universe could have emerged from moving particles. Melander accepts the Cartesian theory and he even summarises the experiment described by Descartes

¹⁹⁹ Hahn-Melander 1693, p. 13-14.

²⁰⁰ Hahn-Melander 1693, p. 23-25, 31-32. Descartes 1644, p. 260, 282-283.

in which a thunderstone is generated by burning clay and some explosive materials.²⁰¹

Although Melander adopted some mechanistic explanations from Descartes, he was by no means a pure Cartesian. For example Melander's understanding of matter is still based on the traditional theory of elements. Like Widebeck, he also proposed several contradictory theories as explanations of certain phenomena. One reason why both Melander and Widebeck stay relatively close to the old ideas may be their sources. Most authors cited by them, e.g. Clauberg, Du Hamel and Le Grand were not orthodox Cartesians themselves, but they were proponents of the so-called Cartesian scholasticism, a philosophical movement which tried to reconcile Aristotelian and Cartesian philosophies or at least to make Cartesian ideas more palatable to Aristotelians by presenting them in Aristotelian terminology. In fact, some Cartesians claimed that their eclectic method represented an unadulterated and a more original form of Aristotelianism than scholasticism did.²⁰² By no means all exponents of the Cartesian system adopted it in its entirety, but modified and developed it in order to meet their various philosophical expectations.²⁰³

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It is, however, a trivial explanation for Widebeck's and Melander's behaviour to refer to the eclectic character of their sources. We may ask how deeply Widebeck and Melander were actually versed in Cartesian philosophy, and whether they really did understand in what respect Cartesian natural philosophical principles differed from the Aristotelian ones. If Melander and Widebeck really read those Cartesian books they refer to, they at least had a chance to learn the main features of Cartesian physics. Information was of course spread also by those theses in which Cartesianism was opposed, albeit that Cartesian theories were not always presented correctly in them. Granting this, we are still left facing two equally plausible, if possibly intertwining ways of interpreting this situation. On one hand I would be tempted to read Widebeck's hesitation to mean that he did not have a very profound understanding of Cartesian physics. This would then have contributed to his difficulty in deciding between the old and new explanations. Not being entirely content with the Aristotelian-Senner-

201 Hahn-Melander 1693, p. 36-37. Descartes 1644, p. 285-286.

202 Bohatec 1912, p. 22, et passim.

203 Brockliss 1981, 1987. Clarke 1989, p. 17-18, et passim.

tian theories either, Widebeck adopted this strategy of balancing between the two.

On the other hand it is possible that our authors have sometimes quite consciously selected and adopted only certain kinds of information from their sources. Only such knowledge would be openly presented as Cartesian as could be interpreted through the Aristotelian-Sennertian framework. Whether this procedure did full justice to either of the philosophies may well be doubted. All in all, it is relatively harmless ideas which have been advanced - there is no talk e.g. about dualism or methodical doubt. Mechanistic explanations had been criticised before, but these mechanistic theories in no way threatened the Aristotelian concept of substance or the status of the four elements as e.g. the vortex theory had done.

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Why then did Melander and Widebeck cite Cartesian authors so frequently, if they were not ready to accept all the most fundamental principles of the philosophy? Did they want to follow the example of their sources and reconcile the two philosophies? At least Widebeck did not believe this was possible for him, although it might have been possible for a *magis ingenii vir*.²⁰⁴ It seems more probable that the old philosophical system had simply lost much of its vigour, but a new system had not made a complete breakthrough either. Breaking away from the conceptual system of the Aristotelian philosophy hardly was an achievement for which an ordinary student's intellectual capacity and courage were sufficient. Probably there was also a lot of genuine uncertainty about which of the philosophies gave better answers in physics. A general trend seems to have been to recast Cartesian ideas in terms of the Aristotelian system and not *vice versa*. The eclectic natural philosophy of the time allowed many kinds of theories to be suggested as long as the fundamental principles of the Aristotelian philosophy were left untouched.

In meteorology there is still one dissertation which surely is worth noticing. Although Andreas Pryss refers to Cartesian authors only twice²⁰⁵ in his thesis on the rainbow, it is the work which most radically differs from the Aristotelian tradition.²⁰⁶ Pryss studies the causes for

²⁰⁴ Hahn-Widebeck 1702, p. 9.

²⁰⁵ This means that only 7.6% of all citations were Cartesian. Pryss mentions Descartes and Le Grand.

²⁰⁶ Slotte 1898, p. 54-55 mentions this thesis and praises it as one of the best published under the direction of professor Hahn. However, Slotte only refers to the

the genesis of a rainbow. He also examines the places and times when these phenomena usually occur. An important question for Pryss is, what causes the the colours and the peculiar figure of a rainbow. Pryss follows Cartesian physics most directly in his description of the colours of the rainbow. He describes Descartes' experiment in which a single drop of water is imitated by a ball of glass which is set against the sunlight. Referring to his optical laws Descartes tries to show by geometrical reasoning, how different reflections of light give rise to different colours. Pryss has not only adopted these ideas from Descartes, but he has also copied a drawing from Descartes *Dioptrics*, which illustrates the experiment.²⁰⁷ Pryss differs from Descartes in one crucial point, however. Whereas one aim in Descartes' discussion on the rainbow was to show that all colours and qualities were in a sense apparent, Pryss retained the traditional conception of the existence of both apparent and real colours.

Pryss does not confine himself to adopting some theory-level ideas from Descartes, however. It is remarkable that Pryss also applies Cartesian method in his thesis. Externally his thesis looks very traditional, and its disposition is an absolutely exemplary presentation of the traditional method with all its nominal and real definitions, four causes and other categories. However, e.g. in the chapter on the form of the rainbow Pryss totally dismisses scholastic terminology. Instead of mentioning the accidentality or substantiality of the phenomenon Pryss describes how straight, refracted and reflected rays of light behave in making a rainbow.²⁰⁸ Even more striking is the fact that Pryss tries to handle all problems which are amenable to such procedures geometrically.

Pryss seems to have chosen his methodological and theoretical guidelines fully knowing where they would lead him. He was a talented student, who soon after his graduation (1694) became an assistant of the Faculty of Philosophy (1698), and was finally appointed professor of eloquence in 1706.²⁰⁹ Pryss' thesis was actually the first at Turku in which mathematical method was used in solving a physical problem. Despite its pioneering contents it seems to be relatively certain

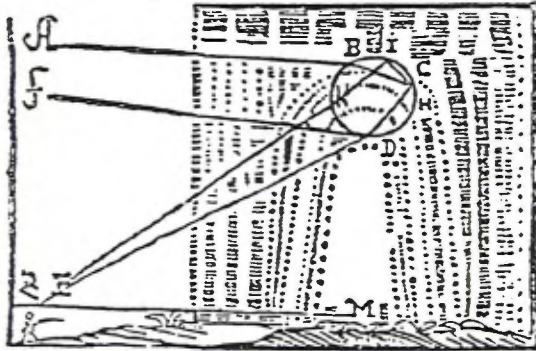
work perfunctorily and without paying any attention at all to the Cartesian contents and its unusual method.

²⁰⁷ Hahn-Pryss 1691, p. 11-13. Descartes 1644, p. 291-295.

²⁰⁸ Hahn-Pryss 1691, p. 6-7.

²⁰⁹ Lagus 1890, p. 230.

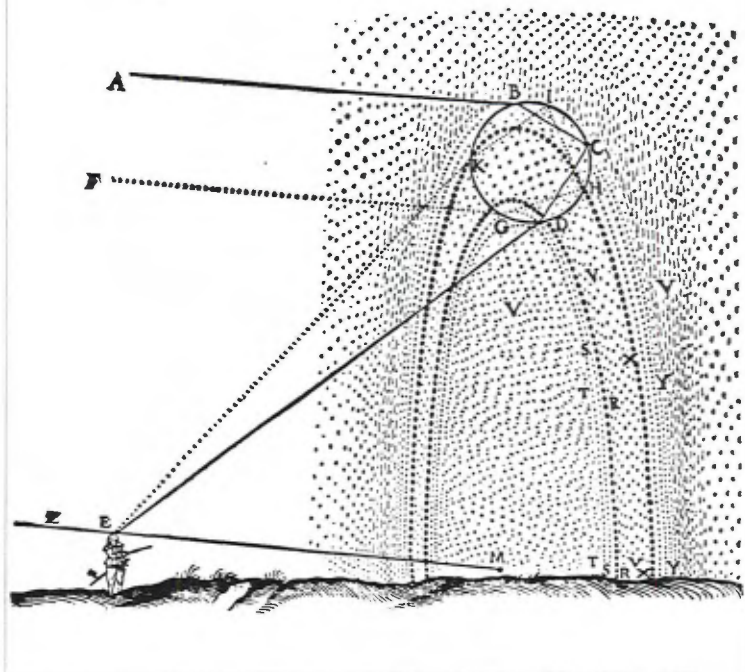
Parte Sexta C. 18. id ostendere placet; Ampullam Vitream, cujus adinstar se habent singulæ guttarum, Aqua limpida impleam B C D soli exponamus, deprehendemus *Sole* ex parte Cæli A F Z radiante & *Oculo* in Puncto E collocato, partem D illius Ampullæ totam rubro colore splendere. Et siue adducatur siue removeatur, idem semper Color nobis apparebit, modo semper, idem servetur situs, & linea D E cum altera E M, quæ per Imaginationem ab



Oculi Centro ad solis Centrum est protrahenda, *Angulum* duorum & quadraginta circiter graduum constitueret, pars illa D æquali semper rubore tingetur. At si hunc *Angulum* paulo amplius dilataveris, dispārebit ille Rubor, & si contraxeris, non ita simul omnis evanescet, sed antea velut in duas partes minus splendentes dividetur in quibus *Caruleus, flavus & alii Colores* conspiciantur. Deinde si *Regionem K* illius Ampullæ perlustramus, animadvertemus factō *Angulo R E M* sc. circiter graduum hanc partem R rubro etiam Colore perfusam esse, verum non ita illustrem ac conspicuam ut D, & dilatato sicut antea *Angulo*, alios ibi Colores oriri sed magis *dilutos*, Eodem autem, aliquantulum *contra* Q vel multum ampliore *fallo*, illos penitus evanescere.

S. IV.

Illustrations in the theses published at Turku were often copied from Central-European sources. Hahn and Pryss have copied Descartes' illustration in their thesis *On the Rainbow* (1691). A tiny glass ball represents a raindrop and the reflections of light from this are studied geometrically. Just like Lundius, Pryss also uses the illustration as an integral part of the argument, which is almost directly cited from Descartes.



that it did not provoke any opposition either in the Faculty of Arts or in the Senate of the University.²¹⁰

It has been stated several times in this study that in Aristotelian-Scholastic scholarship there was a strict hierarchy of the disciplines and the methods appropriate to each discipline. According to the prevalent philosophy, mathematical reasoning could not provide sound arguments in the field of physics. How is it possible then that Pryss was not attacked for category mistakes similar to those Laurbecchius had accused Lipstorp of? First of all, Pryss confined himself to discussion of reflections and refractions of light, and he did not touch upon any of the more sensitive matters such as dualism or heliocentrism. Had Pryss tried to apply geometrical method to the burning

²¹⁰ There are no signs in the protocols of the Senate that the subject had been dealt with. CAAP VII, p. 45-94. (The spring term 1691.)

questions of astronomy, the reception might have been very different. On the other hand, Pryss' thesis was in a sort of gray area between physics, optics and mathematics. Optics was traditionally a discipline in which mathematical argument was legitimate - not to mention Aristotle's geometrical treatment of the subject.²¹¹

On the whole the impact of Cartesianism on physical theories at Turku in the 1690's is limited to some details. In 1697, for example, Cartesian views on tides and the movements of sea were thoroughly described by the professor of eloquence, Christiern Alander. He finds the Cartesian hypothesis extremely good. However, the theory was problematic according to him because it presupposed the movement of the Earth. Therefore Alander is careful not to commit himself to Descartes' own ideas, but to "revised Cartesian" theories.²¹² Strong Cartesian influence at the theoretical level can also be found in Magnus Steen's astronomical dissertations, in which he described the vortex theory. Steen's presentation of the theory is very positive and he is constantly on the verge of accepting it explicitly as well.²¹³

Trail-blazing attempts to use the new methodology were more rare. Besides the few meteorological dissertations analysed above references to Cartesianism are only sporadic. Although theoretically Cartesian ideas could be merged into the Aristotelian system, most ideas with some consequences for metaphysics were irreconcilable with the old theory. However, the 1690's was the decade when Cartesian dualism and epistemology were defended for the first time at Turku.

The Emergence of Cartesian Dualism: the Case of Torsten Rudeen

The first person at Turku to defend Cartesian dualism in a public dissertation was Andreas Lundius. Compared with the theses in meteorology, Lundius' thesis is much more consistent in its Cartesianism. Instead of adopting some single theories and applying them to a Aristotelian scheme Lundius presented a rather consistent Cartesian view of his subject. As we have seen above, Lundius' thesis did not provoke opposition despite its undoubtedly controversial contents. After Lundius, dualism was not propounded in physics dissertations before the

²¹¹ Aristotle 1978, III ch. iv-v.

²¹² Alander-Wasbohm 1697, p. 16-25.

²¹³ See chapter "The Structure of the Cosmos".

Russian occupation (1714-21). It was, however, adopted in some dissertations which deal with subjects belonging to the field of natural philosophy published under the guidance of another professor.

A "real" Cartesian dispute did not arise until 1697 at the University of Turku. It was caused by two theses published under the guidance of Torsten Rudeen. The course of events in this incident has been studied in detail, first in the biography of Rudeen by Arvid Hultin in 1902 and then by Klinge in his *Helsingin Yliopisto 1640-1990*. My account of the dispute owes much to these studies. Research into this subject is made rather difficult by the fact that the protocols of the University Senate for 1695-99 are lost. A major part of our knowledge is based on the information in J.J. Tengström's biography of bishop Gezelius.²¹⁴ It is sensible to deal with it in this study as well, because it was the first institutional clash between the old and new academic traditions, in which openly Cartesian arguments were ranged against Aristotelian.

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Torsten Rudeen had studied at the University of Uppsala, where he received his master's degree in 1691. He became acquainted very early with Cartesian philosophy and undoubtedly was one of its proponents. He defended a Cartesian thesis in 1688 on the separation of the soul and body, which dealt with the primary characteristics of those two substances.²¹⁵ Soon after finishing his studies Rudeen was nominated professor of poetry at the University of Turku. There had been some stir at Turku about the best candidate for the professorsip. Ignoring the proposal of the Senate, the King nominated Rudeen, who undeniably had the best qualifications for the job. The professors at Turku were, of course, dissatisfied, because their proposals had been ignored and because a man unknown to them had been nominated. However, Rudeen soon met with the other professors' approval and by all we can judge he seems to have been very popular with his colleagues and students.²¹⁶

From the beginning it was Rudeen who was on the defensive. In January 1697 bishop Gezelius Jr. (thus the Vice-Chancellor at the University) prohibited the publication of Rudeen's and his respondent Anders Chydenius' thesis *De mente humana*. In the Senate one of the

²¹⁴ Tengström 1833, p. 96-106.

²¹⁵ Hultin 1902, p. 27-28. The thesis was Lagerlöf-Rudeen 1688, *De dissolutione mentis et corporis*. On Rudeen's master degree see Hultin 1902, p. 28-32.

²¹⁶ Hultin 1902, p. 56-60, et passim.

professors of theology, Andreas Wanochius supported the prohibition, and the professor of physics, Petrus Hahn, also opposed some arguments in the thesis. According to Hahn, the statement "Anything which is, is either spirit or body, or can be reduced to either of these." was not true, because there was *radius solaris*, which was body as well as soul.²¹⁷ Rudeen defended the publication of his thesis with an old tactic used by Cartesians: he said he could show that Cartesian principles actually agreed with the old and pure Aristotelian theories. Vice-Chancellor Gezelius answered that in that case he should also speak as the old philosophers had done. Gezelius also referred to two royal edicts of 1691 and 1693, which barred any "useless novelties" in academic dissertations. But as soon as Gezelius had left from Turku, the thesis was ventilated.²¹⁸

The thesis itself was very short - only four pages long. This was mainly due to the poverty of the respondent Andreas Chydenius, who had to pay for the printing of the thesis. It claimed that mind was a *res cogitans*, the only property of which was thinking (*cogitatio*). Although Rudeen's thesis dealt mainly with the mind-substance, there remained no doubt about him accepting dualism as well. The soul was said to differ *realiter* from the body, and to be maintained by God. The Aristotelian dogma that sense perception was the basis for all intellection was also refuted.²¹⁹

Rudeen's thesis is extremely compact and he does not qualify or explain this last statement in any way. What the Cartesians actually objected to in the Aristotelian maxim "*nihil est in intellectu quod non prius fuerit in sensu*" was the first word of the sentence, *nihil*. Matter had only limited powers in Cartesian philosophy and all it could produce was material images in the brain. However, our ideas proper were the product of the immaterial mind, although often stimulated by the material images. Although most of our ideas had their origin in the sense perception, *some* of them were nevertheless irreducible to certain brain-states. In this respect there were also "innate ideas" or principles which on a very fundamental level contributed to our

²¹⁷ Hultin 1902, p. 119. "*Qvidquid est, Spiritum esse vel corpus; vel posse ad alterutrum horum referri.*"

²¹⁸ Hultin 1902, p. 119-120. These two edicts were originally aimed against certain novelties in political thought, which the king regarded as too favourable to the nobility.

²¹⁹ Rudeen-Chydenius 1697.

knowledge about the world.²²⁰

The third thesis in Rudeen's dissertation claims that there is a real distinction between the mind and the body.²²¹ Just like Lundius Rudeen understands the real distinction in a Cartesian way. Rudeen maintains that there is no real difference between an *ens* or substance and its properties. Thus, mind and cogitation were the same.

Cogitation is an attribute and at the same time the substance of mind. It is not necessary that in every relation of attribution there should be a difference between what attributes and what is being attributed. As I have shown, there is a way of speech, in which something is understood with two or more words although the thing is the one and the same.²²²

Although Lundius apparently also favoured the Cartesian understanding of the *distinctio realis*, he did not analyse the concept as Rudeen does.²²³ It may even be that it was just the analysis of the real difference which contributed to the theologians' opposition to Rudeen's thesis. What Rudeen is suggesting here involves a radical change in the way the distinctions between different metaphysical categories were conceived. According to Rudeen the only difference between a substance and its attributes was in the way of speaking, whereas the Aristotelian tradition stressed that there was a real ontological distinction between them. The radicality of Rudeen's view lies precisely in its rejection of the ontological basis of Aristotelianism. In his excuse to Gezelius Rudeen later pleaded that he had not defended these dogmas in the thesis, but only described and explained them.

It was no less than two months later in March when another thesis of Rudeen was picked on by Gezelius. This time the thesis was written

²²⁰ On Descartes' understanding of the innate ideas see Clarke 1982, p. 48-54. Clarke 1989, Ch. 2.

²²¹ Rudeen-Chydenius 1697, Th. III. "Mentem à corpore realiter differre, nec ullum corpus posse cogitare."

²²² Rudeen-Chydenius 1697, Th. IV. "Cogitationem esse attributum & simul substantiam mentis. Non enim requiritur in omni attributione, ut inter id quod tribuitur, & id cui attribuitur, diversitas intercedat; cum detur quoque talis modus loquendi, quo ostendimus, id quod duobus pluribusve verbis intelligitur, esse rem unam et eandem."

²²³ Hahn-Lundius 1690, Adsertum Prooemiale. "Has autem substantias realiter inter se differe, neminem sani iudicii inficias iturum confido."

by the respondent Clemens Thelaus and was called *Cognatio artis atque naturae*. Depending on the texts of J. Chr. Sturm, Thelaus studied the correspondences between nature and the internal structure of artificial objects in his thesis. Instead of Gezelius himself it was the professor of metaphysics Simon Tålpo (Gezelius' son-in-law) who raised an accusation against the thesis before its ventilation. It was said to contain "principles which were contradictory to those which have always been accepted in this academy". Despite this the Senate of the University allowed the disputation to take place. Because Vice-Chancellor Gezelius had earlier refused the public examination of the thesis, he turned the matter over to the Chancellor, Count Wallenstedt. Theologians at the University supported Gezelius' move.²²⁴

Rudeen's letter of response was very thorough. Although he emphasised his dogmatic purity in matters of the Lutheran religion, he did not deny being an adherent of the new philosophy. During his studies at Uppsala it had been common to favour *recentiorum principia*, he stated. Why would it be wrong to support ideas, which common sense and experience had shown to be true? Rudeen maintained, however, that he was a slave neither of the Cartesian nor of any other philosophy, nor did he force his students to believe in this or that philosophy. With clear insight Rudeen expressed his wonder over the fact that his *De mente humana* had been attacked, although similar ideas had previously been proposed by Lundius seven years earlier without any trouble. All in all, if he was said to oppose true philosophical principles, his accusers should define which principles should be called the right ones.²²⁵ The Faculty of Arts took Rudeen's side, and it seems that the conflict was over before the Chancellor's advice to let the matter drop arrived.

Rudeen hits the mark in his response. It was first of all a question of the limits of freedom in philosophy, both in respect of the relationships between theology and philosophy and within philosophy itself. Because the theologians (and also most philosophers) saw philosophy as subordinated to theology, they wanted to keep control over it as long as possible. Because theological dogmas were expressed in philosophical concepts the purity of the philosophy was very important. At Turku there had been very little effort among philosophers

²²⁴ Hultin 1902, p. 121-123.

²²⁵ Hultin 1902, p. 123-125.

to separate philosophical thought from theological, whereas at Uppsala this process had been going on since the 1660's. Rudeen's case was to be the first occasion when these boundaries were questioned in public at Turku. Although I have here emphasized the restrictive role of theology, the purity of dogmas was equally crucial for the survival of the scholastic philosophy.

New definitions of the legitimate realm of philosophy were also demanded by Christiernus Alander.²²⁶ In spring 1697 several theses were published under his direction, which discussed the nature of academic learning and wisdom. However, Alander is very careful not to claim freedom of philosophy directly. In his *De custodibus scientiarum* he discusses the fact that there are different disciplines in the world of learning. On the other hand his *Liber studiosus dissertatione academica limitatus* considers mainly the external forms of students' liberty, for example their legal position.²²⁷ However, he defends "liberty" because of its usefulness, as long as it is based on the right kind of moral principles.

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Discussions on Dualism and the Mind-Body Problem

It seems that problems concerning Cartesian philosophy were discussed at the Academy more often than is apparent from written treatises. For example, Petrus Hahn announced that he would lecture upon various controversial ideas on cognition in 1704, and five years later he lectured upon "the principles of corporeal bodies" and claimed to solve the controversies which have occurred between old and more recent authors on this matter.²²⁸ Unfortunately the contents of his lectures are unknown. After Rudeen we actually meet a defender of Cartesian dualism only once more before the closure of the University in 1713. In 1707 a thesis which dealt with the actions of men, was published

²²⁶ Alander was the professor of eloquence 1692-1704.

²²⁷ Alander-Tolliin 1697. Alander-Werander 1697. Klinge 1987, p. 424-425.

²²⁸ Elenchus Praelectionum, Catalogus 1704. "PETRUS HAHN Professor Physices ordinarius absolutis Principiis Cognitionis humanae, partem Physicae specialem suis Auditoribus, per praecepta methodica & perspicua, Deo vitam sufficiente explicabit, plenaque earum controversiarum, quas veteres & recentiores Philosophi agitarunt, tractatione & decisione illustrabit." Catalogus 1709 "HAHN: Principia rerum Corporearum, earumque Affectiones proponet publice, singularesque de iisdem tam a veteribus quam recentioribus Physicis agitatae controversias decidet."

under the *presidium* of the professor of mathematics, Laurentius Tammelin. As a student Tammelin had studied for a while at Leiden. A rumour exists that Tammelin would have written from there to Johannes Gezelius Jr. In this letter he would have described the success of the new philosophy by saying that "all philosophers are Cartesians here".²²⁹ The collection of Gezelius' letters, which is kept at the State Archives of Finland in Helsinki does not unfortunately include this document. Our knowledge of the contents of this lost letter is therefore very fragmentary. In any case it seems probable that Tammelin knew something about Cartesian philosophy. It has been rightly noticed that Tammelin did not accept Cartesian cosmology.²³⁰ He did, however, allow a thoroughly Cartesian physical thesis to be published under his guidance. It is even possible that Tammelin was the co-author of this thesis.²³¹

Tammelin and Hielm also proclaim dualism. Their reasoning is typical of Cartesian expositions of the subject. That *cogitatio* is the prime characteristic of the mind, and extension of the matter is argued for with the following well-known formula:

...thus all things without which the soul can be understood to exist are different from it. When we have removed everything else, only cogitation remains inseparable from soul unless the concept itself is allowed to collapse. It follows that thinking is essential for mind.²³²

Matter could also be conceived in the same way without all other qualities except figure, magnitude and place. While some qualities such as extension were dependent on matter, the existence of colour, taste, smell, etc. was irrelevant to it. In physics applying this principle naturally meant giving up the Aristotelian mode of explaining natural

²²⁹ Klinge 1987, p. 424. The story does not say whether this was a good or a bad thing in Tammelin's opinion and in which context he would have made this statement.

²³⁰ Ibid.

²³¹ The real author is, once again, an open question. The respondent Andreas Hielm does not announce himself as the author; but on the other hand, it was a graduate thesis, which were often written by the respondent.

²³² Tammelin-Hiellm 1707, p. 3. "...ita ab anima differunt omnia ea, sine quibus illa intelligi possit: quoniam vero remotis omnibus, cogitatio sola ab anima sit inseparabilis nisi ejus conceptus evanescat; omnino sequitur, quod animæ ea sit essentialis."

phenomena by having recourse to its qualitative characteristics. Hielm also claims a real distinction between the substances.²³³ According to him it was the clear and distinct perception of the concepts which guaranteed the reality of the distinction.

Moreover, each of these substances, that which thinks and that which is extended offer us distinct concepts so that we can clearly and distinctly think of the one without the another. From this it can be concluded that there is a real distinction between them.²³⁴

The mind-body problem inevitably followed the acceptance of Cartesian dualism. If there was no contact between the two substances, then how could the immaterial substance affect the material one and *vice versa*? Cartesian philosophy brutally cut the intimate connection between the body and the soul, and maintained that there was a physically and metaphysically real distinction between the substances mind and matter. This idea was defended in public for the first time by Lundius in 1690. Before 1713 he got only a handful of like-minded followers.²³⁵ The mind-body problem was also recognised at Turku and the problem was formulated as follows:

I have said here that the soul is the cause of bodily movements. Because all motion happens through some mutual contact, I wonder in what way would an immaterial entity move a material?²³⁶

²³³ Aristotelian and Cartesian philosophy had different meanings for the terms "real difference" and "substance". Whereas in Aristotelian tradition a real difference existed between two ontological categories like substance and accident, for Descartes it was a line between two equal substances of totally different natures. For Aristotelians a substance was any entity consisting of form and matter. According to Descartes a substance was an entity which could exist by itself, without getting any physical or logical help from other substances. Beside God there were only two entities, which fulfilled these conditions, i.e. mind and matter. On Descartes' meaning of the real distinction see Alanen 1982, p. 66-85.

²³⁴ Tammelin-Hiellm 1707, p. 4. "Porro, cum utraque haec substantia, cogitans nimirum & extensa diversum sui nobis sistat conceptum, ita ut unam sine altera seorsim clare distincteque intelligere possimus, inferre id ipsum, patet, realem utriusque distinctionum."

²³⁵ Hahn-Lundius 1690, Adsertum Prooemiale. Rudeen-Chydenius 1697, Th. I-V, XII. Tammelin-Hiellm 1707, p. 2-3.

²³⁶ Tammelin-Hiellm 1707, p. 10. "Dixi gratis fingi animam motuum corporis esse caussam; cum enim omnis fiat motus per mutuum contactum, quomodo, amabo, immateriale materiale moveat?"

In the Cartesian dissertations written at Turku we find this question being answered only twice. Both authors discuss the subject only briefly, and therefore it may be less appropriate to draw very thoroughgoing conclusions from them. First of all, Lundius has accepted some form of psychophysical parallelism. Mind and body do not touch each other, but perform parallel movements.

The soul and the body work alternately, so that certain movements which originate in the body border the soul. Certain ideas in the soul correspond to these movements, but the ideas in mind limit themselves to the point where they meet the body. In the same way certain movements in the body correspond to these ideas. We cannot explain this mutual reaction in any other way except that the Creator wanted in this way to connect these two extremely different essences, between which there is no other connection and proportion.²³⁷

Lundius refers in this passage to the writings of the famous Cartesians Antonius Le Grand, Adriaan Heereboord and Johann Clauberg. Lundius' ideas seem to fulfil two of the demands which Winfried Weier has defined to construct proper occasionalism. Occasionalism should 1. expect soul and body to be two totally distinct substances, 2. deny the possibility of any natural cause for their interaction, and 3. attribute all interaction of the substances to the perpetual interference of God. According to Weier these three requirements are essential for the various forms of occasionalism and thereby it is of no importance, whether the word "*occasio*" is present or not.²³⁸ Only in one aspect, not expecting God to direct perpetually the interaction between the substances, does Lundius not fulfil the criteria, but the formulation of his text rather seems to suggest that God has ordained this particular order at the beginning of time. As Weier concludes, not even Clauberg (whose works Lundius also refers to) fulfils this prerequisite of occasionalism completely.²³⁹ Despite this metaphysical-

²³⁷ Hahn-Lundius 1690, p. 5-6. "*Anima & corpus agunt in se invicem, adeo ut certi motus in corpore excitati terminentur in anima, quibus motib. certæ ideæ in anima respondent, & animæ ideæ desinant in corpore, quibus ideis parili modo certi corporis motus respondent. Et hanc mutuam reactionem non aliter explicare valemus, quam quod conditor ita voluit adeo diversissimas essentia, inter quas connexio & proportio nulla, connectere.*"

²³⁸ Weier 1981, p. 43.

²³⁹ Weier 1981, p. 52-53.

ly important difference I shall refer to this explanation model as occasionalism in the following discussion.

Another standpoint which approaches occasionalism as well comes up in a thesis written by Tammelin and Hielm, according to whom soul and body had no mutual contact, but affected each other nevertheless. The question of how this happens still remains open:

This action is performed... not as a consequence of a mutual contact ...but... because certain movements in the body correspond to certain thoughts in the mind and conversely, so that the soul which moves by itself... stimulates certain movements in the body. But the body, moved in various ways, gives soul an occasion to bring forth divers ideas. There are manifold movements in the soul which depend on the body in that they could never exist in a soul not stimulated by the body. Indeed, even after they have started to exist, they exist necessarily as long as there is motion in the body. In the same way there are various operations in the body, which not only could not be exerted unless the soul was thinking, but also given this act of cogitation, they will be brought about necessarily.²⁴⁰

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Certain bodily movements would excite movements of mind and *vice versa*, but the mechanism for this remains obscure. In any case this schema involves more impulses or contact-like occasions between the two substances than Lundius' theory does. The same point of view was expressed by Hielm when he investigated the existence of different kinds of ideas in man.

These kinds of mental concepts are usually called innate ideas. Not that the soul would always be conscious of them, but if the soul is left by itself it can find and choose them. Other ideas, which are formed in negotiations with the body, are called acquired ideas. Not

²⁴⁰ Tammelin-Hiellm 1707, p. 12. "Absolvitur haec actio... non secundum mutuum contactum, ...sed... quod scilicet certis animae cogitationibus, certi respondeant motus in corpore, & sic reciproce, ita nimirum, ut anima ex se mota, ...in corpore quasdam excitet operationes; corpus autem varie motum, animae occasionem praebeat varias ideas elicendi. Plurimi namque sunt motus animae, qui a corpore ita dependent, ut in anima corpore non agente nunquam existerent, immo etiam postquam existere caeperunt, ad durationem motus in corpore necessari existant. Sic quoque variae sunt corporis operationes, quae anima non cogitante, non modo non exerentur, sed etiam posita hac cogitatione, necessario eliciantur."

because they are impressed on the soul by some images derived from external objects, but because the soul pays attention to these previously innate ideas only when the external objects offer them an *occasion* to think about them.²⁴¹

One of the most famous ideas in the Cartesian psychology is that the soul might be located in the pineal gland. At least this is how some contemporary scholars understood Descartes.²⁴² At Turku this idea was not accepted in such a crude form. According to Lundius the pineal gland was the seat of *sensus communis*, and a similar idea had been expressed somewhat earlier by Achrelius. Lundius emphasized, though, that the soul "is diffused through the whole body", although it showed some of its powers especially in the heart and brain.²⁴³ The theory of the pineal gland as a sort of "information managing centre" in the brain could as such be incorporated into the Aristotelian scheme too.

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The Question of Innate Ideas and Their Relation to the New Epistemology

Descartes' philosophy gave rise to the old Platonic question about innate ideas. Both some of his arguments for the existence of God and geometrical proofs presupposed the existence of some sort of innate idea.²⁴⁴ The epistemological slogan of the Aristotelian philosophy was largely incompatible with this, there being nothing in the intellect, which has not come through the senses. Although the basic Aristotelian epistemology stated that there could be scientific knowledge of the universals only, this knowledge was ultimately abstracted from particulars. Because of the idea that all the contents of our mind have

²⁴¹ Hahn-Hiellm 1707, p. 14. "Cujusmodi conceptus mentis, innatorum nomine insigniri solent, non quod animæ semper observentur [=observentur, mk], sed quod possit anima sibi relicta illos elicere. Cæteri autem, qui non sine commercio cum corpore exeruntur, adventitii audiunt, non quod per species quasdam ab externis objectis animæ imprimantur, sed quod antea innatos anima tunc demum exerat, cum objecta externa occasionem præbent de illis cogitandi." My italics.

²⁴² Hahn-Rungius 1691, § III. On Descartes' ideas about the seat of the soul see e.g. Voss 1993, p. 134-140.

²⁴³ Achrelius 1682, p. 355-356. "*sit diffusa in universum corpus*" Hahn-Lundius 1690, p. 6. The idea of the pineal gland as the seat of common sense is present at least in the texts of Le Grand. Le Grand 1679, p. 875, 948 ff, et passim.

²⁴⁴ Beyssade 1992, 1993. Doney 1978, p. 5-6.

their origins in sense perceptions, perception played an important role in theories concerning cognition and thought. It had considerable significance in epistemology. This Aristotelian "empiricism" was then fundamentally opposed to both Platonic and Cartesian theories of innate ideas.²⁴⁵

The philosophy at Turku shared this Aristotelian "*nihil est in intellectu quod non prius fuerit in sensu*" notion. It was claimed that all universal ideas in our minds were formed by the intellect, which abstracted them from singular notions derived from the senses.²⁴⁶ "We claim universals are obvious for understanding, for they are... perceived by comparing particulars between each other, and by abstracting from the particulars."²⁴⁷ Contrary to this rather straightforward empiricism, Cartesianism notoriously doubted the reliability of the senses and thereby the validity of experiential knowledge. There is a feature in Cartesianism however which emphasises rationalism instead. The most secure basis for philosophical knowledge for Descartes were certain innate notions or ideas, the most important of which was God, whose existence was for him the ultimate guarantee of stopping methodical doubt.²⁴⁸ What attitude did the authors at Turku take up towards innate ideas? It seems that the problem was discussed to any considerable extent only in the 1690's. Although Cartesian authors are not always mentioned, it is probable that these discussions were at least distantly inspired by Cartesianism.

Descartes classified our ideas into three types: innate, adventitious and fictitious.²⁴⁹ This scheme was outlined for the first time at Turku by Achrelius. In his understanding of the theory, "ideas" played the same role as *species intelligibiles* in traditional Aristotelian psychology.

We understand their habitus without organs with the help of *ideas*, which are things thought of, to the extent that they have objective being in the intellect. *These Ideas* such as the notions of *the sun and the stars*, are *either acquired*, or received from the things through the senses, or they are *fictional*, created by the intellect at

²⁴⁵ For a short but useful discussion of the topic see Marenbon 1987, p. 94-102.

²⁴⁶ Miltopaeus-Enebergh 1667, Th. XXIX.

²⁴⁷ Hahn-Bruzeliuss 1697, p. 12. "Universalia autem intellectioni obvia dicimus, per comparationem nempe singularium inter se, & per abstractionem à singularibus... percipiuntur."

²⁴⁸ Descartes 1973, Vol. I, p. 157-171.

²⁴⁹ Descartes 1973, Vol. I, p. 160.

its own discretion. Such are the concepts of *Chimera* and *Cerberus*. Or they are *innate*, which follow the ability to think and the norms we have for forming concepts.²⁵⁰

This interpretation was typical of those authors who applied Cartesian philosophy only to a very limited extent.²⁵¹ On the other hand, Andreas Hielm, who was a more convinced supporter of Cartesianism, stresses more the importance of innate ideas. Led by his occasionalistic philosophy he claims that adventitious ideas are "not impressed on the soul by some kind of image received from external objects, but are something which previously was innate, but which the soul considers only then when external objects give it an occasion to think about them."²⁵² In fact even adventitious ideas were thus to some extent innate.

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The most problematic of these three ideas for the Aristotelians was the notion of innate ideas. Achrelius gave it the meaning of an ability to think and the power of forming concepts (*cogitandi potentiam formandique conceptus normam*). Related to this view is the idea that the desire for knowledge is innate in all human beings. It was considered to be a relic of the Light kindled by God in man in his original state. This *facultas cognoscendi* was left in human beings after the Fall, but in a deteriorated state. Ignorance of the causes of things produces astonishment in man, who cannot stand the sadness caused by his ignorance and starts to investigate the causes of things. This constitutes philosophy and repels ignorance.²⁵³

²⁵⁰ Achrelius 1682, p. 354. "Intelligimus eorum habitum sine organis ope idearum, quae nihil aliud sunt quam res cogitatae in quantum habent objectivum esse in intellectu, suntque *Ideae istae vel adventitiae*, quae ex rebus per sensus trajectis recipiuntur, ut notitia de *sole & sideribus: vel fictitiae*, quae pro arbitrio ab intellectu configuntur, ut *Chimera & cerberi* conceptus: Vel *innatae*, quae cogitandi potentiam formandique conceptus normam, comitantur." The passage is an almost direct quotation from Antonius Le Grand. Achrelius manages to fully integrate this passage into the Aristotelian theoretical framework. See Kallinen 1991a, p. 122. Cf. also Descartes 1973, p. 163.

²⁵¹ See e.g. Hahn-Gaslander 1707, p. 15-16. Tammelin-Brumerus 1695, p. 2.

²⁵² Tammelin-Hiellm 1707, p. 14. "...non quod per species quasdam ab externis objectis animae imprimantur, sed quod antea innatos anima tunc demum exerat, cum objecta externa occasionem praebent de illis cogitandi."

²⁵³ Tälpo-Sidbeck 1700, p. 3, 11, et passim. Tälpo-Askbohm 1697, p. 29-35, et passim does not approve of admiration as such as the cause of inquiry, but differentiates between vulgar and learned admiration. Tammelin-Brumerus 1695, p. 2. Hahn-Frolander 1692, p. 7-8.

This was not, of course, what the question of innate ideas fundamentally was about. The most thorough study of the problem of innate ideas was published as a dissertation by Hahn and Askebohm in 1695. The author of the theses, Askebohm, is clearly sympathetic to Cartesian philosophy, although he is not over-zealous. First of all he presents the Platonic model, in which our soul has in some previous state or life included all ideas. The conjunction with the body has then corrupted our innate knowledge, but we can become aware of those notions by recollecting them. Knowing is remembering. Totally opposite to this is the Aristotelian model as presented by Askebohm. According to him the human mind is like a *tabula nuda*, in which there are no notions at the time of birth. Only the faculty of acquiring knowledge through the senses was given to man.²⁵⁴

Unlike most scholastic dissertations Askebohm's does not refute these standpoints in detail. He only asserts that "according to many of the most accurate Philosophers of our age, and the opinions of Orthodox Theologians" it was not right to claim that all our ideas are innate or that we receive all notions through the senses, but it was justifiable to assume that there also were innate ideas in man's mind.²⁵⁵ In every man there was an innate idea of God, although only by thinking could this idea be made "clear and distinct" i.e. would man become conscious of its presence.²⁵⁶ However, Askebohm's definition of ideas is broad and rather inaccurate. In his view ideas are all "perceptions of the intellect, whenever we we understand something in some way."²⁵⁷ The idea of God is thus the only innate idea we have, although we are not always conscious of its presence in our minds. We have instead a faculty of recognizing it without any help from the senses.²⁵⁸

²⁵⁴ Hahn-Askebohm 1695, p. 1-6.

²⁵⁵ Hahn-Askebohm 1695, p. 7. "*secundum plerorumque, nostrae aetatis adcuratissimorum Philosophorum, nec non Orthodoxorum Theologorum sententiam*" See also Juslenius-Petrejus 1703, p. 9.

²⁵⁶ Hahn-Askebohm 1695, p. 12, 24-25. Askebohm refers to St. Augustine, Du Hamel and Clauberg on this question.

²⁵⁷ Hahn-Askebohm 1695, p. 11. "*...intellectus perceptio, quando rem aliquam quocunque modo concipimus.*"

²⁵⁸ Hahn-Askebohm 1695, p.11-13. "*Hinc ideam seu notionem Dei non ideo nobis innatam voluit Cartesius, qvasi semper nobis observentur, & non distinctum quid ab ipsa facultate cogitandi sit; Sed quod facultatem habeamus illam ex propriis ingenii viribus, absque ullo sensuum experimento, aut incitamento nobis representare.*"

Despite his obvious sympathy for Cartesianism, Askebohm's opinion is by and large adaptable to the general view on the question expressed at Turku. His "innate idea" is in fact knowledge of God and/or an ability to realise certain notions which refer to God.²⁵⁹ The question of innate ideas was not purely a philosophical and epistemological one, but also had many implications in theological dogma. To claim innate ideas in the Platonic sense would have presupposed some kind of prenatal (and pre-conception) existence of the human soul - or even transmigration. Although this view was naturally rejected by the Lutheran dogma, the orthodox opinion nevertheless agreed that men had some accurately defined sort of innate knowledge of God.²⁶⁰ All the other contents of our mind were derived by abstraction from sense experience.

The question of the existence of innate ideas is related to epistemology, which included one of the most striking differences between the Aristotelian and Cartesian philosophies. It is my purpose in this subsection to determine, whether the Cartesian kind of epistemology got any foothold at Turku during this period.

Although the Aristotelian tradition prevalent at Turku presupposed that all universal notions were abstracted from individual sense-perceptions and that senses were thus the primary source of all knowledge, this empirical principle did not affect natural philosophy very much. In practice the study of nature was based on reverence for certain authorities. Even here we can see a discrepancy between the official policy and academic routine. Even though it was the "old authors" (i.e. authors of antiquity) which were considered the primary source of knowledge, in practice certain "new authors" were referred to at least equally eagerly. In Cartesianism there was also tension between certain epistemological claims and the practical search for scientific knowledge. The rationalistic side of Cartesianism emphasised that mathematics should be applied to physics. But more importantly it stressed the point that the first principles of philosophy were derived from man's own thought without any recourse to sense-perception.

Descartes notoriously claimed repeatedly to have founded his physics on metaphysical, rational principles and - most of all - on mat-

²⁵⁹ Hahn-Littorinus 1685, § II-III, et passim.

²⁶⁰ See Lindborg 1965, p. 70-72.

hematical ratiocination. Most contemporaries of Descartes - and latter-day historians of philosophy as well - have taken Descartes' words at face value. However, this was an ideal which, while it could perhaps be approached, was as hopeless of fulfilment in most of the natural science as the Aristotelian study of nature was of reaching its ideal of strictly syllogistic science based on indemonstrable principles. In fact, Cartesian philosophy was far from hostile to empiricism, if we only take into account what role he gives to *experience*. Despite his distrust of what we would call scientific experiments, Descartes did not deny the importance of "ordinary experience" in acquiring knowledge about the physical world. Adequately controlled, even experimentalism might have a place in Descartes' science.²⁶¹

Empirism in the early modern sense of the word, and experimentalism as its more technical form did not arrive at the University of Turku until late in the 18th century. At Uppsala this empirical attitude had increasingly gained ground during the 17th century, especially in the Faculty of Medicine. Indeed, the free teaching of Cartesianism was argued for because of its benefits for experimental philosophy.²⁶² At Turku philosophical justification of new knowledge had just begun during the period concerned. The role of experience in gaining *new* knowledge was argued for in two theses published during the first decade of the 18th century. The thesis of Juslenius and Brunnus especially, at least as much inspired by Cartesian as Baconian ideas about experience, takes a positive stance towards gaining new knowledge through experience; using new and uncommon methods was not indefensible if the results gained matched the requirements of right reason, experience and the Bible.²⁶³

Brunnus and Petrejus treat experience from the psychological and cognitive point of view. What about experiments and other new met-

²⁶¹ Clarke 1982, 1989, 1992.

²⁶² Lindborg 1965, p. 301 ff.

²⁶³ Juslenius-Brunnus 1709, p. 27-28. "Non itaque quod Philosophia indies incrementum capiat, ceu videmus ex scriptis recentioribus, quippe multas res multi per experientiam observarunt antea ignotas, unde & disciplinas insigniter auxerunt, multasque res solutu difficiles explicuerunt. Procedunt quidam eorum methodo nova & insolita, non tamen ideo plane rejiciendi, si saltem dogmata eorum convenient rectae rationi & experientiae, quibus tertium quoque requisitum nos Christiani addere debemus, nimirum ut nostra Philosophia non deroget Sacrae Scripturae, siquidem ei subordinata esse debet, non vero vi propriae indolis eidem contraria." See also Juslenius-Petrejus 1703. Knuuttila & Niiniluoto 1986, p. 30-32 analyse the Baconian influences in these two theses.

hodologies as scientific *practice* at Turku? Pryss' description of the glass ball experiment explaining the origin of the colours of a rainbow is merely a faint echo of the empiricist program so central to Cartesian science. The geometrical exposition of the subject aimed primarily at conceptualization of an experiment, whether just a thought experiment or one actually performed. It is striking that the first dissertations at Turku, where much of the argument and description was based on the general sort of observation, were written by a man who stood for Cartesianism. Although Rudeen's theses on the swansong and on seals do include a lot of first-hand observations, they do not express any vows on epistemology.²⁶⁴

The rationalistic reading of Cartesian epistemology gained only little ground at the University, from the 1690's on. The certainty of geometrical proofs was not discussed, and more generally the discussion of innate ideas concentrated exclusively on the idea of God. Olaus Askebohm was the first author at Turku who proposed a Cartesian-influenced theory of the epistemology of man. We have also noted that Torsten Rudeen briefly questioned the validity of Aristotelian epistemology. However, Rudeen's statement is painfully laconic: "It is false to say: There is nothing in the intellect which has not come through the senses."²⁶⁵ Ten years later Andreas Hielm gave a fuller analysis of the innate and "adventitious" ideas, although Askebohm had already followed the same line of thought. Both Hielm and Askebohm accepted only one innate idea: the idea of God. This was central to the Cartesian dogma also, and was supported by the orthodox Lutherans.²⁶⁶ The arising of the Cartesian rationalism at Turku was thus very restrained and did not give rise to further polemics. Moreover, the understanding of the role of "innate ideas" in Cartesian philosophy is here restricted to the way innate ideas were traditionally conceived of in the form of the Aristotelian philosophy which was approved at Turku. A slightly different kind of theme, which nevertheless was very much related to Cartesian epistemology was more positively dealt with only in one dissertation concerned with the com-

²⁶⁴ Rudeen-Granroot 1703. Rudeen-Wijkar 1707. The "empiricism" in these theses was so general that it was perfectly compatible with the Aristotelian view of empiricism too.

²⁶⁵ Rudeen-Chydenius 1697, Th. XI. "Falsum esse: Nihil esse in intellectu, quod prius non fuit in sensu."

²⁶⁶ See e.g. Lindborg 1965, p. 71.

patibility of Aristotelian and Cartesian ideas.

It had been a much-used strategy among Central European Cartesians to claim that their "new" philosophy was actually a pure and orthodox presentation of "the old" philosophy.²⁶⁷ At Turku only Ru-
deen had used the argument in his quarrel with Bishop Gezelius. Aristotelian-Scholastic and Cartesian philosophies were considered contrary to each other until the eve of the Russian invasion, especially by the proponents of the old philosophy. In 1712 a physics dissertation was published, in which the relation between the old and new philosophies was considered from a different point of view.

To begin with Asplund regards the fact that when some people call Cartesianism a "new" philosophy, they actually mean it is false, in any case only one could be right. However, as not everything in classical philosophy was true, not everything could be wrong in Cartesianism.²⁶⁸ First of all, there was Cartesian doubt. Was it "new" and impious? The fact was, claimed Asplund, that even the greatest of ancient authorities, Plato and Aristotle, would have regarded doubt as the mother of all inquiry. For Asplund Cartesian doubt meant primarily amazement and uncertainty about the causes of natural things, which preceded the search for knowledge. In this sense Asplund comes very near to the traditional understanding of *admiratio* as the ultimate inspiration of philosophy. On the other hand methodical doubt for Asplund also meant *suspensum iudicii* before the truth was revealed.²⁶⁹

Asplund also tackled the problem involved in the crucial point in Cartesian metaphysics which led man to doubt the existence of God and the real contents of his own mind. Although Asplund saw the sensitivity and centrality of these aspects in the Cartesian theory of doubt, he considered himself able to achieve a consensus between the rival views.²⁷⁰ Doubt would by no means be unlimited, but it confined itself to the notion of a thinking subject: "Whoever doubts, is in any case thinking, and from this it follows that he exists."²⁷¹ Thus, Asplund reached the secure ground of non-dubitation on the same shore as Descartes had done. However, being a new idea was in itself some-

²⁶⁷ E.g. Clarke 1989, p. 36-37.

²⁶⁸ Hahn-Asplund 1712, p. 4-6.

²⁶⁹ Hahn-Asplund 1712, p. 7-15.

²⁷⁰ Hahn-Asplund 1712, p. 16.

²⁷¹ Hahn-Asplund 1712, p. 20. "Qui enim dubitat, cogitat utique, atque ex hoc ipso sequitur eum esse."

thing very questionable at Turku, and Asplund had to dispel the shadow which the alleged innovation cast upon methodical doubt, so he reminded his readers that the certainty about one's own existence had been guaranteed for the first time in the same way by St. Augustine. Not even this was first and foremost a new idea. Ultimately all our knowledge was established by the existence of God.

It follows that the natural Light or the faculty of knowing which GOD has given to us, can never deal with any object which would not be true, as far as it is understood in itself, i.e. it is perceived clearly and distinctly.²⁷²

Whatever was perceived clearly and distinctly, could not be wrong, because God loved the truth. Doubt only liberated mind from the prejudices acquired in childhood. Asplund's strategy was to show the acceptability of certain Cartesian notions by showing their compatibility with ancient theories; thus he reduced the Cartesian idea that mind consists of pure thought to Platonic and Epicurean theories, and the theory of innate ideas to Plato.²⁷³ However, one had to be careful because not all the ideas of the classical philosophers could be embraced either. All in all, the new philosophy was regarded as very useful especially in experimental sciences like medicine and chemistry, and in mathematics. The important thing was that no philosophy, old or new, should plunge the light of revelation into darkness. The Bible should remain the final judge in matters of physics, too.²⁷⁴

It is an interesting notion that many of Descartes' Central European critics had also tried to show his unoriginality. During the 17th century for example Libertus Fromondus, and Pierre-Daniel Huet especially attacked Descartes as a reviver of old heresies and a plagiarist. By the 18th century this view of Descartes vanished and although many of his theories were still rejected, he was nevertheless in this respect granted a position of something like "the founder of modern philosophy".²⁷⁵ Askebohm possibly knew the work of Huet and at least he

²⁷² Hahn-Asplund 1712, p. 24. "Unde sequitur, Lumen naturae sive cognoscendi facultatem, à DEO nobis datam, nullum unquam objectum posse attingere, quod non sit verum, quatenus ab ipso attingitur, h.e. quatenus clarè & distinctè percipitur."

²⁷³ Hahn-Asplund 1712, p. 36-43.

²⁷⁴ Hahn-Asplund 1712, p. 45-48.

²⁷⁵ Jolley 1992, p. 409-410, 416-419.

referred to it.²⁷⁶ But he turned the accusations of Descartes' unoriginality into his good. In a context where proposing novelties was officially forbidden this is an easily understandable strategy. Although Aschbohm strove to strip Cartesianism of its original features, he definitely took the side of the new philosophy. Cartesianism was displayed in a good light.

I have in this chapter described the fate of Cartesianism at the Academy of Turku. This course of events was independent at Turku in the sense that it was not launched by the heated controversies which took place at Uppsala. Arguments for and against Cartesianism did obviously circulate much more easily, although this work has not concentrated upon tracing their origins in European literature. There were no "real" Cartesian disputes at Turku as there were in Uppsala, excluding perhaps the one in which Rudeen was involved. The controversies which touched on persons having something to do with Cartesianism were motivated by many other, often personal causes as well. Cartesianism was first discussed by Laurbecchius in 1661, who connected Cartesianism with Copernicanism. It was only in the 1680's that refutations of the Cartesian concepts of substance began to appear in physical theses, and in the following decade discussion widened to embrace dualism and the mechanistic philosophy more generally. It was common to all these discussions to see Cartesianism breaking the accepted methodological rules or ontological categorizations. It is revealing that most of the proponents of certain Cartesian physical ideas from the 1680's on concentrated on minor details of the philosophy and retained its traditional Aristotelian framework. Although Cartesianism was discussed at Turku, we cannot talk about "Cartesianization" of the University during the period concerned. Cartesian dualism gained only some three proponents in physical dissertations, whereas various physical ideas were somewhat more popular. In the next chapter of this work some remarks will be made concerning this obvious reluctance to accept new ideas.

²⁷⁶ Hahn-Asplund 1712, p. 9.

Stability and Change: Concluding Remarks

1. THE INTERPLAY OF CHANGE AND STABILITY

History of science is primarily interested in describing and explaining scientific change. However, in practice much discussion is also devoted to questions concerning special features of the "normal science" of a time - to use the well-known Kuhnian term in a deliberately vague sense. We have in the foregoing discussion seen how both the contents and method of natural philosophy remained to a great extent unchanged during the period concerned. Of course, this is not to say that minor changes in learning and emphasis on particular topics would not have occurred within the Aristotelian framework, too. The first task in this chapter is to achieve an overview of the question which this kind of situation naturally raises: what changed and what remained unchanged in natural philosophical learning at Turku? What is even more important is to try to find explanations for this. Most of this chapter concentrates therefore on pondering probable causes and other background factors for this relatively great stability.

I would regard it as useful to bring up certain concepts and distinctions concerning our subject matter before I examine the interplay of change and stability. In the chapters "The Academic Context of Natural Philosophy" and "The Body of Knowledge" especially I have discussed topics which could by and large be called as "images of knowledge" and the "body of knowledge" respectively. These concepts are a part of the scheme introduced by Yehuda Elkana for considering science as a cultural system. In this scheme Elkana tries to capture some universally applicable components in science, which we could use to analyse not only modern science but also previous systems which we usually classify as "sciences". According to Elkana

Knowledge grows by the interaction of three factors which can be distinguished only if time is stopped and a socio-cultural situation is, so to speak, photographed. I am idealizing for the sake of clarity. Three factors will be: (a) the body of knowledge; (b) the socially determined images of knowledge; (c) values and norms included in ideologies which do not directly depend on the images of knowledge.¹

I have several reservations concerning Elkana's scheme. First of all we should be careful about the sense in which we can say that scientific knowledge grows or progresses; in scientific change certain elements are usually rejected, some aspects re-interpreted and only a part of the material is new in the sense of adding something to the growth. Elkana seems to refer here to growth in a situation which Kuhn would call "normal science". On the other hand I am not convinced that all "photographs" of science would produce a picture divided in this way. By distinguishing between factors (b) and (c) Elkana actually revives the old distinction between "internal" and "external" in science. There are the images of knowledge, which although socially determined are nevertheless somehow inherent in science. On the other hand there are values and norms "external" to science proper, i.e. the images plus the body of knowledge.

However, the internal-external dichotomy is more or less an impression produced by certain kinds of lighting techniques and the speed of the film than by the firmly verifiable characteristics of the object of the photograph. As many of the recent studies in sociology of scientific knowledge (hereafter SSK) have shown, this kind of distinction is hardly tenable.² Elkana's theory is very schematic which gives rise to certain defects. It does not, for example, illustrate how these images of knowledge are formed. Neither does it shed much light on the problem of how these three factors contribute to scientific change - let alone explaining *why* these changes occur. In fact, all it does is to offer us one way to outline a situation where a scientific controversy is caused when two or more images and/or bodies of knowledge clash.³

¹ Elkana 1981, p. 14. For a German version of Elkana's paper see Elkana 1986.

² The literature arguing for this point is vast and increasing. For some classical representations see Barnes 1977. Knorr-Cetina 1981. Latour 1987, 1988.

³ This is actually what Elkana himself does in his paper. Elkana 1981, p. 21-27. Shapin 1979, 1992. The latter provides a useful overview on the whole internal-

In spite of all my criticism I have found the concepts "images of knowledge" and "body of knowledge" convenient for descriptive purposes. I shall use it here only as a heuristic model for outlining my presentation without wanting to commit myself more deeply to the views Elkana's theory involves. Let us first consider what kind of changes we can discern in the "body of knowledge" i.e. ideas and theories held as true knowledge by at least some members of the academic community.⁴ If not specified otherwise, the group of scholars referred to here are the authors writing on natural philosophy, astronomy or medicine.

We can talk about theoretical change in several respects when it comes to the Academy of Turku. It is not my intention here to recite all the changes which occurred in each branch of natural philosophical knowledge. This can be best done by going back to the relevant sub-sections of the chapters above. I am trying instead to typify the changes in a way which reflects the depth to which each change touches the doctrinal basis of Aristotelian natural philosophy. Most of the changes occurred within this system and implied only modifications of the existing body of knowledge. For example, apart from the very first theses on the structure of the world, the idea of clearly definable elementary spheres - and especially the existence of the fiery sphere just below the moon - was largely rejected from the 1650's on. The idea of elementary spheres was an essential part of the Aristotelian world-view. However, rejecting this notion did not lead to the rejection of the entire Aristotelian theory of elements or the dichotomy between sublunar and supralunar areas.

Not only could a part of an old theory or theoretical system be dismissed, but ideas alien to Aristotelian physics could also be introduced. We have seen how some Cartesian ideas could be merged, e.g. in meteorology, without inflicting major change on the fundamental concepts of physical theory. Eclecticism, a typical feature of the 17th-century learning at Turku, functioned very much in this way, limiting itself to the Aristotelian framework. It is very typical of all changes of this kind that they mostly concern only minor details of the theoretical structure, and leave the fundamental assumptions untouched. It is not always easy to determine how widely accepted these changes

external controversy.

⁴ Elkana 1981, p. 14.

in theoretical details were, because some issues were discussed only by a few authors anyway. On the other hand it was not unusual that contradictory views were put forward by several authors at about the same time, but without any controversy between them (especially in some theses published by Hahn) - or that opposing ideas were promoted even by a single author.⁵

It was very unusual at Turku that a new theory was embraced "as a whole". Actually the only possible instance of this kind of development is the acceptance of the theory of the circulation of blood. Even here I prefer to put the expression "as a whole" in parentheses. It is true that the main idea that the blood circulates in human and animal bodies along arteries and veins with movement caused by the heart, is embraced by the few authors who in the first place refer to the matter.⁶ However, this theory which was originally promoted by William Harvey had lived through several modifications before it was "accepted" at Turku. It was first cited at Turku in its Cartesian form, and later commentators tended to simplify its presentation even more. At the same time there was also a tendency to turn back towards the Galenic understanding of the subject, as is obvious from the treatment Gezelius gives it.

There are a lot more examples available from the third type of change which took place in the body of natural philosophical knowledge at Turku. Let me start with an example which at the same time illustrates the still valid hierarchy of knowledge in the Aristotelian philosophical system. Although mathematical astronomy was ranked lower in the epistemological hierarchy than physics, in physics the knowledge of heavenly bodies was regarded as more noble than that of the elementary world. Hence, whereas the homogeneity of the sublunary world was accepted by practically all scholars at Turku (as far as can be judged by the sources), the homogeneity of the world was a view embraced only by a meagre handful of authors.⁷ Erasing the dichotomy between heavenly and elementary worlds would at the same time have presupposed rearrangements in the order of knowledge too. Not surprisingly the kind of theory which contradicted some of

⁵ E.g. Kallinen 1993, p. 75-82.

⁶ This is said with the reservation that in Hahn-Gezelius the doctrine is unclear enough to allow other readings. See chapter "Anatomy and Physiology".

⁷ The first proponent of the idea at Turku was, of course, Daniel Achrelius. The view seems to be involved also in the Cartesian heliocentrism of Magnus Steen.

the more central doctrines in the dominant philosophical system were favoured by fewer scholars. Often they were also actively criticised, not only by authors in the same discipline but by other scholars too.

Copernicanism is a theory the spread and acceptance of which in different European countries is possibly the most widely-studied topic of its kind relating to the 17th century.⁸ The acceptance of Copernicanism has often been seen as one of the main indicators of a successful breakthrough of the Scientific Revolution. Although accepting Copernicanism is of course an immense change in science and the entire world view, I prefer not to measure the success of *revolution* by it, since many other factors contributed to the rise of modern science as well. With such a mathematically complicated theory as Copernicanism, we must be even more careful when talking about the change its acceptance produces in the body of knowledge. First of all we have to notice the difference it makes to embrace it as a mathematical hypothesis and "instrument" for calculation on one hand and as a physical truth on the other. Moreover, a difficult theoretical construct was probably not understood equally fully by all scholars. There must have been differences between the understanding physicists with little or no mathematical training had of it and how mathematicians - who also were bright to various degrees - saw the theory. At Turku all scholars, including theologians, were ready to accept Copernicanism as a hypothesis, whereas only Magnus Steen seems to have been ready to consider the theory also physically true. His astronomy also merges Copernicanism with the Cartesian theory of planetary vortices. Copernicanism as well as some other physical and metaphysical ideas such as Cartesian dualism or mechanical explanations in physics were very controversial because they challenged certain theological and metaphysical ideas. They could also presuppose changes in the images of knowledge.

According to Elkana the images of knowledge are factors determining what counts as knowledge in a given (scientific) culture at a certain time. Each culture has several sources of knowledge, such as sense-experience, tradition, authority, ratiocination, analogy, beauty and many others. All these sources must be legitimized and they usually have a mutual order or different degrees of importance. In Elkana's view the location of an image of knowledge on a sacred-secular

⁸ See e.g. Dobrzycki (ed.) 1972.

continuum is also a central component of the images in general, but in my opinion we can see this as a special case of legitimization of knowledge.⁹ Elkana also counts the audience or public which shares the images of knowledge, the time-scale continuum and degree of consciousness of the existence of a special image as contributing to the formation of images of knowledge. However, in my view these factors are relevant in respect of the body of knowledge as well. At this point it might also be emphasized that the images and body of knowledge are in many ways interdependent.¹⁰ The other side of this interplay is clearly remarked by Elkana when he writes: "Very often images of knowledge determine the acceptance of a new theory or of a new fact (i.e., they determine that a 'fact' is indeed a fact), even before the body of knowledge supplies all the necessary tools."¹¹ Elkana does not in fact explain in his paper what kind of role he thinks the body of knowledge plays in forming an image of knowledge and yet he stresses their interaction.¹²

As I have shown in chapter "The Academical Context of Natural Philosophy", the disciplinary structure at the Academy of Turku mirrored the epistemological boundaries between the disciplines. Each branch of study had its proper subject matter, legitimate methodologies and distinct aims, which together framed the scope of study for each discipline. It is typical of the learning at Turku that both these "partial" images of knowledge in each discipline, and the "meta-image of knowledge" by which the structure of the whole system of knowledge was justified, were shared and recognized as valid by the entire academic community. A special feature in almost all knowledge, but especially in natural philosophical knowledge, was that it was directed at the very community which produced it. There was no attempt to engage the lay public in the use and acceptance of these images, as is the case in modern science to some extent. But the closedness of natural philosophical knowledge is evident also in comparison with other dis-

⁹ Elkana 1981, p. 16-17. In 17th century scholastic Aristotelianism at Turku we cannot distinguish between "a theological framework and a scientific conceptual structure" at least according to modern criteria. In fact the "location on the sacred-secular continuum" played an important role in legitimizing the hierarchy of the various sources of knowledge, with religiously legitimizable knowledge occupying the top place.

¹⁰ Elkana 1981, p. 15-21.

¹¹ Elkana 1981, p. 56.

¹² Elkana 1981, p. 13-14.

ciplines. The function of theological knowledge was to save the souls of the people and the aim of medicine was to cure their bodies. Computation of planetary movements was an essential tool for compiling almanacs and in this way it became "useful" for the non-academic public, but natural philosophical knowledge mainly had only self-referential motivations. Knowing the causes of things was important in itself and at most it served as a key to wisdom. It also formed the basis on which medical knowledge was built. Finally it contributed to our knowledge of the Creator as well and thus it gave support to theology. These essential features in learning remained basically the same during the whole period concerned.

Although the general picture remains stable, minor changes occurred in the images of knowledge. There are some stylistic and methodological peculiarities, and changes in the emphasis of trends in research, which to some extent represent change in the images of knowledge. We shall next have a brief look at these three topics. I have argued in subsection "The Order of Disciplines" that the order of presentation in physical dissertations was closely bound to the proper method of enquiry in natural philosophy. Therefore, seemingly harmless stylistic changes can in fact imply more profound changes in the field of images of knowledge. The author whose peculiar style came under discussion at the end of the 1670's was Daniel Achrelius. He gives us to understand in the preface to his *Contemplationes mundi* that he had been criticised for his unusual style, among other things. This is somewhat odd, because in the controversy which arose in the Senate of the Academy, one of the main factors which spoke for the continued publication of Achrelius' theses was its style.

It is true, however, that Achrelius for the most part omitted certain central features in the dissertation tradition. He only seldom paid attention to the nominal definitions of things. His style of expression is, of course, unusually ornate and eloquent in other respects too. Ignoring nominal definitions certainly involves a re-evaluation of the purpose and valid methods of natural philosophy. According to Achrelius pondering etymologies, synonymies and homonymies would not bring out much essential knowledge of a thing and therefore the value of the entire procedure decreased in his eyes. This kind of thinking was naturally against the philosophical tradition, and diverging from tradition was an insult against the established hierarchy of legitimate sources of knowledge. In spite of this, not even Achrelius called the grand aim of philosophy into question: he also strove to know the causes of things, even though his idea of what contributes to this knowledge was slightly different from the others.

Similar and more far-reaching stylistic changes can be found in Cartesian dissertations. Interestingly enough the very same Achrelius praises Andreas Lundius in a gratulation for the latter's Cartesian physiological thesis for not immersing himself in scholastic terminology, which he regards as obscure. Observation and dissection instead are much more clear and reliable sources of knowledge according to Achrelius. Although Achrelius' presentation of the "old method" is overdone, a caricature, its main point is the attack on the dominant position of tradition as a judge of what counts as real knowledge.¹³

The "genuinely" Cartesian authors, Lundius and Torsten Rudeen of course had clearly different kinds of images of knowledge to the more traditional authors. They rejected the Aristotelian four causes and concentrated their examination on "efficient" causes only as they could be explained in mechanistic terms. The dualistic conception of substance also rendered the typical Aristotelian questions of matter and form irrelevant from the Cartesian point of view. Not only was the proper scope of inquiry different in Cartesianism, but they also had different views on what counts as an explanation and which sources of knowledge were the best for finding them. However, even if their images of knowledge were different from the Aristotelian ones, the Cartesians did not entirely reject all theories and conceptions which could be placed on the body of knowledge side. It was more usual for them to modify and transform a physical theory or a concept than to reject it altogether. Moreover, the body of knowledge can consist of several strata, so that even the borderline with images of knowledge may become blurred. Let me offer just one example which illustrates these two points. The existence of thunderstones (*lapis fulminaris*) was accepted both by Aristotelians and Cartesians as well. However, Cartesians explained their origin by mechanistic causes, and Descartes also tried to demonstrate this by arranging an experiment. Causal explanations are of course a part of the theory (body of knowledge), but at the same time the plausibility of certain kinds of explanations depends on further assumptions concerning the nature of knowledge in general (images of knowledge).

The third type of change in the images of knowledge, namely changes of emphasis in the orientation of research, is in external appearance very much related to the stylistic changes discussed above. We

¹³ Hahn-Lundius 1690, "Pereximie Dn. Respondens, ... Tuus D. Achrelius".

have seen how the concept of form, and especially ideas on the propagation of form were argued in detail until the 1660's. That the problem was less discussed in the 1670's may be mere chance, as the main interest areas lay elsewhere. In the 1680's and 1690's the same fundamental ideas about the propagation of form were obviously accepted as before, but now the doctrine is usually briefly stated as a matter of fact. The theory is not always even explicitly argued for, but is simply presupposed as a prerequisite for the explanation of related problems and thus left unarticulated. This change of emphasis is caused by the change in the status of the doctrine in question. Obviously the degree of certainty of the idea of the propagation of form was less stable in the early decades of the Academy of Turku. Although no clear antagonist to this theory can be pointed out, the detailed argumentation also served as establishing the preferred view among the local academics as well. This Sennertian interpretation of the propagation of form was of course rather new in the 1640's, which might explain the thorough way it was taught at the Academy. When the status of this idea stabilised in the course of years, the need to argue for it so explicitly diminished. This change then becomes visible in the choice of dissertation themes and other stylistic features.

A somewhat similar change of emphasis can be discerned in astronomical discussions. Now in the first two or three decades of the existence of the Academy physical theses on cosmology tended to be very general. Alanus and Thauvonius especially present summary overviews of the general structure of the universe. Things are stated as matters of fact, and certain ancient conceptions or Copernicanism are only perfunctorily argued against. One gets the impression that this was done because a good thesis had to argue against something simply for dialectical practice. However, during the last quarter of the century much more specific topics such as comets or the Sun are discussed. This change expresses itself as a change of literary genre from systematic compilation of theses (factual statements) to the type of dissertation which consists of nominal and pragmatic definitions. Thus the scope of questions to be asked is differently structured, or at least emphasised in a different way in these theses. On the other hand, mathematical astronomy first started to attack Copernicanism in earnest. Not that it would have been embraced by physicists either, but the mathematicians were the first who built some parts of their argumentation around opposing one and defending another theory. Although the discussion of Copernicanism was not as dominant a theme in astronomical discussions at Turku as might be imagined, it probably shaped the approach of most physicists too. If nothing else,

the emergence of a potential enemy made the scholars more conscious of the legitimate body and images of knowledge in both physical and mathematical astronomy. Aspects which were accepted but might have stayed unarticulated were now brought into discussion with a new intensity.

It might be pointed out here that these kinds of changes of emphasis occur within the dominant philosophical system and they do not involve a change from one tradition or conceptual framework to another. Not even new theories are integrated into the old body of knowledge. The changes of emphasis can therefore be called *changes* in the images of knowledge only as far as the degree of certainty of some parts of the conceptual and theoretical apparatus involves changes. Moreover, all the three types of the change listed here as mutations in the images of knowledge are trifling when seen from the viewpoint of the totality. The more fundamental assumptions about the nature and aims of knowledge remain the same. Only Cartesianism presents clearly different images of knowledge at Turku, but at this time they do not attract very wide support at the Academy. If we follow the model presented by Elkana, the relative stability of the images of knowledge should account for the strikingly small amount and limited depth of changes in the body of knowledge.¹⁴ I am very much inclined to accept this view. However, I would like to look for explanations for this stability from a slightly different point of view, and in this job Elkana's concepts are of much less use. I shall come back to the problem of stability somewhat later below. Before plunging into that problem, however, I shall deal with a matter which has much to do with the way the body of knowledge - and even the images of knowledge - are formed.

I have in this subsection tried to create a picture of the nature of change in natural philosophy. One of the most typical ways in which change occurs in the history of science is the dissemination of knowledge. This concerns practically all aspects of science: theories, methodologies, instruments, types of institutional organization, and so forth. I have pointed out earlier in this work that dissemination always involves many kinds of modifications and transformations of knowledge and this may happen in several ways among different groups of people. A special example of how such dissemination of knowledge

¹⁴ Elkana 1981, *passim*.

works is eclecticism, a process in which several kinds of ideas are combined, modified and accepted. Eclecticism is thus also a force which for its part generates scientific change in this particular historical context.

2. THE ROLE OF ECLECTICISM

The 17th century was a period in European learning when several traditions of natural philosophical learning - or images of knowledge - competed for their place in the sun of acceptance. Traditional Aristotelianism struggled to hold its dominant position in the learning at the universities. Baconian empiricism offered a new model of science especially in England, whereas on the Continent the Cartesian philosophy also achieved some success. On the other hand occult and cabbalistic traditions still offered a serious alternative for the acquisition of knowledge. One approach to science and philosophy which was developed in this shambles of methodologies was eclecticism. On one hand it was not unusual at 17th century universities to read both "old" and "new" authors, but on the other hand eclecticism also became a defined position.¹⁵

Eclecticism (in the sense I shall give it in the following) was perhaps not a wide-spread viewpoint in its own time and in our days it certainly is not a very well known philosophy. Indeed, excluding some quite recent studies in history of science, eclecticism is nowadays very much a forgotten approach. One reason for this general neglect may be the disparaging view of eclecticism which developed especially during the 19th century in connection with Hegelianism. According to this view eclecticism is despicable because it is inherently arbitrary, lacking criteria and inexact.¹⁶ Even some relatively recent accounts in philosophy accuse eclecticism of lapsing into the sin of unoriginality. Thus eclecticism is regarded as a product of minds not capable of anything better.

¹⁵ Gascoigne 1985, p. 395 mentions that it was quite usual e.g. at the University of Cambridge to read both old and new authors. Thus, for example, Newton started with Magirus and later proceeded to reading Descartes' works.

¹⁶ Lalande 1932, p. 186 compiles several negative statements about eclecticism.

Eclecticism is the name given to the position of those philosophers whose thinking is limited to examining the results of the intellectual labor of others. They then pick out what seems true and valuable without making a serious philosophical effort to combine these truths into a unified whole.¹⁷

However, since in the 17th century unoriginality was not a vice but a normal practice, eclecticism was viewed in a different light.¹⁸ This attitude originated most of all as a counterreaction to all philosophy bound up with the schools. This emphasis was still central to eclecticism when it became an ideal philosophy at the University of Uppsala during the first three decades of the 18th century. There eclecticism was seen characteristically as a rationalistic philosophy, as did the philosophers of French Enlightenment later. Uppsala eclecticism was based on the ideas of two German philosophers, Johann Christopher Sturm and Johann Franz Buddeus, who was of a younger generation than Sturm. Whereas Sturm was still ready to count as eclectics those philosophers who aimed at reconciling Cartesian and Aristotelian philosophies, Buddeus' generation dismissed this view as syncretism.¹⁹ The philosophical attitude which thus became dominant at Uppsala in the 18th century already had proponents during the previous century, at least at Turku. The eclectic ideology there is reminiscent of Sturm's, and it is perfectly possible that his writings were known at Turku, although this assumption is difficult to verify.²⁰ What then was eclecticism at Turku like?

It is problematical that not even the more neutral definitions of eclecticism take account of the various senses in which a philosophy can be called eclectic.²¹ Combining ideas in a somewhat random way was not strange for Aristotelianism either. In fact many ideas from other ancient traditions had found their way into the generally-accepted corpus of Medieval and Renaissance natural philosophy, and natural history in particular. On the other hand quite a lot of new knowledge, e.g. on geography, botany and zoology, had been merged into

¹⁷ Brugger & Baker 1972, p. 106.

¹⁸ On the history of the meanings attached to eclecticism see Donini 1988, p. 15-33.

¹⁹ Lindberg 1975.

²⁰ *Elenchus Praelectionum, Catalogus* 1712, 1713. Tammelin announces that he will lecture on Sturm's mathematics, but we cannot know for sure whether these lectures were really held because of the war.

²¹ *The New Encyclopaedia Britannica* 1991, p. 352.

the traditional body of knowledge by the 17th century. In fact, Charles B. Schmitt has based his classification of two types of eclecticism in Renaissance Aristotelianism on these grounds in one of his numerous articles.

Eclecticism in Aristotelian philosophy can be viewed from at least two different approaches. First it may be taken as a general impulse of some Aristotelians to draw material from non-Aristotelian sources simply because they thought that the insights found among the texts from other traditions could usefully be applied to strengthening their own philosophy. A second path lay in the tendency to accept new developments, particularly in science and the formalistic disciplines, which clearly offered superior doctrine to that derivable from normal Aristotelian sources.²²

Partly due to this eclecticism, partly to theological and other interests, different schools and authors had a great diversity in their views both about the fundamental concepts of natural philosophy and details of physical theories. Therefore there never was such a thing as - strictly speaking - *the* Aristotelian natural philosophy. In this sense all European universities were "eclectic" in their learning. We cannot talk about a pure form of Aristotelianism at Turku either, because ideas from many other philosophical traditions were also united to it there. Both types of eclecticism as classified by Schmitt existed at Turku too. For example, the three Paracelsian principles salt, sulphur and mercury, which were the cause of all sensible qualities like taste, colour and smell, were thought to be combinations of the four Aristotelian elements. A certain notion of the existence of atoms was accepted, and the transmutation of elements into each other was refuted. All these ideas were in disagreement with the mainstream of Aristotelian philosophy.

However, such combining of ideas is not really what I mean by eclecticism, which is characteristically a *conscious* approach in natural philosophy. At Turku this kind of approach is met from the 1670's - 1680's on. The word "eclecticism" itself was not always employed, but even then the attitude was expressed in other ways. Jacob Flachsenius puts the concept "Sectae Electicae" into print at Turku in the

²² Schmitt 1983, p. 91-92.

"history of philosophy" which he includes in his logic-book. He refers here to the ancient tradition which was associated mainly with Potamo of Alexandria. Flachsenius does not recommend eclecticism as a method, but he recognizes it as one of the most praiseworthy, if also difficult philosophies.²³

In his *Contemplationes mundi* also Achrelius mentions the "Sectae Electicae", which chose the necessary and rejected the trivial matters, and Asplund in 1712 mentions "eclectic philosophy".²⁴ Although the specific term was generally lacking, eclecticism was nevertheless a clearly defined attitude, according to which theories from different philosophical traditions could and should be brought together, guided by some "proper" or "sane principles" - which they actually were is then a much more complicated matter. In a thesis of 1672 the professor of Latin language Martin Miltopaeus wrote about the nature and proper uses of philosophy as follows:

[We understand by philosophy] neither the Stoic philosophy, nor the Platonic, nor Epicurean, and not Aristotelian philosophy either, but whatever is rightly said by these sects, this selected totality is to be called Philosophy, and it has to be stored up for our use, as Augustinus exhorts us.²⁵

And in 1690 Andreas Lundius who promoted Cartesian ideas in his thesis on sense physiology, denied being a slave of either Cartesianism or Aristotelianism: "I have drawn on several sources, but with my own vessel"²⁶, he says. I would also count as eclectics those authors on meteorology, who were mostly preoccupied with combining Cartesian and Aristotelian meteorological ideas together. Although for example Sveno Melander never abandoned the fundamental ideas of Aristotelian physics, what is significant is that he explicitly

²³ Flachsenius 1678, Appendix, p. 149-150.

²⁴ Achrelius 1682, Cordate et Candide Lector, b3. "Est insuper hic Character SECTAE ELECTICAE, quod seligat ex omnibus necessaria, rejectis supervacuis." Hahn-Asplund 1712, p. 45. "...verae sanaeque electicae Philosophiae..."

²⁵ Miltopaeus-Lithomannus 1672, Th. 1. "...non intelligitur Philosophia Stoica, nec Platonica, nec Epicuræa, aut Aristotelica, sed quæcunque ab his sectis rectè dicta sunt, hoc totum selectum, Philosophia dicendum est, atque in usus nostros, mo-nente Augustino, seponendum."

²⁶ Hahn-Lundius 1690, Apologia Ad Lectorem Candidum & Nigrum. "Ex pleraque hausi fonte; vasculo tamen meo."

confronts the old philosophy with the new and more critical one.²⁷ On the other hand Magnus Widebeck commented in passing on the possibility of combining the diversity of ideas into a coherent theory. He also seems to think that even contrasting ideas can be accepted if they can be "reduced" or modified into a form which fulfils the criteria of the "right" philosophy.

We shall reject the opinions of the above-mentioned authors [i.e. Achrelius, Rohault, Descartes, Clauberg], because they tend towards principles which we disagree upon. These [opinions] could perhaps be retained if time allowed us to properly explain their meanings. (Clauberg p. 48) *It would be ideal and beautifully done, if the thoughts of great men could be reconciled with each other, so that each would keep his position.* But doing this is prevented both by the weakness of our reason and the shortness of time.²⁸

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In other words the borderline between eclectic and syncretic procedures was sometimes a vague one. It seems that the elusive character of eclecticism and syncretism was typical of the 17th-century eclecticism in general, whereas the meaning of these two attitudes became more distinct from the end of the century on especially in the so called Halle school.²⁹ The aforementioned J.F. Buddeus was one of the main proponents of this new kind of eclecticism, which already clearly stood on the side of the new philosophy. At Turku Ericus Asplund referred twice to Buddeus in his thesis of 1712. However, these references are very superficial and do not include anything specific to Buddeus' thinking on eclecticism.³⁰ Although Asplund clearly is disposed to Cartesianism, he is reserved about some "universal" (=me-

²⁷ Hahn-Melander 1693, p. 15. "Sic placuit veteribus, Philosophia autem hodie oculata apparet, credit quod videt, aut immotis argumentis deprehendit, verum esse..." See also Kallinen 1993, p. 76.

²⁸ Hahn-Widebeck 1702, p. 9. "Sententiam autem Clariss. auctorum antea allegatorum [i.e. Achrelius, Rohault, Descartes, Clauberg] [non] rejicimus, nitiur enim principiis à nostris dissentientibus, & si ad mentem eorum illam explicare tempus permetteret, posset forsitan retineri; (Claub.p.48) *Optimum enim & pulchrè factum est si magnorum virorum sententiae possint conceliari, ut utraque locum obtineat, quod jam facere tenuitas ingenii & angustia temporis prohibet.*"

²⁹ Lindberg 1975, p. 225-229.

³⁰ Hahn-Asplund 1712, p. 8, 45. On the latter page Asplund also mentions Gerhard Vossius' book *De philosophia et philosophorum sectis* (1658) as a source for further study about the subject of what kind of ideas can generally be reconciled.

taphysical) features in that philosophy. This is because they are "less congruent with the true and real eclectic philosophy".³¹ Asplund's philosophy also has this syncretistic character, which of course is contrary to Buddeus' view. What Asplund actually tries to do in his thesis is to reconcile the two philosophies as far as is possible and his space allows. Asplund has no unrealistic phantasies about how far this program can be taken: the old and the new are never *entirely* compatible with each other.³²

Most of the eclecticism at Turku was about theories, but we might also ask whether there was not eclecticism about methods, too. This was not very common. However, possibly the most striking example of methodological eclecticism was Andreas Pryss' thesis on the rainbow in 1692. Pryss follows very closely the traditional order of presentation, which mirrored the proper method of inquiry in physics. However, the contents of Pryss' arguments are based on the Cartesian geometrical method. Usually authors who drew physical conclusions from mathematical reasoning were accused of making serious category errors, but nothing of that kind came up in Pryss' case, since his work could be seen optical as well as physical. Mathematical argument was traditionally legitimate in the field of optics. All in all, quite a lot of new ideas on theoretical details could be embraced without any problems at all. In methodology only a limited amount flexibility was possible.

What is more important to notice, though, is that eclecticism was actually seen as a method in itself, and as a new kind of a method. The author at Turku who was most outspoken in support of this approach was Achrelius, and I shall in the following summarise his views. Perhaps the most dominant aspect of eclecticism at Turku was the emphasis on the notion that one should be free of all sects. This demand was very much "in the air" during the 17th century, and it received its most famous expression in the motto of the Royal Society: *nullius in verba*. According to eclectic philosophy the wise man would not be a slavish follower of a ready-made system, but would carefully

³¹ Hahn-Asplund 1712, p. 45-46. "Cartesium utut in nonnullis & quidem praecipue universalibus, quae verae sanaeque eclecticae Philosophiae minus congruere videantur, erroneum, vel novum... suspectum."

³² Hahn-Asplund 1712, p. 5, 16, 19, et passim. p. 5: "Quamvis neque virium mearum neque instituti sit, omnia veterum ac Cartesii dogmata inter se conciliare, vel quid probabilius in utrisque reperiatur, eruere."

select the best views by himself. This idea was expressed by Achrelius, Lundius and Torsten Rudeen as well.³³ This assertion was principally directed against the dominant position of Aristotelianism, but it held good in respect to other philosophies too.³⁴ Of course, the fact that the two Cartesian authors claimed not to be enslaved by the new philosophy may also have been due to a certain caution. It was not, after all, a very wise strategy to pronounce oneself a proponent of such a suspicious philosophy as Cartesianism. Achrelius on the other hand seems to associate the intellectual independence from sects with a better capability to achieve truth. Conversely, this implies that sectarians love their dogma more than the truth.

Finally, to understand is not to belong to this or that Sect, or to venerate one author's name and precepts, despising thereby the internal properties of things, but to be wise is to defend the truth by reading much, being rich in experiences and happy in one's actions.³⁵

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A man free of all sects would be able to choose the best and most useful theories. This process essentially involved careful consideration. Theories were not to be picked out at random. It was necessary to proceed *cum iudicio*, because "monstrous errors" were made by earlier, especially pagan philosophers (*Ethnici*). At this point a question arises quite naturally about the criteria which were to be used for choosing suitable doctrines. In this aspect J. Chr. Sturm and the 18th-century tradition at Uppsala emphasized man's reason and his own experience as the proper criteria for recognizing the truth. Compared with them

³³ Achrelius 1682, Cordate et Candide Lector. "Tunc ea quae quondam ex diversis magistris excerpebam, non ut mancipium ab *alieno nutu pendens*, sed retinens modestae libertatis, placuit colligere, disponere, & in gratiam illorum publicare, quibus propter egestatem non datur facultas, Excellentium virorum monumeta adire." Hahn-Lundius 1690, Apologia. "...Du Hamel (ut qui conciliator utriusque Philosophiae salutatur) paulò pressius fui secutus, ita tamen ut à Nemine compe-des mihi injici patiar: ...Aristotelicae servitutis jugum meae cervici non imponetur." On Rudeen see Hultin 1902, p. 123-125. Klinge 1987, p. 428.

³⁴ Cartesianism was sometimes criticised for its attempt to replace one kind of dogmatism (Aristotelian) with another kind (Cartesian). Clarke 1989, p. 17-18.

³⁵ Achrelius in Hahn-Lundius 1690, Pereximie Dn. Respondens, b. "*Hoc demum est sapere, non alligare se huic vel illi Sectae, vel unius nomen ac praecepta venerari, contempta rerum indole. Sed lectione copiosus, experientia dives, actu felix, eloquio promptus, veritatem defendere.*"

Achrelius appears much more traditional and cautious in his views. Certainly no ideas which implied or led to theological errors could be accepted. But Achrelius also named authority, sense-experience, reason and the "guidance of the nature itself" (*ipsius naturae manu-ductio*) as selective criteria.³⁶

The selection of optimum theories out of a multitude of alternatives was made possible by philosophical or academic freedom. Because according to eclecticism no predetermined and ready-made set of truths existed (it was considered characteristic of the sects to claim that there were), new truths could be found. In this sense knowledge could also thus grow. However, this idea of progress was not a modern one, Achrelius referring here to the antique authorities.

*This Queen [=truth] is revered by the honest Academic freedom together with the privileges which the most wise of the Romans gives us with his very brief words, which nevertheless are well worth thinking about: they who lived before us did a lot but they did not accomplish everything. There still is much left for our age to do, and the possibility of still adding something is not excluded even from someone born after a thousand centuries.*³⁷

A central implication in the concept "philosophical freedom" was that it gave the philosopher licence to deal with doctrines which were perhaps very tempting, but suspicious and unacceptable from some more important point of view. Usually it was theology which set this limit for acceptability. When Achrelius excused himself in the preface of his *Contemplationes mundi* for discussing the homogeneity of the cosmos, he did this expressly by pleading his philosophical freedom.³⁸ Perhaps more explicitly than any other author at Turku Achrelius de-

³⁶ Achrelius 1682, Cordate et Candide Lector, b3. According to Lindberg eclecticism at Uppsala also served the function of mediating between theology and natural philosophical ideas potentially in disagreement with it. Lindberg 1975, p. 218-220, 230-232.

³⁷ Achrelius in Hahn-Lundius 1690, Pereximie Dn. Respondens, b. "*Hanc Reginam [=veritatem] adorat sincera libertas Academica juxta privilegia quae nobis dat sapientiss. Romanorum brevissimis verbis sed proluxae meditationis: multum egerunt, qui ante nos fuerunt, sed non peregerunt; multum adhuc temporis restat, nec ulli nato post 1000. secula praecluditur occasio aliquid addendi.*" Achrelius refers here to Seneca's 64. letter to Lucilius. This particular citation was much used in the 17th century. Eriksson 1969b, p. 164.

³⁸ Achrelius 1682, Cordate et Candide Lector, b3.

rives a certain kind of scepticism from his eclecticism. The multitude of probable-looking theories and the obvious inability of men to reach unanimity e.g. in respect to astronomical theories was for Achrelius a sign of the feebleness of man's reason. On the other hand this insecurity also provided a useful screen. Whether we end up promoting this or that theory, we can never attain absolute certainty: man must be humble before God's creation. You accuse me of embracing false theories - do you thus regard yourself as more competent than all other men to judge these things? This was fine and convincing rhetoric. As I shall argue later in this conclusion, setting oneself above others was a serious offence according to the 17th-century mentality.

Thus, on the whole the use of philosophical freedom presupposed mature consideration. A freedom which had been misused (i.e. unacceptable theories had been embraced) was not *libertas* but *licentia*, arbitrariness.³⁹ This view of the limited freedom of philosophy received official expression in 1689, when the king handed down his decision on the Cartesian disputes at Uppsala, permitting the free use of philosophy provided the monarchy was not offended and Holy Writ was not criticised. Thus not even the Bible's sayings about the constitution of the natural world could in principle be repudiated. It is clear that this kind of resolution could not settle the matter. Indeed, both parties to the Cartesian controversy interpreted it as victory.⁴⁰ The settlement was gradually achieved by socially negotiating the rules of mutual conduct.⁴¹ For example, the Bible was not explicitly criticised, but it was the result of social agreement to judge what would count as criticism. The rules for the right selection of theories in Achrelian eclecticism worked ultimately in very much the same way.

I have suggested the German philosophers such as Sturm and Buddeus, and even the Dutch humanist Gerhard Vossius and his son Isaac as the possible models for the eclecticism at Turku. However, there is also another source of inspiration here, which cannot be left unnoticed. The demand for philosophical freedom, scepticism about sects, anti-Aristotelianism and the emphasis on clarity of expression are all

³⁹ Lindberg 1975, p. 230.

⁴⁰ Lindberg 1975, p. 218-219, 232.

⁴¹ For social negotiation in modern science or the so-called closure mechanisms of otherwise potentially unending controversies see e.g. Collins 1992, p. 127-130, et passim.

features found e.g. in Achrelius' *Apologia*, but they also played a central role in Ramism.⁴² Ramus' philosophy had been directed mainly against the dominance of Aristotelianism in school philosophy, and revolt against Aristotelianism was a central motive behind eclecticism as well. Unlike most of Europe, Ramism had maintained a favoured position in Sweden well into the 1650's. The tradition was thus not far removed and Achrelius' eclecticism especially may very well partially echo the Ramistic program as well.

During the 17th century eclecticism surely was a symptom of dissatisfaction with the explanatory models which Aristotelian philosophy could offer. It also obviously helped to bring up new ideas, and broke the methodological dominance of scholasticism. What is more, it stressed the importance of the scholar's own judgement as against predigested and systematised information. As a force for change it was nevertheless rather inefficient, mostly because its criteria for the selection of the "best theories" were still closely bound up with old values - or if you wish - the old images of knowledge.

Achrelius' conceptions of eclecticism and the freedom to philosophize are organically related to his need to defend himself against accusations of introducing novelties. I shall in the following introduce these novelties; what were they and what do the attitudes towards them tell us about 17th-century philosophy in general?

3. FACING THE NOVELTIES

As Yehuda Elkana has stated in his analysis of the images of knowledge, the pursuit of originality is a driving force in present-day science. Although the metaphysical implications of this standpoint are not

⁴² Sellberg 1979, p. 103-108, et passim. Achrelius 1682 expresses his demand for clarity in "Cordate et Candide Lector", b3. Although he states it as a rhetorical principle, clarity is realized by avoiding typically scholastic terminology and such definitions as were central to dissertation writing at Turku. "*Fabius Perspicuitatem primam eloquentiae virtutem appellavit, Inde effugere volui horridam spinositatem & terminorum jejuna, placideque ad communem sensum candide & intrepide sensa animi mei efferre.*"

usually discussed, the scientists often treat innovation or technological advance as a criterion for knowledge, and, for instance, strive to use the latest machinery for their experiments. Indeed, original discoveries are essential stepping-stones in a scientist's career.⁴³ In the 17th century the general attitude towards innovation was very much the opposite. To be a new idea was in itself something bad. Whereas the "traditionalists" saw "novelties" as inherently bad or at least suspicious, the proponents of modern science often railed against this attitude.⁴⁴ For instance, the way in which the two contemporary authors John Donne and Francis Bacon in England expressed these views has become a classic of the history of literature.

And New Philosophy calls all in doubt,
The Element of fire is quite put out;
The Sun is lost, and th'Earth, and no man's wit
Can well direct him where to look for it.⁴⁵

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John Donne has become famous for expressing the feeling of insecurity ("all coherence was gone") - but also for a sort of titillating excitement in facing the novelties of the new science. On the other hand we can hear Francis Bacon in his *Novum Organum* bewail the conservative attitude at the Universities:

Again in the customs and institutions of schools, academies, colleges and similar bodies, destined for the abode of learned men and the cultivation of learning, everything is found adverse to the progress of science. ...For the studies of men in these places are confined and as it were, imprisoned in the writings of certain authors, from whom if any man dissent he is straightaway arraigned as a turbulent person or innovator.⁴⁶

⁴³ Elkana 1981, p. 20. Knorr-Cetina 1981 goes deeper to explain the social motives behind this respect for innovation. On the rhetoric of constructing an innovation see Blakeslee 1994.

⁴⁴ A basic study which discusses the polemics about the terminology and attitudes towards old and new forms of scholarly work is Jones 1961.

⁴⁵ The relevant passage from Donne's *An anatomy of the world* from 1611 is frequently quoted in histories of science. See e.g. Brooke 1991, p. 56.

⁴⁶ Bacon 1988, Book I, Aph. XC.

The avoidance of innovation was a wide-spread and established attitude in Europe in the 17th century. It is not surprising then to find it well alive at Turku either. But what was this "anti-noveltism" like at Turku, then? It is notable that in Sweden just as in some other countries and organizations this attitude was an official policy.⁴⁷ There is a famous remark by the Rector of the University in 1642, that: "every professor must be careful not to present new ideas, since he would seem to be doing more and better things than the others, and thereby would undoubtedly awaken suspicions and disagreement."⁴⁸

Three years later the matter was put even more plainly in a statement, made in the Senate of the Academy:

It was also remarked here in the Senate that none of the professors may, without the consent of His Royal Majesty or the Chancellor of the University, publicly lecture on any other author but those especially mentioned in the constitutions of the University. The lectures must also be hurried on so that an author's text will be dealt with in the prescribed time. And nobody must oppose the good opinions of the old authors, and defend one's own or some new opinions in public. But if there is some mistake or error in the old authors, the best should be made of it, and a well-grounded opinion should be explained to the students in addition, so that they can choose the better alternative opinion.⁴⁹

⁴⁷ Jesuits for example prohibited teaching and holding new doctrines or opinions in 1586 in order to secure the position of faith. Ariew 1992, p. 66-67.

⁴⁸ CAAP I, 14.5.1642, p. 54. "...absoluto ita feliciter examine publico, bleeff Consistorium hållit, då gratuleradhe Rector Magnificus, at examina publica nu äre tillbörligen ändade. Ther hooss ratione officij admonerade wenligen, at hwar och en professor achtar sigh för all tingh therföre, at han icke något nytt proponerar till then ändan, at han skulle synas något mehra eller bättre kunna göra ähn the andra, ther af twifwels uthan, förargelse och osämia kan sedhan förorsakas."

⁴⁹ CAAP I, 22.1.1645, p. 149. "Bleff och ornalt här in Consist., at ingen af profess. må vthan H.K.M:tz eller Acad. Cancell. special befallning publ. läsa någon annan authorem, vthan then, som in constit. vthtryckeligen nämpnes; och ändtligen medh praelectionibus så foort sättiandes, at author innan den tijdh, som föreskrifuit är, berömligen absolveras. Eij skall heller någon lasta gamble authorum godhe meningar och sin egen eller någon nye authoris meening eller opinion eenwissligen publice defendera. Vthan the så hende, at någor feel funnes i thee gamble authoribus, sådant må man i besta mätto vtthya, och ther jämpte sin grundade meening discipulis kungöra, at thee sedhan måge eligera, then som better synes om saken, döma."

These quotations show quite a strong vein of official traditionalism. This policy was valid throughout the period concerned in this study. It should be noted, however, that these bans were not directed exclusively against new ideas in natural philosophy or astronomy. The church and the state were much more interested in potential deviations from the right religion or the right course of political thinking. Of course, even general bans against novelties could be turned against natural philosophy as well. Most of the ideas which were labelled as such at Turku were of Cartesian origin, but authors such as Achrelius and some theologians also had to face the accusation of being innovators.

The next question we have to ask is what a "novelty" was, in fact. It seems that for some it was any idea deviating from the established way of thinking. Indeed, in 1712 an author begins his thesis by remarking that when some people call Cartesianism a "new" philosophy, they actually mean it is a false one: "But this [Cartesian philosophy] is called *new* not only because it has arisen closer to our times, but the word unfairly also equates to unknown, unfamiliar or sometimes even false."⁵⁰ The use of the concept "novelty" actually does bring very strong connotations of falsehood, although it might be too daring to equate its meaning with it. As my discussion in the next subsection of this chapter will show, the category of novelty had a distinctly negative meaning of its own.

But there are other characteristics of innovation which should be taken into account. The concept itself indicates that the idea in question should preferably also be a new one. However, this is not strictly speaking always the case. For example, heliocentrism had all the qualifications for being called a novelty. It was a relatively new idea, and it was an idea which was certainly not accepted at Turku for most of the 17th century. Nevertheless Copernicanism was not labelled as a novelty at Turku, but was belittled by associating it with an ancient tradition which had only recently been revived. On the other hand it was possible to label an old concept a novelty. There was a well-known controversy in theology in 1666 about Petrus Bång's doctoral thesis, one of the controversial aspects of which was that he had called God the instrumental cause of the Christian church. Because of this

⁵⁰ Hahn-Asplund 1712, p. 4. "Sed cum illud [Philosophia Cartesiana] non tantum dicatur novum, quod tempore nobis est propius; verum etiam incognito, inaudito, imo falso quandoque, quanquam abusivè aequivalet."

and some other expressions other theologians accused him of introducing a novelty. However, the concept supposed to be a novelty here, *causa instrumentalis*, was an old scholastic concept. In this case it had only been used in a new context and therefore presented certain dogmas in a slightly different manner and, as its opponents suspected, also changed the meaning of the dogma.⁵¹ I mention only two examples here, but we must in general be careful when talking about novelties, because there seems to be different ways in which an idea could be called so.

In fact, it seems that most of all "novelty" was a very efficient rhetorical category. This does not mean, of course, that it was somehow without any further content. On the contrary, only ideas which posed a threat to some fundamental part of the traditional philosophical system were called novelties. But it obviously was used as a rhetorical device both for inhibiting the spreading of new ideas and for shaping the self-image of the new science. The latter use is clear for example in the quotation from Bacon which I cited above. There were several strategies for dealing with the innovations which were employed at the University of Turku too. A brief summary of the strategies both *pro* and *con* innovation will further illustrate my point.

Cartesianism was considered to be one of the most serious threats to right philosophy at Turku, and therefore it might best offer us an overview of the matter to look at the reactions and responses this philosophy provoked. The main strategy of protection at Turku was to keep Cartesianism away as long as possible, and judging by the historical evidence this strategy was very successful for a considerable period. Several tactics were used for achieving this goal. First of all Cartesian ideas were labelled as contrary to theology, and often equated with religious heresies (or opinions characteristic of non-Lutheran confessions). This was done for the first time by Petrus Laurbecchius in 1661, who in his strongly polemical work equated Cartesian views on substance and especially extension with Calvinistic thought. Laurbecchius was also the first to bind Cartesianism together with another unwelcome theory, Copernicanism. For the proponents of these philosophies it made things more difficult, because each of their claims tended to involve a growing number of very difficult implications. Therefore it became more laborious for them to make positive state-

⁵¹ Laasonen 1977b, p. 303.

ments concerning either Cartesian or Copernican ideas. However, it was most of all Cartesian metaphysics which was generally found unacceptable. All in all, Cartesian theories were in the 1660's and 1680's especially interpreted from the Aristotelian point of view and therefore it was easy to accuse them of category mistakes in methodology. The picture offered of Cartesianism was often very fragmentary: only individual propositions were treated and there was no attempt to see them in the larger context of the Cartesian philosophy. It was also typical that the knowledge of the system was usually based on secondary sources.

Despite all this, Cartesian ideas could be introduced without difficulty, if the theories embraced concentrated on details of, say, physiological or meteorological theories, and the validity of Cartesian dualism or epistemological principles was not defended. It is very probable that most authors would not even have accepted these ideas themselves. On the contrary, there was an eclectic tendency to select and embrace some Cartesian ideas, and a "syncretistic" tendency to adjust them to the traditional philosophical framework as much as possible. Indeed, we can say that the main strategy for introducing new ideas was to adjust them to the existing body of knowledge. Those authors, especially Torsten Rudeen, who introduced some exceptionally radical new ideas at Turku, had to employ different kinds of strategies. In responding to the accusation of proposing new ideas which had been brought against him, Rudeen claimed, for instance, that he was not presenting anything new. Rudeen claimed that Cartesianism was only a purified and original form of the old Aristotelian theories. In the course of the controversy he at one point denied being an adherent and proponent of the new philosophy, and stated that he was only explaining it. Rudeen also appealed to the general practice of the day, saying that the ideas he stood for had been accepted elsewhere. Finally Rudeen emphasized that his teachings were in no way against religion.⁵²

The argument Rudeen employed had many characteristics which were common in the European Cartesian disputes in general. However, it is notable here that many of his arguments show that also he took the accusation of introducing novelties seriously. There is one more very exceptional excuse that was made with regard to innovation which might be worth having a look at. This example takes us fifteen

⁵² On Rudeen see subsection "The Emergence of Cartesian Dualism".

years back from the time of Rudeen's controversy. I have in the foregoing repeatedly referred to the various kinds of excuses Daniel Achrelius made in the preface to readers of his book *Contemplationes mundi*. Achrelius also draws upon the argument that the alleged novelties are in fact old. The peculiarity of his argument lies in the assumption that ideas return cyclically in the course of times.

Moreover, if they [= A.'s critics] smell novelty in the things which I present [then I shall tell them] that all ancient dogmas return to daylight in circular course. Indeed, I do not present here a single line which I could not if necessary prove either by authority, senses, reason or by the guidance of nature itself.⁵³

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Novelty was an important concept in the 17th-century learning in general. The word had a notorious reputation and even those authors who presented new ideas attempted to dissociate themselves from allegations that they had favored novelties. Opposing them was also an official policy, and efficient rhetorical strategies (and sometimes plain censorship) were employed to dispel these unwanted ideas. This policy was well in line with the ideology which stood behind the foundation and function of the university. As one of the main aims of the University was to guard the right religion, any ideas which would potentially erode the structures on which the dominant status of orthodox Lutheran religion was built would therefore have to be eliminated. Stability was after all perhaps a more characteristic feature of the learning at the Academy of Turku than change in the period concerned. In the next subsection I shall try to show what might have caused this stability.

⁵³ Achrelius 1682, Cordate et Candide Lector, b3. "Porro si novitatem sapiunt quae adfero, per gyrum redeunt in lucem universae vetustatis dogmata, sanè, vero nullam lineam adduco, quam non auctoritate, sensu, ratione, & ipsius naturae manuductione, possum ubi opus fuerit probare."

4. EXPLAINING STABILITY

The question about stability in science can be put in many different ways, some of which are less satisfactory from the historiographical point of view than others. We must be careful when asking why scientific change was delayed or did not occur in this or that country or discipline. The way in which this question has been put in some studies smacks of asking "Why did the inevitable not happen?" or "What inhibited the people from accepting these clearly more advanced and correct claims about nature?"⁵⁴ This kind of approach not only implies an idealised and untrue picture of science,⁵⁵ but it also drives us alarmingly near to the sin of presentism, i.e. appreciating historical events on the basis of our own evaluations of what the "proper" scientific practice should be. Evaluative anachronism cannot avoided either, if stability is contrasted with progress. This view was in fact taken as the starting point in a fairly recent study, in which the causes of the "stagnation" of astronomical learning at the Academy of Turku were considered.⁵⁶ The concept of progress is almost inevitably bound up with our own evaluations, and is therefore not suitable for the kind of historiography of science I want to promote in this study. I would like to put the question mentioned above in another sense.

My search for the causes of stability, or tardiness of change should be taken as a part of the general description and analysis of a certain historical context. Stability is a historical phenomenon as well as change. Instead of evaluating the past, my analysis of stability endeavours to explain historical processes on their own premises. The "changes" we are after are naturally those reorganizations both in the

⁵⁴ Good examples are to be found in Lehti 1979, p. 63-97.

⁵⁵ This so-called "sociology of error" has been criticised in numerous articles from the 1970's on. See e.g. Bloor 1976, p. 10-11. Knorr-Cetina 1981.

⁵⁶ Lehti 1979, p. 63, et passim. "...at the beginning of the eighteenth century the view of the location of the Earth among other planets (which Copernicus had put forth over 150 years earlier and which many of the greatest scientists in history had proved indisputably true during the seventeenth century) was still dogmatically rejected without making oneself familiar with the theory. Thus it has to be said that here is a paradigm of the lack of progress or stagnation. In this chapter I intend to shed light on the question about the causes and manifestations of stagnation." (translation mine)

body and images of knowledge which are so well-known in the 17th-century history of science. The Aristotelian natural philosophy and concept of science were abandoned, and the new models for scientific enquiry came from various traditions, usually Baconian or Cartesian. One of the main indicators of this "scientific revolution" has also been the acceptance of the heliocentric system. I am not asking why none of the trail-blazing inventions of the new science or contributions to them were made at Turku, because I find this kind of speculation pointless. But I am going to ask which factors in the organization of learning at the Academy of Turku were responsible for the fact that some of these typical features of new science were not accepted - or even discussed - more quickly at Turku. Talking about slowness or rapidity is of course always relative to something else. Thus we can ask further, whether this process of change was slower at Turku than elsewhere in Sweden and Europe. I shall deal with the topic of the University of Turku in an all-European context somewhat later below. Here it suffices to mention that change, or giving up Aristotelian natural philosophy did not necessarily happen much later at Turku than in many other European universities. In a way the whole question of the pace of change is due to an illusion caused by comparison with the very pinnacle of 17th-century new science.

The causes by which we can try to explain stability are very similar to those by which change can be explained. In whatever kind of institutions or organizations science is pursued, it is never entirely separated from the culture and society around it. Depending on the point of view we can say that science is always a part of culture, or that science is a culture. Just like all other "cultures" (such as art, religion, politics etc.) science interacts in many ways with surrounding political, economic and social forces. It is shaped by them and conditions them in turn. It is then the task of an historian to consider how science is involved in these processes in different historical contexts. It has been typical of earlier historiography of science to see the production of scientific knowledge as separate from social and economical processes. However, modern SSK studies have taken quite a different view, claiming that social processes are involved in the production of all kinds of scientific knowledge. Although it is not my intention here to apply any of the sociological approaches in full, it should become clear from the following that much of the structure of learning consists of specific kinds of social relations.

The SSK approach disputes the existence of the traditional division into "internal" and "external" factors in respect to the production of

scientific knowledge.⁵⁷ More generally, however, it is very difficult to discuss these factors without committing oneself to some sort of division, at least linguistically. One of the typically "external" forces in this respect is economics. We can ask, whether the stability of learning at the Academy of Turku could be explained at least partially by the economic situation of the country. Of course, it would be naive to expect any direct causal dependence to exist between certain natural philosophical ideas and economic factors. Neither does it lead us any further to claim that the economic structure of Sweden, and especially its province Finland was entirely agrarian and therefore there was nothing in its economy to stimulate scientific change. Either economic life does not produce scientific change in a way characteristic of simplistic Hessianian views, or the connection between science and economics is only very rarely as direct as this.⁵⁸

Of course economic factors did play a significant role in creating the general conditions for the function of the University. We know, for example, that the professors at Turku were paid less than their colleagues at Uppsala, and that the payments were often late.⁵⁹ It could therefore be supposed that Turku was not an attractive place for the more gifted scholars, who preferred to stay at the wealthier Uppsala instead. The university also had only a limited amount of money to invest in books or scientific instruments. However, these are very trivial explanations and do not in themselves explain such things as by which criteria it was determined which books were to be acquired for the Academy.

On the other hand economic motives could direct the course of scientific activities. During the 18th century mercantilistic and utilitarian thinking achieved a great vogue in Sweden. It was then generally thought that universities should also participate in enriching the nation by producing knowledge which could be economically valuable.⁶⁰ Charting the mineral and botanical resources of the country became a major area of emphasis in natural history, and meteorology was met with new interest in "physics" because the climatic conditions

⁵⁷ From the large amount on literature see e.g. Knorr-Cetina 1981. Latour 1987, 1988. Shapin 1992.

⁵⁸ For a critique of this approach on its "home ground" see e.g. Henry 1992, p. 178-181.

⁵⁹ Klinge 1987, p. 146-167.

⁶⁰ Liedman 1986.

of agriculture were to be studied. Economic interests became involved in many ways in the production of knowledge. As the main expression of this new attitude the chair of poetry at Turku was changed to a chair of economics in 1747.⁶¹ In the 17th century, however, university learning in general and natural philosophy in particular were not supposed to produce such economically straightforwardly utilizable results. I would claim that this had not so much to do with the predominantly agricultural structure of the country (that aspect remained much the same even in the 18th century) as with the pre-established ideals of what knowledge was all about. The task of natural philosophy was to find the causes of natural things and this activity as *scientia* was sharply separated from manual arts. This was not merely a question of appreciation but was based on an epistemological division between arts and sciences.

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This leads us to ask whether there were any stabilizing factors inherent in the Aristotelian system itself. Indeed, it was a central feature of the Aristotelian philosophical system that it was considered to be essentially ready-made. But Aristotle's and his commentators' texts were full of ambiguities and gaps. Much of the medieval scholars' time had gone into making sense of all this. Thus, although the system could be organised in a better way and could be supplemented by adding some details, on the whole of the enterprise of natural philosophy was already complete.⁶² Therefore it also lacked a concept of progress, which sees progress consisting in the rejection of old and acceptance of new and "better" ideas. As Edward Grant has pointed out in one of his articles, the corpus of Aristotelian knowledge was "atomized" into single *quaestios* which inhibited the formation of any coherent whole which would then have drawn attention to possible inconsistencies. By the 17th century this inconsistency simply grew because new knowledge was merged into the framework of the old system. In a way then, as Grant suggests, the problem of Aristotelianism was not inflexibility but too much flexibility.⁶³ Although there certainly is some truth in Grant's view, it does not reflect the situation at Turku. The body of knowledge there might have included inconsistencies, but we hardly can say it was necessarily "atomized" to any considerable extent. There was, for example, a relatively coherent

⁶¹ Lindroth 1978, p. 40, 91-145.

⁶² See e.g. van Berkel 1981.

⁶³ Grant 1978b.

view on what kinds of explanations would count as efficient causes. The same views also set limits to the flexibility of the system.

In other words it is evident that we must give up the attempt to employ the "external" (especially economic) factors on such a coarse level as described above. We should rather approach the matter from a different angle and consider how the economic and political factors formed part of the social structures which tended to favour the production of certain kinds of knowledge. On the other hand we have seen that merely "internal" explanations prove to be insufficient as well. What seems to be inherent to the intellectual structure of the system is in fact produced by various kinds of social processes and negotiation.

I have claimed in this work that the socio-professional roles in the academic world were based on epistemological boundaries and *vice versa*. Every discipline had a specified subject matter and the methodologies to be used in each of them were also closely defined. Moreover, each discipline had a proper end or *finis*, which the enquiry was supposed to fulfil. These disciplinary boundaries then served as a basis for the formation of professional roles. More crudely the differences between professional statuses were of course visible in rates of pay: according to the statutes the yearly income of the professors of theology was considerably higher than that of the professors in the Faculty of Arts.⁶⁴ But even more importantly the various disciplines were respected to a different extent. (Of course even the grading of salaries was ultimately based on differing appreciation of the disciplines.) Furthermore, the evaluation of different disciplines had its source in the more general cultural values of the time, thus theology as the science of God and salvation of souls was of an extreme importance. These appreciations created a hierarchy which determined the views on competence; it conditioned who was qualified to produce and judge certain kinds of knowledge. In this sense the disciplinary boundaries also had an important social dimension.

This picture is however more complicated in reality. It has been stated several times in this work that it was not unusual for professors to publish theses on subjects other than what their own profession actually prescribed. In other words it seems that in daily practice the

⁶⁴ Schybergson 1918. However, the professors of law were the worst paid, because they were expected to receive extra income from other sources.

professional roles were not as profoundly differentiated as might be expected. However, the flexibility of the professional roles was limited by the epistemological boundaries: whatever the status and profession of the author, the methodological rules of the discipline in which the subject matter belonged had to be followed.⁶⁵ Because the whole hierarchy of knowledge and the social roles intertwined with it were based on the epistemological boundaries, they had to be respected, too. It seems that this criss-crossing of professional boundaries provoked argument between the professors only when these boundaries were broken in some respect and/or some personal grudge was involved.

The immediate reasons why a professor wrote about a subject not in his proper field ranged from personal interest to an increased demand of certain kinds for thesis caused by special conditions at the Academy. However, what ultimately made this flexibility possible is a special property of knowledge which was inherent in the Aristotelian system. I call this factor the "impersonality of knowledge". Aristotelian philosophy was characteristically a system of *learning* as opposed to those of inventing and discovering. There were neither groups nor particular kinds of individuals specialized in the production of new knowledge. As long as you were a member of the academic community and respected the boundaries implied by the definitions of knowledge you got access to the entire body of philosophical knowledge *in the sense* that there was no *expertise*. Some scholars might have been better-versed in certain branches of knowledge than others, but the knowledge itself was potentially attributable to any scholar. It is also due to this impersonality of knowledge that the students were trained so that they could at least in principle either defend or oppose any thesis.

Obviously then some of the epistemological and/or social borders were more rigid than the others. For example, the transition from philosophical geography to the description of the mores and history of the people living in the area in question could be effortless, while the borderlines e.g. between physical and mathematical astronomy or between theology and philosophy in general were much sharper. The

⁶⁵ This feature was not peculiar to Turku, but it was in fact rather usual for the early modern academics to shuttle between different disciplines whilst never challenging the lines separating them. Westman 1980, p. 105. Westman 1980b, p. 90-91.

renegotiation of disciplinary boundaries and the social roles involved in the production of knowledge in the 16th and 17th centuries have recently been examined especially in respect to the borderline between physics and mathematics, but interesting surveys on the relationships between physics and medicine have also been made.⁶⁶ These studies show very clearly that there is a connection between the social order and epistemology or the "images of knowledge". The status of mathematical knowledge and thus mathematicians was the subject of much discussion during the latter half of the 16th century and at the beginning of the 17th. For example, both Copernicus and Galileo had either to employ certain kinds of argumentative strategies or, in the case of Galileo, to create for himself a new social role in order to be able to make credible mathematical claims about physical nature. At the same time the institutional status of mathematicians changed and often came to involve non-academic patrons and organizations.⁶⁷

Similar kinds of tensions between disciplines probably evolved at Turku too, especially with the advent of Copernican and Cartesian ideas. However, there were no such channels at Turku into which this tension could have been directed, in which it would have had soil to grow and space finally to burst out, producing new solutions, and thereby changing science. For example, for Galileo the evolving absolutist court culture and royal patronage offered an opportunity to institute a new position as a royal astronomer, separate from the traditional university structures bound to Aristotelian conceptions of the status of mathematics. During the 17th century many European royal courts did indeed become considerable centres of scientific and scholarly activity as the philosophers were supposed to attain glory of their patrons by their own fame. At the same time the connections between courts and universities often became more frequent. In Sweden Queen Christina fostered this kind of court culture, importing several scholars to the country to build up a reputation as a cultivated monarch. However, after Christina's abdication this kind of court culture quickly evaporated and came to play no greater role in the development of sciences in Sweden. The situation was somewhat different in respect to historical and antiquarian research, which became important vehicles

⁶⁶ On the boundary-work between physics and mathematics see e.g. Westman 1980. Dear 1987. Biagioli 1993. On the changing relations between natural philosophy and medicine see Cook 1991.

⁶⁷ Westman 1980, p. 111, 115-117. Biagioli 1993, p. 1-6, et passim.

for state ideology.⁶⁸ All in all, the lack of competing organizations and institutions strengthened the monopoly of knowledge and learning which the universities had in Sweden. This also may serve as a partial explanation for the stability which characterized 17th-century learning at Turku.

Thus the epistemological and disciplinary boundaries were not simply a means for organizing the function of the university institution, but more importantly they also formed a considerable power-structure. This power was usually of a very abstract kind, the power over knowledge, and only through that did it become power usable in the social realm of life. The academicans had the power to determine what counts as real philosophical knowledge and they were understandably reluctant to resign it to those proponents of new science who indeed already claimed it themselves. I would like to illustrate my point from two different ways in which this power-struggle surfaced and became more apparent.

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The second Cartesian dispute at Uppsala (1686-89) began, when the Clergy demanded a full prohibition of Cartesian philosophy in Sweden at the Diet of 1686. Only the teaching of "experimental philosophy" in physics was to be permitted. The Clergy's proposals for realizing this prohibition included far-reaching measures against the then existing practices in which non-theological faculties were relatively independent. For example, an extensive right to censor theses in all faculties was proposed, and the right to control all nominations to academic posts. The clergy also demanded that physics teaching which then was located in the Faculty of Medicine at Uppsala, should be returned to the Faculty of Arts. Behind this proposal was the idea to bring natural philosophy back onto ground more easily controllable by theologians. Cartesianism had a strong foothold in the Faculty of Medicine, whereas the Faculty of Arts had until then remained more faithful to Aristotelian philosophy. From the clergy's point of view, these demands were legitimized by the idea that philosophy should be theology's servant. Discharge of an insubordinate servant was therefore fully justified.⁶⁹

Such extensive demands quite naturally evoked a strong response. The clergy's demands for increased control were, in fact, very straight-

⁶⁸ Lindroth 1975, p. 197-204, 235-348.

⁶⁹ For the details of the clergy's claims see Lindborg 1965, p. 226-244, et passim.

forward. On the practical level the controversy was urged by demanding that all faculties give a written response to the clergy's proposals, and the king would then settle the matter on the basis of these answers. The controversy was quite explicitly over the question who should have the right to control the contents of teaching. In other words, should the teaching of physics be transferred to the Faculty of Arts or not? The issue of philosophical liberty became central. Although Cartesian philosophy hardly was introduced into Uppsala in order to create a gulf between philosophy and theology, in the course of the controversy Cartesian philosophy became a symbol for the reorganization of the spheres of natural philosophy and theology. In this historical situation the Faculty of Philosophy - previously rather traditional in its actions - was also ready to join the medics in attacking Aristotelian philosophy, and stand up for the "freedom of philosophy".⁷⁰

Developments at Turku took a totally different route. No movement for more freedom in philosophy arose at Turku, thinking and social relations being much more homogeneous in this respect. The Faculty of Theology was even more dominant at Turku than at Uppsala, where for example the Faculty of Medicine had a considerably more powerful position in relation to other faculties. The relatively powerful position of the Medical Faculty on the other hand was due to the good relations which it had with certain powerful noblemen (especially to the De la Gardies' through Olaf Rudbeck Sr.). Turku, however, was much more outside the interest of nobility. The homogeneity of thought at Turku may have had other contributing factors as well, since the town was small and the social circles of the learned class were small indeed. The academic community was bound together by several marriages, and also this kind of communality may have strengthened the us-against-the-newcomers feeling.⁷¹ It is no wonder that those scholars who had studied at Uppsala, such as Rudeen, and had been used to the confrontational relations between theology and philosophy and to the somewhat more liberated position of philosophy, got into trouble when they tried to continue in the same way at Turku.

My other example is more directly connected to Turku, although it also involves more abstract conceptions of power. The question is about Copernicanism and the burning issue of its incompatibility with

⁷⁰ Lindborg 1965, p. 277-307.

⁷¹ Klinge 1987, p. 221-231.

the Bible. It is not my intention here to show that the only causes for rejecting Copernicanism for so long were theological, although dogmatic arguments obviously played an important part in the process. Motion of the Earth was interpreted as against the word of the Bible. However, another way of interpreting it was also available. This so-called principle of accommodation was expressed as early as 1584 by an Augustinian hermit Diego de Zuñiga in his *Commentary on Job*, but it really became famous only when Kepler and Galileo especially started to employ it in their arguments for the heliocentric world system.⁷² According to this view the Bible talks about most natural phenomena in accordance with people's vague and simple understanding. Thus when the Bible says that the Sun and the Moon stood still it could be interpreted as meaning only how this phenomenon would *seem* to us. This interpretation was banned by the Catholic church in 1616 after having been used by such a skilled propagandist as Galileo. This interpretation could no more be embraced by the orthodox Lutheranism than be tolerated by the Roman Catholic Church.

When the 17th-century theologians argued against this interpretation, they said that it denigrated the nobility of the Holy Book. God would not lie, not even about the physical facts. In my opinion the matter can also be seen from a different point of view. The reason why the principle of accommodation was regarded as so dangerous was that it implied a threat to the dominant position of the clergy. We can first of all ask what constituted the "nobility" of the Bible. The argument against the principle of accommodation used by theologians implies that nobility of the text was constituted by the expertise needed for its interpretation. It was stated that if the Bible had been written in accordance with the understanding of the common man, this would produce "vulgarity". In other words, it would indicate that "ordinary people" were supposed to be capable of interpreting it. Whatever the intentions of Luther's reformation in translating the Bible and bringing it closer to the people, the orthodox tradition certainly did not grant the right to interpret the Scripture to just anyone. The authority to make judgements concerning the words of the Bible was bound to theological expertise, and the expression of legitimate expertise was the priesthood. According to the orthodox Lutheran dogma the Holy Ghost was included in the text itself, which made literal reading of

⁷² Moss 1993, p. 129-147.

the Bible possible. However, in practice the ability to interpret rightly was bound up with a certain professional status.⁷³ For example Miltopaeus was made to feel this in being officially reproached for making statements concerning theological matters when he had opposed the use of some concepts in Petrus Bång's thesis.⁷⁴

Although the Galilean controversies were well-known in Europe, this did not defer an author at Turku from promoting the principle of accommodation. This was of course Kexlerus, who in his astronomical manuscript took a positive stance towards this interpretation. Was Kexlerus then a religious dissident demanding more democratic rights for interpreting the Scripture? Hardly so, but in his case we might think of two possible reasons for adopting this exceptional view. First of all he probably relied heavily on the ability of mathematical astronomy to produce knowledge that really had relevance for physics. By the 1660's it was no longer unusual for astronomers elsewhere to defend the validity of some form of this principle.⁷⁵ This was then combined with a less rigid view of religion, Kexlerus belonging to the generation which was still much inspired by the older sort of orthodox Lutheran tradition which was less aggressive in many respects, although not directly accepting the principle of accommodation.

All in all it seems that the social and disciplinary relations at the University formed a power-structure which had a strong tendency to maintain itself. More radical changes which would have shaken these power-structures were difficult to achieve without strong impetus from outside. Indeed, there was a tendency at Turku to see most influences coming from outside as bad and disturbing. But it also seems that the maintainance of the established disciplinary structures and thereby the old forms of knowledge had support in a larger context too. I have highlighted the reluctance of the church and theologians to accept changes; however, the old order was much preferred by the king too. Of course both the church and the state needed well-educated but docile servants who would do their duties without wasting their time on new ideas which might even lead them to questioning the premises of the established system. This aspect was especially important for an

⁷³ Hägglund 1971, p. 281-284. Klinge 1987, p. 606.

⁷⁴ On the Miltopaeus case see section "Theology and Philosophy - Subordination or Submission?"

⁷⁵ Brooke 1991, p. 57, 100, et passim. Westman 1986, p. 89-93. Shea 1986, p. 118-133. Westfall 1986.

absolute monarch whose authority presupposed to a great extent the internal stability of the country's institutions. For example in France - the absolutist state par excellence - the main motive force of change in learning, Cartesianism, was regarded also as politically suspicious. This was because Cartesianism was thought to be connected with Jansenism, a religious heresy which emphasized the intellectual and spiritual freedom of man. Indeed, as D.M. Clarke has remarked, the Cartesians "were correctly identified as sharing the Jansenist belief in the authority of human reason". This was of course a force competing with the absolute authority of the king.⁷⁶

On the whole the role of the king in directing academic life was highlighted during absolutism. Whereas in the earlier parts of the 17th century Swedish universities had been relatively independent from each other, from the 1680's on a new centralization policy became apparent in the universities. We have seen that the king served as the highest authority in resolving doctrinal disputes. In addition to this resolution on Cartesianism in 1689 the king normally also sent other circulars to all academies. Their contents varied from forbidding the espousal of "useless novelties" to urging more control of students' pub-crawling. The role of Uppsala as the main university of the country was emphasized. On the other hand the Chancellor, a nobleman, provided another kind of tendency in the state's educational policies. An expression of this new policy at Turku was that in the 1690's several new professors from Uppsala were nominated to various chairs, some of them against the will of the Senate of the Academy. It was common to these men, Magnus Steen, Torsten Rudeen and Christiern Alander, that they had adopted ideas still very controversial at Turku, such as Copernicanism and Cartesianism. In this way state policy did not one-sidedly aim at a *status quo*, but it also indirectly changed the course of learning at Turku.⁷⁷

Both the absolutist monarchy and the university institution itself were based on a common feature, the need for subordinates to trust their authority. The rationalistic principles of Cartesianism placed a much greater role on the independent reason of the individual: "Car-

⁷⁶ Clarke 1989, p. 28-33.

⁷⁷ Klinge 1987, p. 125-128. Whereas the idea that more Uppsala men should be appointed to posts at other universities was in accordance with the centralization politics driven by the King, it was the Chancellor of the Academy of Turku, Count Wallenstedt, who pushed these particular men into office at Turku.

tesians were accurately perceived, therefore, as challenging the assumption that scientific issues could be resolved by reference to anyone's authority, Aristotle's, the church's, or the king's."⁷⁸ Independent thought in natural philosophy was not only dangerous because it could spread from there to disrespect of other authorities, but also because it destroyed one central characteristic of Aristotelian knowledge, its impersonality. However, Cartesianism was not the only threat to the impersonality of knowledge; eclecticism also emphasized the active role of an individual in judging the validity of various claims to knowledge. It is probably no coincidence that eclecticism was promoted at Turku expressly by Cartesians, and Daniel Achrelius. Although Achrelius was by no means an anti-monarchist, his political sympathies were clearly on the side of the aristocracy.⁷⁹ As a political counterbalance to the absolute monarch's power the aristocracy was also more liable to adopt those ideals which emphasized individuality against absolute authority. In this respect the somewhat more independent thinking of eclecticism could well suit their world-view.

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Another point of view the importance of which should be considered is that the Academy of Turku was very new in the 17th century. It has been suggested that the need to procure basic academic education partially caused the slowness of change at Turku.⁸⁰ When teachers had to concentrate on teaching the basics to the students they did not have the time and possibly not the capacity to adopt new ideas. However, in my opinion this explanation is not fully plausible. The freshness of the institution does not in itself explain dogmatism. Higher education did not have much older roots in Sweden either, where the University of Uppsala started functioning effectively only during the 1620's. Nevertheless, this institution was more prone to adopt new ideas than the Academy of Turku. On the other hand, in the Netherlands the dynamic character of the universities such as Leiden was partly due to the fact that they were new and thus not stuck to any old traditions. I do not think that it was so much the need to give basic instruction as other factors which made this new university so conservative. The professors in a small community without their own long traditions may have felt insecurity and inferiority in their position, and by sticking to the old forms they may have tried to convince

⁷⁸ Clarke 1989, p. 35-36.

⁷⁹ Klinge 1987, p. 596.

⁸⁰ Lehti 1979, p. 64-65.

themselves and the others of their competence. New ideas got the status of deviant science and/or heresy. They functioned as a contrast, by which one's own practices could be compared. In this way the proponents of new and yet unsettled academic traditions at Turku defined their own internal coherence. Thereby they also outlined and strengthened their own position.⁸¹ Together with strong religious dogmatism this would lead to the situation described in this work.

The factors which contribute to the stability of learning at the Academy of Turku are often subtle and it is not always easy to substantiate these claims very strongly, even less so with the final feature which I would like to advance. I would like to spend some time speculating on an idea which I think might help us understand the "anti-noveltism" which was, of course, a central factor contributing to the slowness of change. It seems to me that the causes behind this conservatism were not simply dogmatic, but stem from the more general features of the social ethics of Lutheran culture and even penetrate to the deeper level of community mentality. The reluctance to accept change arises at least partially from the communality which in the 17th century pervaded all spheres of life. To start with, I would like to briefly portray an analogical case from religion and explain how communality originated in the religious sphere of life.

Lutheran social ethics emphasized the priority of the interests of the whole community in relation to individuals. All members of the community had to adapt their actions and behaviour so that they would promote the need of society to secure its own existence. Selfishness was dangerous, and according to a parable used by Luther it was sometimes better to amputate a limb so that the rest of the body would survive. However, the Lutheran ideal of society was very hierarchical. It was up to the authorities to decide what would serve the good of the entire community; moreover, it was stressed that even the secular authority had its ultimate source in God.⁸² Another train of thought which is relevant to communality stems from the Augustinian tradition, which had a strong influence in Lutheran thought in general. What interests us here is St. Augustine's attitude towards sin and the relations between sin and community. In his *De Civitate Dei* St. Augustine talks about family and how peace is maintained in a family.

⁸¹ On the role of deviant science as a determinant of "official science" see Dolby 1979. Kurtz 1983.

⁸² Laulaja 1981, p. 95-120, 178-179, et passim.

Now as St. Augustine explicitly says, families are the elements of which the entire society consists. Therefore his ideas about family are applicable to the entire "City of God".⁸³ St. Augustine's own words will put the matter most clearly:

And if any member of the family interrupts the domestic peace by disobedience, he is corrected either by word or blow, or some kind of just and legitimate punishment, such as society permits, that he may himself be the better for it, and be readjusted to the family harmony from which he had dislocated himself. For as it is not benevolent to give a man help at the expense of some greater benefit he might receive, so it is not innocent to spare a man at the risk of his falling into graver sin. To be innocent, we must not only do harm to no man, but also restrain him from sin and punish his sin, so that either the man himself who is punished may profit by his experience, or others be warned by his example.⁸⁴

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We have here the source of the idea that a community must not put up with an individual committing sin. The sinner must be punished and his or her behaviour rectified by the community - the damaged limb must be amputated. Indeed it is not "innocent" for a community to allow sin to flourish in some of its individuals. A community doing so will be considered as committing sin itself and consequently will be punished by God. Several seventeenth-century dissertations written at Turku stress that wars, failures of crops and other disasters were punishments sent by God to rectify sinful behaviour.⁸⁵ Punishment for an individual's sin could befall the whole village or parish or the nation. Religion was therefore by no means a personal matter, but very much a communal matter. This kind of an attitude naturally caused very tight internal control and caution inside the community. Any deviant behaviour became a potential sin.

Another strain of communality stems from the general living conditions of the majority of people. To put it simply and briefly: the prevalent agrarian system in southern and western Finland, the so-cal-

⁸³ St. Augustine 1990, Book XIX, Ch. 16. On St. Augustine's social views see Markus 1988, p. 95-100, 140-144, et passim.

⁸⁴ St. Augustine 1990, Book XIX, Ch. 16.

⁸⁵ Achrelius 1682, p. 148, 154, 163. Hahn-Melliin 1686, p. 10, 14, 27, 41. Hahn-Iflander 1961, p. 9-10. Hahn-Ekedahl 1695, p. 15.

led "open-field system", forced people to work together in their fields. The land was so scattered around that it was impossible to cultivate one's own piece of land only. Therefore, everyone's work was demanded for the survival of the community. Moreover, the communality of life including religion was strengthened by the fact that the villages were closely built. The pressure for uniform behaviour was strongly felt in all areas of peasant and small-town cultural life.⁸⁶

All this is of course very roughly put and has to be taken as a very generalised description. The main point I am putting forward here is, however, that 17th-century life in general and religion in particular were very communal so that every individual's behaviour and beliefs were considered to influence the future of the larger community.

The academic world was also a community, for which coherence was also important. The bans on novelties cited above explicitly show concern for averting disagreements. An individual's exceptional behaviour or his unusual ideas could easily be seen as a threat to the coherence of the community. When somebody presented new ideas in philosophy he not only violated the accepted dogmas, but he also stepped out of line, making himself different from others. Often he was also seen to set himself above others. Doing this he obviously broke the hierarchical order. In religion every kind of deviant behaviour was a potential sin. In philosophy, every new idea was also a potential heresy, either theological or philosophical, and often in both senses. In other words the mere act of differing from the (academic) community was threatening in itself. Dissent, revolting against the set rules and hierarchical structure of the community became a "sin" in itself, and should be punished accordingly.

What has to be emphasised here is that I am not suggesting a causal connection between religious beliefs and practices on one hand, and the conservatism in philosophy on the other. I am nevertheless suggesting that there is a parallel or an analogy between them, and a pattern of thinking can easily be transferred from one sphere of life to another. Religion and learning were not so very separate spheres of life anyway, especially because the general rules of Lutheran ethics applied to the both. There were of course differences as well. In the secular sphere of society what counted as a crime or an offence was defined by the law. In religion the nature of sin was a stated dogma

⁸⁶ Anttila 1986, p. 354-355.

as well. In philosophy there was, of course, the official policy of anti-innovationism, but nevertheless the definition of what was novel was blurred. In my opinion this parallel between religious conformity and hostility to new ideas in philosophy, does indeed make the 17th-century mentality more understandable to us, although it may not offer any causal explanations of this attitude. The fact that the hostility towards the new was not peculiar to Lutheran Finland only is of course somewhat problematic, but in my opinion it does not necessarily diminish the explanatory power of this analogy. There is no reason why wide-spread phenomena could not have also local factors contributing to their existence in a certain area.

To sum up, we can hardly discern any single major cause of the stability of learning at the Academy of Turku. Various intellectual, institutional, social, political and economic factors, even those pertaining to the 17th-century mentality intertwine and interact, thereby constituting instead a context in which hostility is a natural response to most types of change. According to Martha Ornstein's famous study this is the attitude all European universities adopted during the 17th century. In the next, and at the same time the last subsection of this chapter I shall consider the question of whether Turku thus genuinely represents an all-European trend, or was there something more typically peripheral in the attitudes adopted there? Where should we place Turku on the academic map of Sweden and Europe?

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5. PART OF SWEDEN, PART OF EUROPE

The purpose of this subsection is to consider what role the Academy of Turku played in the educational system of Sweden, and what kind of demands and conditions this role made on learning in natural philosophy at Turku. A further question is whether there was something in this role which would explain the special characteristics of natural philosophical learning at Turku. Conversely we could also ask whether there was something in the learning itself which might partly explain the institution's role in general.

What were the other Universities in Sweden like during the 17th century? The University of Tartu was founded in 1632 on the model

of the University of Uppsala. It was founded in a recently-occupied part of the country, and its explicit aim was to educate local youth and thereby root Swedish law and clerical culture in the country. Despite these well-meaning intentions, the University had little effect on the Balts themselves. Most of the approximately ten professors were German, and the majority of students came from Sweden and Finland. Otherwise the strong cultural influence of the German-Baltic nobility was felt in the life of the Academy too. Located in a restive area near the Russian border, the University of Tartu soon fell under Russian control. It stopped in 1665 (having functioned in Tallinn from 1656 to 1665), and it was not refounded until 1690. Even then the proximity of the border brought a great degree of unrest to the life of the University. In 1699 it had to be moved to a safer location to Pernau, and in 1710 it closed down again. Although the German influence was strong in the University even at the later stage of its existence, most professors were now Swedish. The University was rather lively, modern ideas such as natural right and pietism being openly taught there. The number of students remained relatively small, however, and on the whole the University did not meet the expectations which had been set for it.⁸⁷

The University of Greifswald was also located on land occupied in the 1630's. However, it was of older German origin and not founded by the Swedes. It functioned according to its old German statutes and was never joined to the tradition Uppsala and Turku shared. During the Thirty Years' War until 1648 the University hardly functioned at all. Although this University with its ten ordinary and eight extraordinary professors was rather well-off especially towards the end of the century, it caused all other kinds of trouble throughout the century. There was a conspicuous lack of discipline and the status of the degrees became notoriously low. It is a special feature of Greifswald that due to its geographical location it constantly had to compete for students with several other universities on German ground. Greifswald was nevertheless popular among Swedish-Finnish students as well - Lars Nihlén assumes that poorer students especially found Greifswald attractive.⁸⁸ Whatever importance it may have had in its time, some historians regard its influence on the Swedish culture in general as

⁸⁷ Lindroth 1975, p. 48-50. Klinge 1987, p. 119-122. Piirimäe 1985, p. 29-53, 56-65.

⁸⁸ Nihlén 1983, p. 98.

very slight indeed.⁸⁹

Life at the University of Lund was not much more peaceful than in the other two Universities. Just like Tartu and Greifswald, Lund was located on recently acquired land. This also caused much of its difficulty. Warfare between Sweden and Denmark went on during the 17th century, and the Academy founded in 1666 was soon trampled under soldiers' feet. To start with it was supposed to be a big institution, and it even had its own statutes (although modified from those of Uppsala). However, lack of money and a certain degree of inconsistency in its planning shrank it to only a medium size. Most of the students were Danish, German or Swedish. Although not as successful as expected in this early phase the University of Lund became a quite respectable institution. This is true especially of the time after the break (1676-1682) which the war caused in its operation. In this latter period it got statutes from Uppsala, the professors nominated there were exclusively Swedish and the foreign students had left during the war. Lund became characteristically a provincial university for Skåne and Blekinge, which then undoubtedly could effectively fulfil its main function in "swedifying" previously Danish provinces. Lund University's provincial character was strengthened by the fact that it remained relatively small. With its roughly 200 students it was clearly smaller than Uppsala and Turku.⁹⁰

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Thus, compared with the other provincial universities in Sweden Turku seemed a peaceful and reliable university indeed. The focus of the state policy was directed towards Central Europe and Poland for most of the century. This made Turku politically a safe haven far from the centres of crisis. The internal discipline at the University was relatively good too. Of course, there always was some squabble caused by the young, noisy and all-too-often drunken students, but the reputation of Turku in this respect was no worse than of most other university towns. Moreover, Turku was located in an old province which was an established part of the country. There was thus no need for such an ideological campaign at Turku as there was in Tartu and especially in Lund. All in all Turku must have appeared a relatively good and secure choice for getting a degree in Sweden. It

⁸⁹ Lindroth 1975, p. 47-48. "Men det lilla Greifswaldsuniversitetet behöll sin tyska prägel och blev tills vidare inte av någon betydelse för vår nationella kultur." Klinge 1987, p. 122-123.

⁹⁰ Lindroth 1975, p. 53-56. Klinge 1987, p. 124-125. Weibull 1868, p. 1-148.

was located far enough from Stockholm and Uppsala not to be directly under the eyes of the nation's rulers all the time, and this increased its autonomy in certain matters, but it certainly was not in any distant periphery either; the merchants at least sailed frequently between the two staple towns Turku and Stockholm. So what was the relationship between the Academy of Turku and the University of Uppsala, then?

The main university of the country was founded in 1593 by the famous Uppsala meeting, in which the confessional Swedish state-bound church was also born. Swedish nationality was set there against the old Union-period Danish direction and the more recent Polish and catholic connections. The university therefore had to be national and Lutheran - the two themes were closely bound together in the politics of the 1590's. It was, after all, only about seventy years previously that the country had been forced into reformation by king Gustaf Vasa in the 1520's. The clerical connection of the new university was established by the fact that the new university was located at Uppsala, which was traditionally the town of the arch-bishop. It was officially founded in 1595, but the beginnings were modest and torn with internal controversies. From 1613 on the circumstances gradually improved and in the 1620's the university was profoundly modified and strengthened. Although the education of vicars remained its main function, the emphasis in its learning shifted from clerical needs towards fulfilling the needs of the state. Ramistic philosophy and the ideals of Renaissance humanism were new leading motives, and gradually the University of Uppsala made itself attractive for the education of the nobility. With its 20 professors and around 1000 students by the 1630's it was not only a big university, but was also crucial for the state because of its location near Stockholm. In the aristocratic world of the 17th century it was not unimportant that Uppsala had several highly-ranked noblemen such as Skytte, Oxenstierna and De la Gardie as its patrons (chancellors).⁹¹

Although the University of Uppsala thus was clearly the most important university of the country, and its constitution was copied in both Tartu and Turku, and later in Lund, it nevertheless remained relatively separate from its younger sister-institutions. It is also curious how little of the doctrinal developments at the University of Uppsala became known and were discussed at Turku. This was not necessarily

⁹¹ Lindroth 1975, p. 16-47. Klinge 1987, p. 24-32, 39-48.

due to lack of contact, because many students studied at both universities. Moreover, the ratio between Finnish-born and Swedish professors at Turku shows only a slight advantage to the Finns: altogether 21 professors of 46 during the years 1640-1713 came from Sweden and 25 from the province of Finland.⁹² During the Cartesian disputes in the 1680's, for instance, some professors from Turku took an active part in the disputes at Uppsala. Nevertheless the natural philosophical learning at the University of Turku followed its own characteristic trends in relation to its mother university despite the fact that the tradition was originally brought ready-made from Uppsala. It was not until the absolutist king adopted a new kind of centralization policy that the two universities became more tightly bound together. Both universities produced mostly clergymen, although Uppsala was specially characterised by the education of nobility. The statistics comparing the background of the students and their profession after finishing their studies reveals quite a lot about the direction in which the main function of the University of Turku lies.

Clearly the largest proportion of students at Turku came from the homes of priests or professors. From 1640 to 1709, 15-26% of all students were clergymen's sons. The local townsmen were also relatively eager to send their sons to get higher education, since 5-11% of students came from tradesmen's or craftsmen's families. About the same number of students, 3-8%, and in the period 1700-1709 as much as 14% came from the lower clergy's and teachers' rank. Only 3-6% of students were of noble descent - the proportion declining sharply after the beginning of the war in 1700. Peasants' sons formed 3-5% of the students, whereas all other major groups of people such as officials give rise only to one or two percent each. These statistics are only indicative, because 61-40% of the social status of the students' fathers remains unknown. The students choice of a clerical career is more clear; as many as 40-50% of students became priests of some rank. The production of bureaucrats was surprisingly small relatively, as only 3-6% of students ended up as officials or local judges. Here one has to remember that the need for civil servants was still relatively limited after all. University education was obviously not a very efficient way of rising to the ranks of nobility, because only

⁹² Lindroth 1975, p. 52. Of course, these numbers also prove that the Academy became an important educational channel for the people in this province. On students visiting both Turku and Uppsala see Strömberg (forthcoming).

3-7% of students were granted these privileges - about the same percentage of students belonged to the nobility even while studying. Once again the marginal for error is considerable, because the latter phases of the lives of 32-49% of students remains obscure.⁹³

Obviously then the main role of the University of Turku was to produce orthodox Lutheran clergymen. However, this was not exclusively for the needs of the province. (About half of the students came from the bishopric of Turku. One half to one third of the students came from other parts of Sweden.⁹⁴) This context explains the status of natural philosophy. For intending vicars natural philosophy was important only as far as the knowledge of natural phenomena was necessary for their all-round education, and of course as preparatory studies before taking courses in the higher disciplines. From this point of view it should not be surprising that the reluctance for change was especially strong for theological reasons at Turku. There is nothing new in these remarks and they only remind us of the fact that the institutional setting created a context which set the limits to the scope of possible actions this particular discipline could take. On the other hand nothing seems to indicate that the reverse situation would have had any importance. The seemingly conservative character of the University of Turku and the slow rate of doctrinal change there did not diminish its importance on a national scale. On the contrary, some parents may have preferred to send their sons to Turku than to Uppsala, which was torn by Cartesian disputes and was therefore a less "safe" place for clergymen-to-be.

What it comes to the all-European scale, the University of Turku did naturally not have such a meaningful function as it had within the Swedish state. All it had to offer European learning were the inscription payments by the peregrinating students who came to complete their studies at some, predominantly German and Dutch universities. But was the rate of change at the Academy of Turku then much slower than in other European universities? It is not my intention to give a thorough picture of learning in Europe, but just to sketch the situation in order to be able to relate Turku to these developments.

England was of course one of the leading nations in promoting the new science, and the situation there is one of the most studied in

⁹³ The percentages are based on the statistics compiled by Strömberg 1987, p. 322-323.

⁹⁴ Strömberg 1987, p. 307-309.

history of science. The "new Baconian science" especially succeeded in making a breakthrough there and the Royal Society quickly became its authoritative proponent. Universities, on the other hand, were for a long time hostile to the new scientific institutions. The foundation of new kinds of institutes threatened the educational monopoly of the universities, which meant danger not only for their intellectual status, but also a toughened competition for patrons and finances. Opposition to the new natural philosophy itself was much less, and indeed a remarkable amount of "new" material was included in university curricula during the 17th century.⁹⁵ Empiricism and experimentalism became the prevalent attitude in England, which to some extent discouraged the acceptance of mechanistic philosophies such as Cartesianism.

Although France played little part in giving birth to the new science, it came to hold an eminent position in this field later in the century. In France we meet a considerable variety of educational institutions. In addition to traditional Universities there were the so called *collèges de plein exercice*, which gave courses in philosophy and humanities. Many of these colleges were run by religious organizations such as the Jesuits. Aristotelianism remained a particularly vivid tradition in French universities, and there was for a long time no consensus about the proper philosophical basis of the emerging new science or natural philosophy. For certain religious and political reasons mechanistic philosophy made its breakthrough only from the 1690's on. By the 1660's empirical philosophy was already in vogue and there was an abundance of astronomers, chemists and anatomists especially. Instead of flourishing much in the universities, the new science grew especially in the scientific salons in Paris established around the 1650's and 1660's. This new philosophy was embraced especially by court aristocracy and the urban elite. As a sign of the official recognition of experimental philosophy, the *Académie royale des Sciences* was established in 1666, which at the same time brought the new science under state control. As the popularity of experimental science grew in the latter part of the seventeenth century, mostly due to successful popularization, the creative activity became more centralized in Paris. In France too the Universities were mainly to educate priests, and the reluctance to change was obvious even there. Only the fear of losing

⁹⁵ Feingold 1991. Gascoigne 1985. Henry 1992.

respect in the eyes of the Parisian establishment and consequently a considerable number of students made the Universities to adopt new material into their curriculums.⁹⁶

A general feature of the many new philosophies of this age was that most of them placed importance on the role of mathematics as the language of (experimental) philosophy, although each in a different respect and to a various extent. In Italy this approach was naturally promoted first and foremost by Galileo. The new science was favoured for the most part by regional princes. Botany and medicine especially kept on flourishing in Italy, but the general tendency is that after the 1670's Italian science became more and more marginalized from European developments - Spain and Portugal remained scientifically backward for most of the century.⁹⁷ The vivid scientific practice in the Low Countries during the seventeenth century had been based on a considerable amount of activity during the previous century. At the turn of the sixteenth and seventeenth centuries the Low Countries underwent a boom in founding new universities. Mathematics, natural history and medicine prospered, and often the traditions of empirical investigation and mathematical accuracy were combined in the activities of the same persons. The Dutch were no great system-builders but they did a great job in getting straight many of the details in the natural world. On the other hand the Netherlands was blessed with skilled craftsmen who for their part contributed to the birth of new science by manufacturing scientific instruments of outstanding quality.⁹⁸

Some parts of the German-speaking area of Europe had suffered severely during the Thirty Years' War. It also seems that German universities lost much of their eminence during the war. The whole of German-speaking area was split up into principalities, and the state of learning varied greatly in different universities. In the small principalities, universities were more to guard the "right" religion and show the power of the ruler than to promote new and often rebellious ways of thinking. It was no wonder, then, that so-called Neo-Scholasticism still flourished also in the University of Wittenberg, which the scholars of Turku held in high esteem.⁹⁹ On the other hand, some

⁹⁶ Brockliss 1981, 1987, 1992. Clarke 1989.

⁹⁷ Biagioli 1992. Goodman 1992.

⁹⁸ Cook 1992. Ruestow 1973.

⁹⁹ Evans 1981. Lindroth 1975, p. 56-65.

Germans were deeply interested in instrumental experimentation, and after 1670 many universities got their physics classes structured around experiments. It was typical of German learning however, that it still mostly relied on the Aristotelian framework although Paracelsian, atomistic and Cartesian elements were gradually fused into it.¹⁰⁰

It seems then that there is no single pattern of development in seventeenth century natural philosophical learning. Indeed, in comparison with the developments in other European universities learning at Turku did not change at a very different pace. If we illustrate this development for example by comparing the arrival and at least partial acceptance of Copernicanism and Cartesianism in various countries, we get the following picture. In Oxford and Cambridge Cartesian philosophy had been discussed since the 1640's, and such conspicuous figures as Newton studied Cartesian physics.¹⁰¹ In Paris Cartesianism became triumphant only in the 1690's, and in Protestant Geneva Chouet introduced the new natural philosophy during the 1680's.¹⁰² In the Netherlands Cartesianism had been discussed from the 1640's on. Although most German States despised or even prohibited this philosophy, some elements of it nevertheless managed to infiltrate into their universities.¹⁰³ Copernicanism, on the other hand, was accepted as the superior cosmological theory in most Protestant universities in the period 1650-1700. Catholic Europe tended to embrace heliocentrism considerably later. Only in Louvain in the Low Countries did most professors "convert to heliocentricity" between 1650-1670, whereas in France the more secular scholars adopted the theory in the 1690's. But the Jesuit colleges in France as well as the other predominantly Catholic countries such as Hungary, Poland and Spain yielded themselves to Copernicanism only during the period 1750-1770.¹⁰⁴

The picture thus achieved is of course defective in many respects. It does not, for instance, tell us what parts of Cartesianism were accepted and in which form. However, it becomes quite clear that the

¹⁰⁰ Clark 1992b.

¹⁰¹ Gascoigne 1985, p. 405-406.

¹⁰² Brockliss 1981, p. 52-60. Heyd 1982, *passim*.

¹⁰³ Cook 1992, p. 129-131. Ruestow 1973, p. 36-72. Clark 1992, p. 107.

¹⁰⁴ Brockliss 1990, p. 201-203. Brockliss writes about the Protestant universities: "Heliocentricity captured Leiden and Oxford in the 1650s, Cambridge, Geneva, Copenhagen and the Scottish universities in the 1660s and 1670s, and Basel and the Swedish universities in the 1680s and 1690s." See also articles in Dobrzycki (ed.) 1973.

slowness of change at Turku is more or less an illusion caused by comparison not with other universities but with other factors which contributed to or followed from the rise of new science. Most universities in Europe had broadly speaking similar aims, i.e. they taught priests and lawyers. Therefore they were also less eager to make radical changes to curriculums which suited their purposes. New kinds of scientific institutions and the rise of other non-academic learned groups such as court-scholars, almanac-makers and surgeons put Universities in a competitive position in the 17th century historical context. In Sweden, and especially in Finland there were either no such competitive institutions or groups, or they were too weak to pose a challenge to academic learning. The Academy of Turku had a monopoly on learning, and this position was about to turn it monolithic.

But the eighteenth century brought in its train many social and political changes. After the Great Northern War Sweden had lost its powerful political position. Absolutist monarchy was gone and the new Constitution of the country gave much power to the Parliament. Even the orthodoxy of the Lutheran church had to adapt itself to new conditions when pietism strengthened its hold. Outwardly the University of Turku did not change much, its basic disciplinary structure, constitutions and even its main function remaining the same. However, in this new cultural and social context not even the University could avoid change and it gradually started to respond to the demands of new utilitarian thinking. Old forms and practices were imbued with new values and aims. It did not immediately adopt all the niceties of new science, become creative, dynamic and international, but the new generation of professors which came to be nominated after the break from 1713 to 1722 certainly belonged to a different scientific culture. The time of scholasticism was inevitably over.

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