Dissertatio Astronomica
de
Corrigendis Erroribus Instrumenti Culminatorii,

QUAM
Cons. Ampl. Facult. Philos. Aboëns.

Præside
Mag. *JOHANNE HENRICO LINDQUIST,*
Math. Prof. R. & Ord. R. Acad. Scient. Stockh. & R. Societ. Scient. Upsal. Membro,

Pro Gradu Philosophico
publicæ censuræ submittit
GEORGIUS LAURELL
Stip. Reg. Satac.

In Audit. Minori die 20 Decembris 1797.
a. m.

ABOÆ, TYPIS FRENCKELLIANIS.

§. I.

Tam ad tempus verum inveniendum, quam ad determinandas differentias inter Ascensiones rectas stellarum, haud quidem difficilis censenda est methodus, quæ dicitur *Altitudinum Correspondentium*. Hæc vero quum præter alia eo laboret incommodo, quod majus requiratur temporis intervallum inter correspondentes istas observationes, & haud raro accidat, ut altitudinibus ab una parte meridiani sumtis, æquales ad alteram partem obtinere nubilum prohibeat cœlum; diversa Astronomi excogitarunt alia artificia, quibus tutius & minori temporis dispendio eundem conseqverentur finem. Inter hæc inprimis referenda est inventio *Instrumenti Culminatorii*, cujus ope transitus stellarum per Meridianum commodissime observantur, quodque ideo etiam *Instrumentum Transituum* (Gall. *Instrument des Passages*, Angl. *the Transit Telescope*, Germ. *Mittagsfernrohr*) vocari solet. Hoc scilicet constat telescopio seu tubo

Astronomico, circa axem fixum ita volubili, ut axis opticus tubi in plano meridiani semper positus sit. Quam ob caussam requiritur, ut axis iste fixus, circa quem revolvitur tubus, exacte sit 1:o horizontalis atque 2:o ad planum Meridiani perpendicularis, & ut 3:o axis ipsius telescopii sit ad axem istum revolutionis accurate normalis. Tria igitur hæc momenta pro quovis tubo culminatorio ante omnia diligenter examinanda erunt, atque errores in iis obvenientes singuli rite corrigendi, pro quibus correctionibus variæ traduntur regulæ ab Astronomiæ practicæ Scriptoribus. *Cfr. Astronomie par* FRANÇAIS LA LANDE *Edit.* 3: *e*, *§. §.* 2600-2612, VINCE *Treat. on practical Astronomy* §. §. 79-85. SMITHS *Lehrbegriff der Optik, ausg. von* KÄSTNER 3 *Buch.* 5 *Cap.* &c. Hæ vero præter instituendas observationes Altitudinum correspondentium, plura etiam supponunt artificia Mechanica, quæ peculiaribus & non semper facile parabilibus egent instrumentis. Quamobrem operæ pretium duximus breviter disquirere, quomodo per solas observationes Astronomicas, iidem hi errores detegi atque corrigi queant. De dictis vero erroribus Instrumento culminatorio propriis acturi, ipsum telescopium rite constructum, & debite examinatum supponimus, antequam ad axem istum rotationis applicetur; adeo ut scilicet utraque ejus lens, objectiva & ocularis, rite formata sit, & axis utriusque in eandem lineam cadat, quæ igitur axem

axem opticum tubi constituet: ut porro duo fila micrometrica ad focum lentis objectivæ exacte ita applicata sint, ut in ipso axe tubi se mutuo decussent, atque ambo tam huic axi, quam sibi invicem perpendiculariter insistant.

§. 2.

Sit Q (Fig. 1.) punctum cœli, versus quod dirigitur axis revolutionis, atque ABC arcus circuli, quem axis opticus tubi productus revolutione sua in sphæra cœlesti describit, cujus igitur circuli polus erit Q. Existente P polo elevato æquatoris, & Z zenith loci, ductisque circulis maximis MPZ (qui erit Meridianus loci) & PQ; statuatur ang. $ZPQ = 90^\circ - z$, arcus $PQ = 90^\circ - y$, atque ex Q ad quodvis circuli ABC punctum ductus circuli maximi arcus $= 90^\circ - x$. His positis manifestum est, errores istos instrumenti culminatorii per x, y & z determinari. Ad hos inveniendos, ope horologii cujus sit motus æquabilis, pro tribus diversis stellis A, B, C observentur temporum momenta, quibus singulæ in axe optico tubi culminatorii apparent, simulque per altitudines correspondentes determinentur culminationes veræ earundem stellarum. Sit itaque t temporis intervallum inter transitus stellæ A per axem tubi & per verum meridianum, atque dicatur tempus totius revolutionis hujus stellæ, eodem horologio mensuratum $= R$; erit ang. $ZPA = \frac{360^\circ t}{R}$, qui angulus dicatur α. Eodem modo pro stellis B & C inveniantur anguli horarii $ZPB = \beta$, & $ZPC = \gamma$. Dentur præterea earundem stellarum declinationes apparentes a, b & c respective, adeo ut sit $PA = 90^\circ - a$, $PB = 90^\circ - b$, & $PC = 90^\circ - c$. Ex his α, β, γ & a, b, c datis, errores istos x, y & z investigaturi, ad distinguendas quantitates positivas a negativis, assumimus punctum Q in hemisphærio occidentali situm, atque angulos α, β, γ a Z versus occidentem numeratos, declinationesque a, b, c ab æquatore versus polum elevatum computatas, unde si qua harum quantitatum in contrarium sensum cadat, negative sumenda erit. Qvum jam (Elem. Trig. Sphær.) in $\Delta\Delta$ PAQ, PBQ & PCQ, posito sinu toto $= 1$, sit:

(I.) $\mathrm{Sin}\, x = \mathrm{Cos}\, a\, \mathrm{Cos}\, y\, \mathrm{Sin}\, (\alpha + z) + \mathrm{Sin}\, a\, \mathrm{Sin}\, y$;
(II.) $\mathrm{Sin}\, x = \mathrm{Cos}\, b\, \mathrm{Cos}\, y\, \mathrm{Sin}\, (\beta + z) + \mathrm{Sin}\, b\, \mathrm{Sin}\, y$; &
(III.) $\mathrm{Sin}\, x = \mathrm{Cos}\, c\, \mathrm{Cos}\, y\, \mathrm{Sin}\, (\gamma + z) + \mathrm{Sin}\, c\, \mathrm{Sin}\, y$;
æquationem I cum II & III comparando, obtinetur:

(IV.) $\mathrm{Tg}\, y = \frac{\mathrm{Cos}\, b\, \mathrm{Sin}\, (\beta + z) - \mathrm{Cos}\, a\, \mathrm{Sin}\, (\alpha + z)}{\mathrm{Sin}\, a - \mathrm{Sin}\, b}$; &

(V.) $\mathrm{Tg}\, y = \frac{\mathrm{Cos}\, c\, \mathrm{Sin}\, (\gamma + z) - \mathrm{Cos}\, a\, \mathrm{Sin}\, (\alpha + z)}{\mathrm{Sin}\, a - \mathrm{Sin}\, c}$;

ex quibus æquationibus IV & V inter se collatis, sequitur fore:

(VI.)

(VI.) $(\mathit{Sin}\, b - \mathit{Sin}\, c)\, \mathit{Cos}\, a\, \mathit{Sin}\, (\alpha + z) - (\mathit{Sin}\, a - \mathit{Sin}\, c)$ $\mathit{Cos}\, b\, \mathit{Sin}\, (\beta + z) + (\mathit{Sin}\, a - \mathit{Sin}\, b)\, \mathit{Cos}\, c\, \mathit{Sin}\, (\gamma + z) = 0$.
Ponendo igitur $\mathit{Cos}\, a\, (\mathit{Sin}\, b - \mathit{Sin}\, c) = 2\, A'$, $\mathit{Cos}\, b\, (\mathit{Sin}\, a - \mathit{Sin}\, c) = 2\, B'$, & $\mathit{Cos}\, c\, (\mathit{Sin}\, a - \mathit{Sin}\, b) = 2\, C'$; seu $A' = \mathit{Cos}\, a\, \mathit{Cos}\, \tfrac{1}{2}\, (b + c)\, \mathit{Sin}\, \tfrac{1}{2}\, (b - c)$;
$B' = \mathit{Cos}\, b\, \mathit{Cos}\, \tfrac{1}{2}\, (a + c)\, \mathit{Sin}\, \tfrac{1}{2}\, (a - c)$, &
$C' = \mathit{Cos}\, c\, \mathit{Cos}\, \tfrac{1}{2}\, (a + b)\, \mathit{Sin}\, \tfrac{1}{2}\, (a - b)$, æquatio iſta VI hanc induit formam:

(VI.) $A'\, \mathit{Sin}\, (\alpha + z) - B'\, \mathit{Sin}\, (\beta + z) + C'\, \mathit{Sin}\, (\gamma + z) = 0$.

Si jam compendii cauſſa fiat

(VII.) $\frac{1}{n} = A'\, \mathit{Cos}\, \alpha - B'\, \mathit{Cos}\, \beta + C'\, \mathit{Cos}\, \gamma$;

terminos æquationis VI evolvendo obtinetur

(VIII.) $\mathit{Tg}\, z = -\, n\, A'\, \mathit{Sin}\, \alpha + n\, B'\, \mathit{Sin}\, \beta - n\, C'\, \mathit{Sin}\, \gamma$.

Ex hac æqu. VIII, collata cum IV vel V, eruitur:

(IX.) $$\frac{\mathit{Tg}\, y}{\mathit{Cos}\, z} = \tfrac{1}{2} n\, \mathit{Cos}\, a\, \mathit{Cos}\, b\, \mathit{Sin}\, (\alpha - \beta) - \tfrac{1}{2} n\, \mathit{Cos}\, a\, \mathit{Cos}\, c\, \mathit{Sin}\, (\alpha - \gamma) + \tfrac{1}{2} n\, \mathit{Cos}\, b\, \mathit{Cos}\, c\, \mathit{Sin}\, (\beta - \gamma);$$

& denique has æquationes VIII & IX applicando ad alterutram æqv. I, II vel III, obtinetur

(X.) $$\frac{\mathit{Sin}\, x}{\mathit{Cos}\, y\, \mathit{Cos}\, z} = \tfrac{1}{2} n\, \mathit{Cos}\, a\, \mathit{Cos}\, b\, \mathit{Sin}\, c\, \mathit{Sin}\, (\alpha - \beta) - \tfrac{1}{2} n\, \mathit{Cos}\, a\, \mathit{Cos}\, c\, \mathit{Sin}\, b\, \mathit{Sin}\, (\alpha - \gamma) + \tfrac{1}{2} n\, \mathit{Cos}\, b\, \mathit{Cos}\, c\, \mathit{Sin}\, a\, \mathit{Sin}\, (\beta - \gamma).$$

Qvarum itaque formularum ope, ex datis α, β, γ, a, b & c, generatim determinari poſſe errores iſtos z, y & x manifeſtum eſt.

§. 3.

§. 3.

Calculus vero, qui secundum formulas (§. 2.) allatas instituendus nimis molestus foret, ut Logarithmorum ope commodior reddatur, eodem hic uti præstat artificio, quo Problema huic affine solvitur in Dissert. de Methodo inveniendi tempus verum ex observatis æqualibus diversarum stellarum altitudinibus. Aboæ 1785, §. 3.

Ponendo scilicet $\alpha + z = \zeta$; $\alpha - \beta = f$, & $\alpha - \gamma = g$ adeoque $\beta + z = \zeta - f$, & $\gamma + z = \zeta - g$; æquationes IV & V (§. 2) evolutæ transformantur in has:

$$(\mathfrak{A})\ Tg\, y = \frac{(Cos\, b\, Cos\, f - Cos\, a)\, Sin\, \zeta - Cos\, b\, Sin\, f\, Cos\, \zeta}{2\, Cos\, \tfrac{1}{2}(a + b)\, Sin\, \tfrac{1}{2}(a - b)};\ \&$$

$$(\mathfrak{B})\ Tg\, y = \frac{(Cos\, c\, Cos\, g - Cos\, a)\, Sin\, \zeta - Cos\, c\, Sin\, g\, Cos\, \zeta}{2\, Cos\, \tfrac{1}{2}(a + c)\, Sin\, \tfrac{1}{2}(a - c)}.$$

Si jam æquationi $\mathfrak{A}$ perfecte homologa seu identica statuatur æquatio: $Tg\, y = tg\, \varphi\, Cos\, \psi\, Sin\, \zeta - tg\, \varphi\, Sin\, \psi\, Cos\, \zeta$, (ita ut coëfficientes ipsorum $Sin\, \zeta$ & $Cos\, \zeta$ in utraque respective æquales ponantur), & pariter æquationi $\mathfrak{B}$ homologa fiat æqv. $Tg\, y = tg\, \varphi'\, Cos\, \psi'\, Sin\, \zeta - tg\, \varphi'\, Sin\, \psi'\, Cos\, \zeta$; ex harum æquationum cum æqv. $\mathfrak{A}$ & $\mathfrak{B}$ comparatione, eadem methodo ac in Dissert. cit. sequentes eliciuntur formulæ:

$$(\text{I.})\ Tg\,(\psi - \tfrac{1}{2}f) = Tg\, \tfrac{1}{2}f\, Cotg\, \tfrac{1}{2}(a + b)\, Cotg\, \tfrac{1}{2}(a - b);$$

$$(\text{II.})\ Tg\, \varphi = \frac{Cos\, b\, Sin\, f}{2\, Sin\, \psi\, Cos\, \tfrac{1}{2}(a + b)\, Sin\, \tfrac{1}{2}(a - b)};$$

(III.)

(III) $Tg\,(\psi' - \frac{1}{2} g) = Tg\,\frac{1}{2} g\; Cotg\,\frac{1}{2}(a + c)\; Cotg\,\frac{1}{2}(a - c)$;

(IV.) $Tg\,\varphi' = \frac{Cos\,c\; Sin\,g}{2\, Sin\,\psi'\; Cos\,\frac{1}{2}(a + c)\; Sin\,\frac{1}{2}(a - c)}$;

(V.) $Tg\,(\zeta - \frac{1}{2}(\psi + \psi')) = \frac{Tg\,\frac{1}{2}(\psi + \psi')\; Sin\,(\varphi' + \varphi)}{Sin\,(\varphi' - \varphi)}$; &

(VI.) $Tg\,y = tg\,\varphi\; Sin\,(\zeta - \psi)$ vel $Tg\,y = Tg\,\varphi'\; Sin\,(\zeta - \psi')$;

quæ ſingulæ per logarithmos facile computantur, quarumque igitur ope commode inveniuntur ζ & y, adeoque etiam $z = \zeta - \alpha$. His vero inventis innoteſcit quoque x, ſi in alterutro Triangulorum APQ, BPQ vel CPQ, ex cognito Angulo ad P & lateribus hunc comprehendentibus, quæratur latus tertium $= 90^{\circ} - x$. Et quidem hac methodo univerſaliter ſolvitur Problema noſtrum, quanta demumcunque fuerit tubi culminatorii aberratio a meridiano.

§. 4.

Quoties autem, ut plerumque accidit, hæc aberratio eſt admodum exigua, commoda omnino ex allatis (§. 2.) formulis VII...X deducitur methodus quantitates iſtas x, y & z computandi, quum angulos tam exiguos ſuis ſinubus proportionales, & eorum Coſinus ſingulos = 1 aſſumere liceat. Hic vero diverſi ſeorſim conſiderandi ſunt caſus:

Caſ. I. Si ſtellæ A, B & C (Fig. 1.) omnes in ſuperiori ſuo per Meridianum tranſitu obſervatæ fuerint,

fuerint, iisdem ac supra (§. 2) adhibitis denominationibus, ob $Cos\ \alpha = Cos\ \beta = Cos\ \gamma = 1$, erit $\frac{1}{n} = A' - B' + C'$; unde substitutis ipsorum A', B' & C' valoribus in æqv. VII... X (§. 2.) & facta debita reductione, sequentes eruuntur formulæ:

1:o $\frac{1}{n} = 2\, Sin\, \tfrac{1}{2}(a-b)\, Sin\, \tfrac{1}{2}(a-c)\, Sin\, \tfrac{1}{2}(b-c)$;

2:o $z = -n\alpha\, Cos\, a\, Cos\, \tfrac{1}{2}(b+c)\, Cos\, \tfrac{1}{2}(b-c)$
$+ n\beta\, Cos\, b\, Cos\, \tfrac{1}{2}(a+c)\, Cos\, \tfrac{1}{2}(a-c)$
$- n\gamma\, Cos\, c\, Cos\, \tfrac{1}{2}(a+b)\, Cos\, \tfrac{1}{2}(a-b)$;

3:o $y = -n\alpha\, Cos\, a\, Sin\, \tfrac{1}{2}(b+c)\, Sin\, \tfrac{1}{2}(b-c)$
$+ n\beta\, Cos\, b\, Sin\, \tfrac{1}{2}(a+c)\, Sin\, \tfrac{1}{2}(a-c)$
$- n\gamma\, Cos\, c\, Sin\, \tfrac{1}{2}(a+b)\, Sin\, \tfrac{1}{2}(a-b)$;

4:o $x = -\tfrac{1}{2} n\alpha\, Cos\, a\, Sin\,(b-c) + \tfrac{1}{2} n\beta\, Cos\, b\, Sin\,(a-c)$
$- \tfrac{1}{2} n\gamma\, Cos\, c\, Sin\,(a-b.)$

Cas. 2. Si alterutra stellarum e. g. B (Fig. 2) in inferiori, reliquæ vero A & C in superiori transitu per meridianum observatæ sint; posito ang. ZPB $(= \beta) = 180° - \beta'$, retentis de cetero prioribus denominationibus, erit $Cos\, \beta = -Cos\, \beta' = -1$, $Sin\, \beta' = \beta'$, $Sin\,(\alpha - \beta) = -\alpha - \beta'$, & $Sin\,(\beta - \gamma) = \beta' + \gamma$, unde ex æqv. VII...X (§. 2.) facta reductione hæ deducuntur regulæ:

1:o $\frac{1}{n'} = +2\, Cos\, \tfrac{1}{2}(a+b)\, Sin\, \tfrac{1}{2}(a-c)\, Cos\, \tfrac{1}{2}(b+c)$;

2:o

$$2{:}o\ z = -n'\alpha \, Cos\, a \, Cos \tfrac{1}{2}(b+c) Sin \tfrac{1}{2}(b-c)$$
$$+ n'\beta' Cos\, b\, Cos \tfrac{1}{2}(a+c)\, Sin \tfrac{1}{2}(a-c)$$
$$- n'\gamma\, Cos\, c\, Cos \tfrac{1}{2}(a+b) Sin \tfrac{1}{2}(a-b);$$
$$3{:}o\ y = -n'\alpha\, Cos\, a\, Cos \tfrac{1}{2}(b+c)\, Cos \tfrac{1}{2}(b-c)$$
$$+ n'\beta' Cos\, b\, Sin \tfrac{1}{2}(a+c)\, Sin \tfrac{1}{2}(a-c)$$
$$+ n'\gamma\, Cos\, c\, Cos \tfrac{1}{2}(a+b)\, Cos \tfrac{1}{2}(a-b);$$
$$4{:}o\ x = -\tfrac{1}{2}n'\alpha\, Cos\, a\, Sin\,(b+c) + \tfrac{1}{2}n'\beta'\, Cos\, b\, Sin\,(a-c)$$
$$+ \tfrac{1}{2}n'\gamma\, Cos\, c\, Sin\,(a-b);$$

Quarum formularum in utroque caſu ſinguli termini per Logarithmos facile computantur. Pro reliquis caſibus, quando ſcilicet vel duæ ſtellæ infra & tertia ſupra polum, vel etiam omnes tres infra polum obſervantur, pariter ex æquationibus iſtis VII... X (§. 2) elici poſſunt regulæ, quas vero brevitatis ſtudio omittimus, quum minus frequens ſit harum uſus.

Scholion. Si in formulis Cas.2. ponatur $a = b$, obtinentur regulæ pro caſu iſto ſpeciali, quo obſervatur ſtellæ cujusvis circumpolaris tranſitus uterque, ſcil. ſuperior in *A* atque inferior in *B* (Fig. 2), & præterea tranſitus ſuperior alius cujusdam ſtellæ *C* (quam quidem proximam ad æquatorem ſumere præſtat); quas igitur regulas fuſius exponere ſuperfluum eſt. Hoc tantum obſervamus, valorem ipſius z, qui pro hoc ſpeciali caſu eruitur $= \tfrac{1}{2}(\beta' - \alpha)$, generatim valere pro quavis aberratione utcunque magna. Quum ſcilicet ſit $PA = PB$ & $QA = QB$, ob latus QP commune in $\Delta\,\Delta\ PAQ$, PBQ erit ang. $APQ = BPQ = \tfrac{1}{2}(180^\circ - \beta' - \alpha) = 90^\circ - \tfrac{1}{2}(\beta' + \alpha)$, adeoque

ang.

ang. $ZPQ = 90^\circ - z = 90^\circ - \frac{1}{2}(\beta' + \alpha) + \alpha = 90 - \frac{1}{2}(\beta' - \alpha)$, & $z = \frac{1}{2}(\beta' - \alpha)$.

§. 5.

Obſervationibus igitur (§. 2) inſtitutis, & hinc per calculum (§. §. 2. 3. 4.) detectis erroribus x, y, z, videndum eſt, quomodo hi errores in ipſo inſtrumento culminatorio tollantur. Ad errorem x corrigendum commodisſimum erit ipſum tubum axi ſuo rotationis ope cochleæ, quam deſignemus litera X, ita adjungere, ut per revolutiones hujus cochleæ inclinatio tubi ad eundem axem emendari queat. Ceteri vero errores y & z per calculum ulterius reſolvendi ſunt in binos alios, quorum alter verticalis $= v$ inclinationem axis revolutionis ad horizontem metitur, alter horizontalis $= u$ declinationem ejus a punctis cardinalibus occid. & or. indigitat. Fulcrorum videlicet, quibus axis hic incumbit, utrumque cochlea ſua inſtructum eſt, quarum cochlearum una (quæ dicatur V) verticalis errori v, altera (quam appellemus U) horizontalis ipſi u corrigendo inſervit. Ut igitur ex cognitis z & y, & data præterea loci latitudine $= p$, inveniantur v & u, ſit (Fig. 3.). EH horizontis & EN æquatoris arcus, factaque de cetero eadem ac antea conſtructione, & retentis prioribus denominationibus, circulus verticalis ZQ occurrat horizonti EH in H, & circulus declinationis PQ ſecet æquatorem EN in N; quibus poſitis erit

ang.

ang. $EPN =$ arc. $EN = z$, $QN = y$, $QH = v$, & $EHQ =$ $= EZH = u$. Hinc per resolutionem Δ:li ZPQ, in quo dantur $ZP = 90^\circ - p$, $PQ = 90^\circ - y$ & ang. $ZPQ = 90^\circ - z$, innotescunt ang. $PZQ = 90^\circ - u$ & latus $ZQ = 90^\circ - v$. Aliter ducto arcu QE idem obtinetur resolvendo Triangula QNE & EHQ ad N & H rectangula, unde sequentes oriuntur regulæ:

1:o $Tg\, NEQ = \frac{Tg\, y}{Sin\, z}$; 2:o $Sin\, v = \frac{Sin\, y\, Cos\,(NEQ - p)}{Sin\, NEQ}$;

3:o $Tg\, u = \frac{Tg\, z\, Sin\,(NEQ - p)}{Cos\, NEQ}$.

Utraque solutio generatim pro aberratione quantacunque valet. Existente vero hac aberratione admodum parva, posterior methodus multo concinnior fit, ipsos arcus y, z, v & u pro Sinibus & tangentibus eorum in formulis allatis substituendo.

Si jam ad inventos errores x, v, u tollendos agitentur cochleæ X, V & U fiantque in his revolutiones 𝔵, 𝔴 & 𝔲 respective; denuo instituendæ sunt observationes pariter ac antea (§. 2.) docuimus, & ex his calculo (§. §. 2..5) eruendi errores x', v', & u', qui instrumento post factam istam mutationem competunt. His computatis pro quavis cochlea X, V, U per regulam proportionum invenitur revolutionum numerus: $\frac{\mathfrak{x}\, x'}{x - x'}$, $\frac{\mathfrak{w}\, v'}{v - v'}$, & $\frac{\mathfrak{u}\, u'}{u - u'}$, qui ad errorem x', v', u' respective tollendum requiritur. Horum numerorum si quis negativus prodeat, conversio cochleæ competentis in contrarium ſenſum fiet. Supponuntur vero hic errores admodum parvi; alias loco ipſorum arcuum x, x', v, v', u & u', eorum tangentes in computandis his cochlearum revolutionibus ſubſtituendæ erunt.

Scholion 1. Suppoſuimus (§. 2.) tranſitus ſtellarum in ipſo axe optico tubi culminatorii obſervatos, ſub qua igitur conditione perinde eſt, qualem verſus horizontem atque planum meridiani ſitum habeant fila illa in foco lentis objectivæ poſita (§. 1), dummodo ad axem tubi dignoſcendum in hoc axe ſe mutuo ſecent. In praxi tamen commodius erit, alterutrum filum verticaliter poni, quo etiam ſtellæ ſupra vel infra axem transeuntes obſervari queant. Factis vero jam erroribus x, v, u aut nullis aut ſaltim admodum parvis, facile eſt ſitum hujus fili examinare & ſi opus fuerit corrigere. In objecto ſcilicet quodam remoto ſi obſervetur punctum fixum in axe tubi conſpicuum, tubo ſurſum deorſumque agitato filum iſtud, ſi verticaliter poſitum fuerit, punctum hoc continue tanget; ſi vero deviatio quædam hic detegitur, corrigendus erit ſitus fili. Pariter poſitio fili horizontalis examinari poteſt ope ſtellæ cujusdam fixæ, cujus aut nulla aut ſatis parva eſt declinatio; hujus videlicet per campum tubi tranſeuntis ſemita apparens filo iſti congruens erit. Unde utroque examine facto ſimul invenitur filorum ad ſe invicem poſitio.

Scho-

Scholioo 2. Quum successu temporis variationem quandam subire possint & ipsum instrumentum & fulcra, quibus incumbit, haud abs re erit, examen ejus sæpius repetere. Circa usum ejus præterea sollicite cavendum, ne majori caloris gradui unum quam alterum exponatur fulcrum. Si enim ob diversam temperiem alterutrum magis expandatur, necesse est axem revolutionis e situ suo horizontali turbari. Quamobrem tutissimum videtur, thermometris utrinque applicatis circa quamvis observationem inquirere in temperiem fulcrorum, ut certius de exactitudine ipsius observationis ferri queat judicium.

§. 6.

Quamvis tradita (§. 5.) methodus errores instrumenti transituum corrigendi, theoretice spectata recte se habeat, in praxi tamen ob cochlearum inæqualitates variasque alias caussas vix unquam, nisi sæpius repetita operatione, errores isti penitus tolli possunt. Quum vero frequentiori cochlearum agitatione hoc instrumentum vacillans facile fiat, satius erit, inventis (§. §. 2.. 4) erroribus x, y, z singulis paucorum scrupulorum, pro observanda qvavis stella S (Fig. 3,) cujus detur declinatio = δ, calculo eruere intervallum temporis = τ, quo in tubo culminatorio serius quam in ipso meridiano contingit ejus transitus. In hoc calculo non opus est erroribus u, v ad horizontem reductis (§. 5.), verum expeditius tem-

 pus

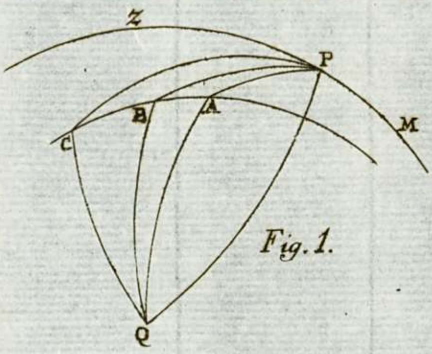

Fig. 1.

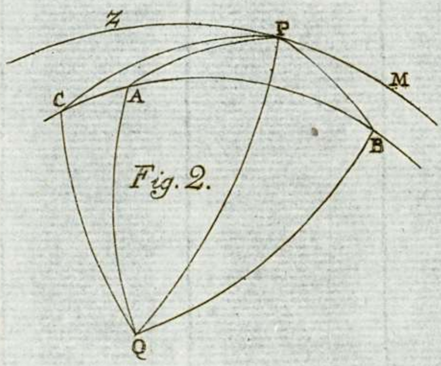

Fig. 2.

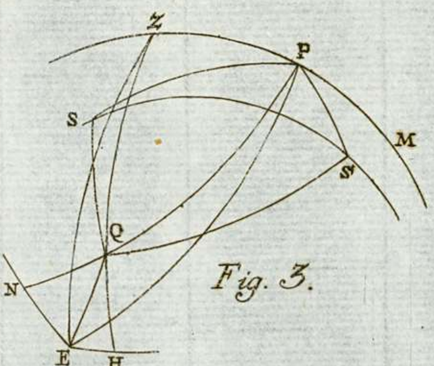

Fig. 3.

C.L.S. sc

pus τ mox ex ipsis z, y, x datis computari potest. Denotante scilicet (ut antea) R tempus revolutionis diurnae stellae S, & facto $\frac{360\ \tau}{R} = \pi$, erit ang. $ZPS = \pi = 90° - z - QPS$. Per resolutionem Trianguli sphaer. PQS in quo dantur tria latera: $PS = 90° - \delta$, $PQ = 90° - y$ & $QS = 90° - x$, invenitur ang. QPS, unde itaque ang. π, adeoque tempus τ, generatim innotescit, quanticunque fuerint dati isti errores. Quando vero hi admodum parvi sunt, commodissime invenietur pro transitu stellae superiori tempus istud τ per formulam:

$$\tau = \frac{R}{360°}\left(\frac{x}{Cos\ \delta} - y\ Tg\ \delta - z\right).$$

Pro eadem autem stella infra polum in S' observanda, tempus $= \tau'$, quo in tubo prius quam in ipso meridiano fit ejus transitus, computatur secundum hanc regulam:

$$\tau' = \frac{360°}{R}\left(\frac{x}{Cos\ \delta} - y\ Tg\ \delta + z\right).$$

Unde facile construetur tabula, ex qua pro singulis declinationum gradibus correctio ista temporis in utroque casu mox depromi potest. In qua vero tabula condenda pro declinationibus a 90° parum differentibus (seu pro stellis polo ipsi admodum vicinis) tempus hoc per priorem illam methodum generalem exactius computabitur.