



1768

# De telescopiis quatuor lentibus instructis eorumque perfectione

Leonhard Euler

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DE  
TELESCOPIIS

QUATTOR LENTIBVS INSTRVCTIS EORVM.  
QVE PERFECTIONE.

Auctore

L. E V L E R O.

I.

Cum telescopia vulgaria binis lentibus, altera convexa altera concava, instructa hoc incommodo laborent, quod campum nimis arcum ostendant, neque ad maiores multiplicationes extendi queant; telescopia autem astronomica, binis lentibus convexis instructa, in sua inverte obiecta exhibeant, quo contemplatio obiectorum terrestrium non mediciter perturbatur; ut huic duplici incommodo occurratur, telescopia ex quattuor lentibus convexis componere coeperunt. Tubo scilicet astronomico adiunxerunt insuper binas lentes convexas, quibus repraesentatio inverte nova inverte erecta redderetur. Primo quidem has novas lentes adiectas inter se aequales fecerunt, tum vero inaequalitatem admitiendo animadverterunt, campum conspicuum aliquantum augeri, atque adeo consulsionem colorum iridis imminui posse, quo pacto hoc telescopiorum genus haud mediciter est perfectum.

2. Nu-

2. Nuper autem in Anglia his telescopis ex quattuor lentibus compositis quintam lentem atque adeo mox sextam adiecerunt, haecque lentem multiplicatione insignia commoda obtinere posse animadverterunt, dum non solum campus conspicuus multo magis ampliari, sed etiam repraesentatio a coloribus iridis penitus liberari poterat. Cum autem sola experientia ducti hunc perfectionis gradum sint adepti, neque vlla Theoria in subsidium vocata videatur, nullum est dubium, quin haec eadem commoda beneficio Theoriae augeri, atque adeo ad maximum gradum, quem quidem natura admittit, euehi queant.

3. Veram autem Theoriam, cui omnium instrumentorum dioptricorum tam telescopiorum quam Microscopiorum constructio innitur, in XIII. Volumine Actorum Academiae Regiae Borussicae equidem mihi tradidisse video, unde omnia, quae ad horum instrumentorum perfectionem spectant, hauriri debere videntur. Quanta igitur incrementa hinc tam pro quattuor lentibus, quam iis insuper quintam ac sextam adiciendo, assequi liceat, hic diligentius inuestigare constitui. In quo negotio ne in nimis longas ambages incidam, ex loco allegato subsidia, quae tam ad campum amplificandum, quam ad colores iridis tollendos faciunt, depreoriam, neque principis, quibus innuntur, commemorandis immorabor. De lente etiam obiectiva perficienda hic non ero sollicitus, cum iam saepius docuerim, quomodo

modo eius duplicatione vel etiam triplicatione confuso ab eius apertura oriunda non solum imminui, sed etiam ad nihilum redigi debet.

*De Telescopiis quatuor lentibus instructis.*

Tab. III. 4. Quatuor lentibus super eommuni axe in A, B, C, D constitutis, ante omnia ad binas imagines est respiciendum, quarum altera in foco lentis obiectivae A, qui sit in  $\alpha$ , est sita, atque inversa, altera autem in  $\gamma$  focum lentis ocularis D cadere debet, eaque ut est erecta, oculo in O posito obiecta situ erecto spectanda offert. Binac igitur lentes mediae B et C imaginem ex  $\alpha$  in  $\gamma$  transferre debent, ac vulgo quidem eae ita constitui solent, ut lens B focum suum in puncto  $\alpha$  habens, radios parallelos ad lentem C mittat, quae deinde eos in  $\gamma$  iterum colligat, ita ut huius lentis focus in  $\gamma$  incidat.

Fig. 3.

5. Idem autem effectus praeterea duplici modo obtineri potest. Primo enim si intervallum B $\alpha$  minus sit, quam distantia foci lentis B, haec imaginem antrorsum proiciet in B, vnde lens C eam demum colliget in  $\gamma$ . Hoc casu in denominationibus a me visitatis erit numerus  $B = \frac{-B\epsilon}{B\alpha}$ , quem propterea ponam  $B = \frac{-b}{\epsilon}$ , existente  $b > 1$ , ut sit  $B = \frac{b}{\epsilon + 1} = b$ ; deinde pro lente C erit numerus  $C = \frac{c\gamma}{\epsilon} = \frac{c}{1 - \epsilon}$ , existente  $\epsilon < 1$ , ut sit  $C = \frac{c}{1 - \epsilon} = c$ ; ubi

videndum in casu vulgari fieri  $b = 1$  et

Secundus casus est, quo intervallum B $\alpha$  superat distantiam foci lentis B, tum ista lens imaginem ex  $\alpha$  retrorsum proicit in B, vnde lens C eam reducit in  $\gamma$ . Hoc ergo casu ob numerum  $B = \frac{+B\epsilon}{B\alpha}$  ponam  $B = \frac{b}{\epsilon - 1}$ , existente  $b < 1$ , ut sit  $B = \frac{b}{\epsilon - 1} = b$  et pro lente C ponam numerum  $C = \frac{c\gamma}{\epsilon} = \frac{c}{1 + \epsilon}$  ut sit  $C = -c$  vnde iterum casus vulgaris resultat si  $b = 1$  et  $\epsilon = 0$ ; posterior autem ex priori oritur sumendo  $\epsilon$  negativum.

6. Sit nunc distantia foci lentis obiectivae  $p = \alpha$ ; lentis B =  $p'$ , lentis C =  $p''$  et lentis D =  $p'''$ ; ac semidiametri aperturae harum trium posteriorum lentium statuantur  $\theta'p'$ ;  $\theta''p''$  et  $\theta'''p'''$ . Tum posita multiplicationis ratione  $m:1$  et semidiametro campii apparentis =  $\Phi$ , habemus statim  $\theta''' + \theta'' + \theta' - \Phi = -m\Phi$  ideoque  $\Phi = \frac{\theta''' + \theta'' - \theta'}{m - 1}$ . Deinde ob

$$B = \frac{-b}{\epsilon}; B = b; C = \frac{c}{1 - \epsilon}; C = c; D = \infty \text{ et } \mathcal{Q} = 1$$

ponamus porro:

$$\Pi = b\theta - \Phi; \Pi' = c\theta'' + \theta' - \Phi; \Pi'' = \theta''' + \theta'' + \theta' - \Phi$$

eruntque distantiae focales lentium:

$$p' = \frac{b^2}{m^2} \alpha; p'' = \frac{bc}{m^2}; p''' = \frac{bc}{(b-1)(1-\epsilon)} \frac{\Phi}{m^2} \alpha$$

et intervalla lentium :

$$AB = \frac{b\theta'}{n'}\alpha; \quad BC = \frac{b}{b-1} \cdot \frac{\Phi(c\theta'' - (b-1)\theta')}{(b\theta'' - \Phi)(c\theta'' + \theta' - \Phi)}\alpha;$$

$$CD = \frac{-b}{(b-1)(\theta' - c)} \cdot \frac{\Phi(-\theta'' + (c-1)\theta')}{n''n'''}\alpha \text{ et pro loco oculis } \frac{\theta''\theta'''}{n''n'''} = DO.$$

7. Cum haec intervalla esse debeant positiva et  $AB > \alpha$  patet primo tam  $\theta'$  quam  $\Pi'$  positiva esse debere. Deinde ut campum apparentem quam maximum reddamus, statuamus  $\theta' = q\omega$ ,  $\theta'' = -\omega$ , et  $\theta''' = -\omega$ , ita ut sit  $q < 1$ , et  $\Phi = \frac{z - q}{z - 1}\omega$ , ubi si hae lentes sunt aequae convexae vringue, sumi potest  $\omega = \frac{1}{2}$ . Sit quoque brevitatis gratia  $\Phi = M\omega$  seu  $M = \frac{z - q}{z - 1}$ , et ob

$$\Pi' = (bq - M)\omega; \quad \Pi'' = (-c + q - M)\omega; \quad \Pi''' = -(z - q + M)\omega$$

habebimus :

$$p' = \frac{bM}{bq - M}\alpha; \quad p'' = \frac{bc}{b-1} \cdot \frac{M}{q - c - M}\alpha; \quad p''' = \frac{bc}{(b-1)(\theta' - c)} \cdot \frac{M}{z - 1 + M}\alpha$$

$$AB = \frac{b}{bq - M}\alpha; \quad BC = \frac{b}{(b-1)(bq - M)} \cdot \frac{q - c + M}{q - c - M}\alpha; \quad CD = \frac{bc}{(z-1)(c - q - c - M)} \cdot \frac{b^2 - c^2 + M}{z - 1 + M}\alpha$$

et pro loco oculi  $DO = \frac{1}{z - q + M}p'''$ . Vbi notandum est si  $b > 1$ , litteram  $c$  capi debere positive, negative vero si  $b < 1$ .

8. His praemissis, quibus campo iam maximam amplitudinem conciliaimus, dummodo fractio  $q$  tam exigua accipiat, quam reliquae circumstantiae permittunt, consideremus conditionem, quam

quam destructio colorum iridis postulat, in hac aequatione contentam :

$$\frac{\theta'}{n'} + \frac{\theta''}{n''} + \frac{\theta'''}{n'''} = 0 \text{ seu } \frac{bq}{q - c - M} - \frac{1}{q - c - M} + \frac{1}{z - q + M} = 0$$

ideoque  $\frac{bq - M}{q - c - M} = \frac{z - 1q + c + 1M}{z - q + M}$ , unde invenitur

$$b = \frac{M}{q} + \frac{(q - c - M)(z - q + M)}{z - 1q + c + 1M} = \frac{(z - q)MM + (z - 1q + c + 1M) + (z - q)(M - c)}{q(z - 1q + c + 1M)}$$

quem valorem oportet esse maiorem unitate, si fraktionem  $q$  notabiliter maiorem capi debere, quam  $c + M$ , quia alioquin fractio  $\frac{q - c - M}{q - c - M}$  fieret nimis magna, unde etiam fractio  $\frac{bq - M}{q - c - M}$  ac propterea intervallum  $AB$  enormiter augetur.

9. Ne igitur hoc eveniat, atque ut ob minutam fractionem  $q$  etiam campus amplietur, convenit fractioni  $c$  valorem tribui negativum simul: sumi  $b < 1$ , ex quo formulae nostrae erunt :

$$p' = \frac{bM}{bI - M}\alpha; \quad p'' = \frac{bc}{1 - b} \cdot \frac{M}{q + c - M}\alpha; \quad p''' = \frac{bc}{(z-1)(1 + c)} \cdot \frac{M}{z + 1 + M}\alpha$$

$$AB = \frac{bI}{bq - M}\alpha; \quad BC = \frac{bI}{(1 - b)(bq - M)} \cdot \frac{q + c + M}{q + c - M}\alpha; \quad CD = \frac{bc}{(z-1)(1 + c)} \cdot \frac{b^2 + c^2 + M}{z + 1 + M}\alpha$$

et pro loco oculi  $DO = \frac{1}{z - q + M}p'''$ . At ut iris dis colores evanescent, fieri debet  $b = \frac{1 + c - M}{z - 1q + c + 1M}$ , quem valorem unitate minorem esse oportet, quod in assumptione numeri  $c$  probe est observandum; simul vero etiam ut  $bq - M$  positivum prodcat, quorum utrumque postulat, ut  $c$  notabiliter minus quam  $z - 2q - 1 - 2M$  accipiat. Interim tamen ob  $b < 1$  sumi oportet  $q > M$ , quod ob  $M$  fractionem eo

eo minorem, quo maior est multiplicatio, non im-  
pediet, quo minus campus apprensus  $\Phi$  satis prole-  
ad  $\frac{2\omega}{m-1}$  accedat, dum casu vulgari  $q$  maius semissi-  
mitatis accipi debeat.

10. Statuamus ergo  $q = nM$ , ut sit  $n > 1$ ,  
eritque

$$p' = \frac{b}{bn-1} \alpha; p'' = \frac{bc}{1-b} \frac{M}{c+(n-1)M} \alpha; p''' = \frac{bc}{(1-b)(1+c)} \frac{M}{2(n-1)M\alpha} \alpha$$

$$AB = \frac{b}{bn-1} \alpha; BC = \frac{b}{(1-b)(bn-1)} \frac{M}{c+(n-1)M} \alpha; CD = \frac{bc}{(1-b)(1+c)} \frac{M}{2(n-1)M\alpha} \alpha$$

et  $D\dot{O} = \frac{1}{2(n-1)M} p''$ . Tum vero ob  $M = \frac{2}{m-1}$   
erit  $M = \frac{2}{m+n-1}$  et  $\Phi = \frac{2}{m+n-1} \omega$ ; et colorum  
destructio praebet:

$$b = \frac{1}{n} + \frac{(c+(n-1)M)(c-(n-1)M)}{2-c+(n-1)M} \text{, unde cum esse debeat}$$

$$b < 1 \text{ erit } \frac{(c+(n-1)M)(c-(n-1)M)}{2-c+(n-1)M} < \frac{n-1}{n} \text{ hincque.}$$

$c^{\frac{2(n-1)}{n}} - (n-1)M < \frac{2(n-1)}{n} \frac{c^{2(n-1)} - 1}{2} M + (n-1)^2 MM$ .  
Ergo quia  $M$  est fractio valde parva erit  $c < \frac{2(n-1)}{2n-1}$   
et propius  $c < \frac{2(n-1)}{2n-1} - \frac{2(n-1)(5n-4n+1)}{(2n-1)^2} M$ .

11. *Exemplum I.* Sit  $n = 2$ , hincque  $M = \frac{2}{m+1}$   
et  $\Phi = \frac{2\omega}{m+1}$ , atque capiatur  $c = \frac{1}{2}$ , fiet  $b = \frac{1}{2} + \frac{2}{2+2M} \frac{M}{4M}$ , qui valor cum ex loco oculi,  
vnde colores irides euanescent, deductus summi-  
rigoris non sit capax, sufficit valorem prope ve-  
rum assumisse. At si multiplicationem sumam  
 $m = 15$ , fit  $M = \frac{2}{17}$ , et  $b = \frac{1}{2} + \frac{2}{17}$ , qui valor tam  
prope ad unitatem accedit, ut intervalla lentium  
pro-

prodirent nimis magna. Quare capiamus  $c = \frac{1}{3}$ , et  
pro casu  $M = \frac{1}{3}$  reperimus  $b = \frac{1}{3} + \frac{15}{15}$ ; ex quo sta-  
tuamus  $b = \frac{1}{3}$ , ac determinationes nostrae erunt

$$p' = \frac{2}{3} \alpha; p'' = \frac{2}{3} \frac{M}{1+3M}; p''' = \frac{2}{3} \frac{M}{5M}$$

$$AB = \frac{2}{3} \alpha; BC = \frac{2}{3} \frac{M}{1+(3M)} \alpha; CD = \frac{2}{3} \frac{M}{5M} \alpha$$

vnde Telescopium eritur vehementer longum. Ra-  
tio huius incommodi in hoc sita est quod  $bn = 2$   
adspiciatur valorem nimis paruum.

12. *Exemplum II.* Sit  $n = 3$ , ideoque  $M = \frac{2}{m+3}$

et  $\Phi = \frac{2\omega}{m+3}$ ; debet ergo esse  $c < \frac{2}{3} - \frac{1}{3} M$  et  $b = \frac{1}{3} + \frac{(c+3M)(c-M)}{2-c+3M}$ ; vbi ne intervallum  $AB$  fiat ni-  
mis magnum, numero  $b$  maximus valor tribui de-  
bet, at ob  $b < 1$  fiet tamen semper  $AB > \frac{1}{3} \alpha$ . At

ne intervallum  $BC = \frac{bc + 3c - 3cM - 3M}{(1-b)(1+c+3M)} \alpha$  fiat nimis

magnum fractio  $\frac{c}{2}$  diminui debet quantum fieri  
potest. Quod si ponamus  $c = \frac{1}{3}$  fit  $b = \frac{1}{3} + \frac{2(1-M)(1+2M)}{7-10M}$ ,

et  $b = \frac{2}{15}$  casu  $M = \frac{1}{16}$  fit ergo  $c = \frac{1}{3}$  fit  $b = \frac{1}{3} + \frac{2(1-\frac{1}{16})(1+\frac{2}{16})}{7-\frac{10}{16}}$ ,  
ergo  $b = \frac{1}{3}$ , et  $c = \frac{1}{3}$ , habebimusque has determi-  
nationes:

$$p' = \frac{1}{3} \alpha; p'' = \frac{2}{3} \frac{M}{1+3M}; p''' = \frac{2}{3} \frac{M}{6(1-M)}$$

$$AB = \frac{1}{3} \alpha; BC = \frac{2}{3} \frac{M}{1+(3M)} \alpha; CD = \frac{2}{3} \frac{M}{6(1+3M)(1-M)}$$

qui valores pro multiplicatione  $m = 20$  circiter  
erunt iusti.

13. *Exempl III.* Sit  $n=5$ , ideoque  $M=\frac{2}{n+1}$  et  $\Phi=\frac{2}{n+1}$ , atque quo facilius omnes variationes ex variis valoribus  $e$  oriundas perspicere queamus, calculum ad datam multiplicationem  $m=28$  accommodemus, ut sit  $M=\frac{2}{18}$ , eruntque formulae nostrae

$$p' = \frac{2a}{5b-1}; p'' = \frac{bc}{1-b}; p''' = \frac{bc}{(1-p)(1+q)} \frac{a}{a}$$

$$AB = \frac{2b}{5b-1}; BC = \frac{b(1+c+s(1-b))a}{4(1-b)(1-X+9c)}; CD = \frac{bc(1+c)a}{2(1-b)(1+q)(1+c)}$$

at esse oportet  $b=1+\frac{2(1+9c)}{5}$ , et  $e < \frac{2}{30}$ ; Hinc

$\delta$  fit; erit

$$e = \frac{2}{15}; b = \frac{2}{5} \text{ et } \begin{cases} p' = \frac{2}{15}a; p'' = \frac{1}{15}a; p''' = \frac{1}{15}a \\ AB = \frac{2}{5}a; BC = \frac{1}{15}a; CD = \frac{1}{15}a \end{cases} : AD = 3 \frac{2}{15}a$$

$$e = \frac{2}{15}; b = \frac{1}{2} \text{ et } \begin{cases} p' = \frac{1}{15}a; p'' = \frac{1}{15}a; p''' = \frac{1}{15}a \\ AB = \frac{1}{2}a; BC = \frac{1}{15}a; CD = \frac{1}{15}a \end{cases} : AD = 2 \frac{1}{15}a$$

$$e = \frac{2}{15}; b = \frac{1}{3} \text{ et } \begin{cases} p' = \frac{1}{15}a; p'' = \frac{1}{15}a; p''' = \frac{1}{15}a \\ AB = \frac{1}{3}a; BC = \frac{1}{15}a; CD = \frac{1}{15}a \end{cases} : AD = 2 \frac{2}{15}a$$

$$e = \frac{2}{15}; b = \frac{1}{4} \text{ et } \begin{cases} p' = \frac{1}{15}a; p'' = \frac{1}{15}a; p''' = \frac{1}{15}a \\ AB = \frac{1}{4}a; BC = \frac{1}{15}a; CD = \frac{1}{15}a \end{cases} : AD = 2 \frac{3}{15}a$$

ulterius fractionem  $e$  diminuere non licet, quia lens ocularis nimis feret exigua.

14. *Exempl. IV.* Minuamus aliquanto magis campum sitque  $n=9$  ideoque  $M=\frac{2}{n+1}$ ; maneat  $m=28$ , et fit  $M=\frac{2}{11}$ , unde

$$p' = \frac{2b}{9b-1}; p'' = \frac{bc}{2(1-b)(1+q)} a; p''' = \frac{bc}{2(1-p)(1+q)} a$$

$$AB = \frac{2b}{9b-1} a; BC = \frac{2b(1+c)}{2(1-b)(1+q)} a; CD = \frac{2b(1+c)}{2(1-p)(1+q)} a$$

tum

tum vero  $b=1+\frac{15(1+9c)}{9}$  et  $e < \frac{2}{36}$ . Hinc

$\delta$  fit; erit

$$e = \frac{2}{18}; b = \frac{2}{9} \text{ et } \begin{cases} p' = \frac{2}{18}a; p'' = \frac{1}{18}a; p''' = \frac{1}{18}a \\ AB = \frac{2}{9}a; BC = \frac{1}{18}a; CD = \frac{1}{18}a \end{cases}$$

$$e = \frac{2}{18}; b = \frac{1}{2} \text{ et } \begin{cases} p' = \frac{1}{18}a; p'' = \frac{1}{18}a; p''' = \frac{1}{18}a \\ AB = \frac{1}{2}a; BC = \frac{1}{18}a; CD = \frac{1}{18}a \end{cases}$$

$$e = \frac{2}{18}; b = \frac{1}{3} \text{ et } \begin{cases} p' = \frac{1}{18}a; p'' = \frac{1}{18}a; p''' = \frac{1}{18}a \\ AB = \frac{1}{3}a; BC = \frac{1}{18}a; CD = \frac{1}{18}a \end{cases}$$

$$e = \frac{2}{18}; b = \frac{1}{4} \text{ et } \begin{cases} p' = \frac{1}{18}a; p'' = \frac{1}{18}a; p''' = \frac{1}{18}a \\ AB = \frac{1}{4}a; BC = \frac{1}{18}a; CD = \frac{1}{18}a \end{cases}$$

$$e = \frac{2}{18}; b = \frac{1}{5} \text{ et } \begin{cases} p' = \frac{1}{18}a; p'' = \frac{1}{18}a; p''' = \frac{1}{18}a \\ AB = \frac{1}{5}a; BC = \frac{1}{18}a; CD = \frac{1}{18}a \end{cases}$$

15. Potremus hic casus imprimis ad praxin accommodatus videtur, quia lentis obiectivae distantia focalis  $a$  fit pro hac multiplicatione circiter 45 dig. sique tota tubi longitudo erit 65 dig. et campus conspicuus maior erit eo, quem huiusmodi tubus more vulgari constructus offendit. Nollem hic  $e$  minus accipere, quia lentes  $p'$  et  $p'''$  nimis fierent parvae, hocque ipso confusioem auferent. Verum si campo plus detrahere velimus tribuendo ipsi  $n$  maiores valores, breuiora telescopia huius generis obtineri poterunt, quae vulgaria cum ratione campi, tum puritate repraesentationis superabunt. Videamus autem quantum lucrì impetrare valeamus, si quintam insuper lentem adiungamus, quam primo ante focum obiectivae lentis confitui conveniet

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instructis.

16. Secunda lente B ante focum obiectivae constituta, erit pro ea  $B = \frac{b}{1+d}$  et  $\mathcal{B} = -b$ , reli-  
quae lentes sint dispositae ut ante ideoque  $C = \frac{c}{1+d}$ ;  
 $E = c$ ;  $D = \frac{d}{1+d}$ ;  $\mathcal{D} = -d$ ;  $E = c$  et  $\mathcal{E} = 1$ . Hinc  
adpeturas in computum dicendo ponatur brevitatis  
ergo  $\Pi' = -b\theta' - \Phi$ ;  $\Pi'' = r\theta'' + \theta' - \Phi$ ;  $\Pi'''$   
 $= -d\theta''' + \theta'' + \theta' - \Phi$  ac denique  $\Pi'''' = \theta''''$   
 $- \theta'''' + \theta'''' + \theta'''' - \Phi$ , denotante  $\Phi$  semidiametrum  
campi conspici: ac si multiplicatio fiat  $\Pi' = m$ ,  
erit  $\Phi = \frac{m}{1+d} \frac{b}{1+d} \frac{c}{1+d} \frac{d}{1+d}$ , unde patet si singulis  
litteris  $\theta'$ ,  $\theta''$ ,  $\theta'''$  et  $\theta''''$  valores negativos tribue-  
re liceret eosque maximos, campum apparentem  
vlietius augeri posse. Saut autem hae litterae  $\theta$   
eiusmodi fractiones, ut si  $p$  fuerit distantia foci  
lentis, ad quam referretur,  $\theta p$  sit semidiameter apertu-  
rae, unde patet valores harum litterarum non vl-  
tra  $\frac{1}{2}$  augeri posse.

17. His positis habemus in genere pro len-  
tium singularum distantis foci earumque interuallis  
sequentes formulas, denotante  $\alpha$  distantiam foci len-  
tis obiectivae:

$$\begin{aligned} p' &= \frac{1+\mathcal{B}\Phi}{n'} \alpha; & AB &= (1 + \frac{\Phi}{n'}) \alpha = \frac{\Phi + n'}{n'} \alpha \\ p'' &= \frac{1+\mathcal{B}\mathcal{E}\Phi}{n''} \alpha; & BC &= \frac{1+\mathcal{B}\Phi(n'' - \alpha)}{n''} \alpha \\ p''' &= \frac{1+\mathcal{B}C\mathcal{D}\Phi}{n'''} \alpha; & CD &= \frac{1+\mathcal{B}C\mathcal{D}(n''' - \alpha)}{n'''} \alpha \\ p'''' &= \frac{1+\mathcal{R}C\mathcal{D}\mathcal{E}\Phi}{n''''} \alpha; & DE &= \frac{1+\mathcal{R}C\mathcal{D}\mathcal{E}(n'''' - \alpha)}{n''''} \alpha \end{aligned}$$

ac

ac pro loco oculi  $EO = \frac{\theta''''}{\theta''''} p''''$ .  
Tum vero ut colores iridis euanescent, huic satis-  
feri oportet aequationi:

$$\frac{\theta'}{n'} + \frac{\theta''}{n''} + \frac{\theta'''}{n'''} + \frac{\theta''''}{n''''} = 0.$$

18. Sit  $\omega$  maximus valor, quem fractiones  $\theta$   
assequi possunt, si quidem lens fuerit vtriusque ac-  
que conuexa, ac pro campo amplificando ponamus;

$$\theta'''' = -\omega; \theta'''' = -\omega; \theta'''' = -r\omega \text{ et } \theta' = q\omega$$

ut fiat  $\Phi = \frac{1+r}{m} \omega$ , seu  $\Phi = M\omega$  posito  $M = \frac{1+r}{m}$ ,

Tum ob  $\Pi' = -(bq + M)\omega$ ;  $\Pi'' = -(cr - q + M)\omega$ ;  
 $\Pi''' = (d - r + q - M)\omega$  et  $\Pi'''' = -(2 + r - q + M)\omega$ ,  
erit

$$\begin{aligned} p' &= \frac{bM}{b_1 + M} \alpha; & AB &= \frac{bq}{bq + M} \alpha \\ p'' &= \frac{bc}{1+b} \frac{M}{q-cr-M} \alpha; & BC &= \frac{b}{1+b} \frac{M(b_1 + r)q - cr}{(b_1 + M)(q - cr - M)} \alpha \\ p''' &= \frac{bcd}{(1+b)(1-d)} \frac{M}{d-r+q-M} \alpha; & CD &= \frac{bc}{(1+b)(1-d)} \frac{M(d-r-cM)}{(d-r-M)(q-d+q-M)} \alpha \\ p'''' &= \frac{bcd}{(1+b)(1-d)} \frac{M}{2+r-q+M} \alpha; & DE &= \frac{bcd}{(1+b)(1-d)} \frac{M(1+d)}{(d-r+q-M)(2+r-q+M)} \alpha \end{aligned}$$

et pro loco oculi  $EO = \frac{p''''}{2+r-q+M}$ .  
19. Cum igitur destructio colorum hanc re-  
quirat aequationem:

$$\frac{bq}{1+b} + \frac{1}{q-cr-M} + \frac{1}{d-r+q-M} = 2+r-q+M$$

vbi per hypothesin  $q$  debet esse quantitas positiva,  
Ideoque quam minima accipienda; ante omnia vi-  
dendum est, num litterae  $r$  valor positivus tribui  
possit,

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possit, quo pacto augmentum in campum apparentem inferretur. Hunc in finem ponamus primo  $r=0$ , hincque fiat necesse est

$$\frac{b^2}{bq+m} + \frac{1}{d+q-m} = \frac{1}{2-q+m} \text{ existente } q > M$$

vbi obteruo, quodsi secunda lens B in ipsum focum lentis obiectivae incidat, fore  $b=∞$ , ideoque  $d=2-2q+2M$ , qui casus vitique meretur, ut studiosus expendatur.

20. *Casus I.* quo  $b=∞$  et  $r=0$ . Ob  $d=2-2q+2M$  habebimus sequentes determinaciones: Primo  $\Phi = \frac{2-q}{m} \omega$  et  $M = \frac{2-q}{m} \alpha$ . Deinde:

$$p' = \frac{2}{q} \alpha; \quad AB = \alpha$$

$$p'' = c \cdot \frac{2}{q+m} \alpha; \quad BC = \frac{c}{q+m} \alpha$$

$$p''' = \frac{cd}{1-c} \cdot \frac{2}{2-q+m} \alpha; \quad CD = \frac{c}{1-c} \cdot \frac{2}{(q-m)(2-q+m)} \alpha$$

$$p'''' = \frac{cd}{(1-c)(d+2)} \cdot \frac{2}{2-q+m} \alpha; \quad DE = \frac{2cd}{(1-c)(d+2)} \cdot \frac{2}{2-q+m} \alpha$$

$$\text{et pro loco oculi } EO = \frac{p''''}{2-q+m},$$

vbi ob quantitatem  $d$  iam definitam, quantitates  $q$  et  $c$  determinandae supersunt, ita tamen ut sit  $q > M$  et  $c < 1$ , tum vero videndum est, ne distantia focalis  $p''$  nimis fiat exigua; vnde  $c$  vix minus quam  $\frac{1}{2}$  accipiendum videtur, siquidem lens obiectiva parum confusiois pariat; ac ne rubus nimis fiat longus fractionem  $q$  maiorem quam  $2M$  capi conveniet.

21. Quod-

21. Quodsi ergo ponamus  $c = \frac{1}{2}$ ,  $q = (n+1)M$  erit  $d = 2(1-nM)$  et  $\Phi = \frac{2-(n+1)M}{m} \omega$  existente  $M = \frac{2-(n+1)M}{m}$  seu  $M = \frac{2}{m+1}$  et  $\Phi = M\omega$ , tum vero

$$p' = \frac{2}{n+1} \alpha \quad AB = \alpha$$

$$p'' = \frac{1}{n} \alpha \quad BC = \frac{1}{n} \alpha$$

$$p''' = \frac{2(1-nM)}{2-nM} M \alpha \quad CD = \frac{2(1-nM)}{n(2-nM)} \alpha$$

$$p'''' = \frac{2(1-nM)}{(1-nM)(2-nM)} M \alpha; \quad DE = \frac{2(1-nM)}{(1-nM)(2-nM)} M \alpha.$$

et pro loco oculi  $FO = \frac{p''''}{2-nM}$ , quibus formulis cum praecedentibus comparandis patet pro eadem multiplicatione eodemque campo aliquid lucris longitudine rubi obtineri posse. Posito enim ut supra  $n=28$ ,  $n=8$  ut sit  $M = \frac{1}{15}$ , reperitur

$$p' = \frac{1}{9} \alpha; \quad p'' = \frac{2}{15} \alpha; \quad p''' = \frac{2}{15} \alpha; \quad p'''' = \frac{2}{15} \alpha$$

$$AB = \alpha; \quad BC = \frac{1}{9} \alpha; \quad CD = \frac{1}{15} \alpha; \quad DE = \frac{1}{15} \alpha$$

22. Quando autem lens obiectiva est simplex, tum  $\alpha$  tantum valorem obtinet, ut licet ponere  $c = \frac{1}{2}$ , vnde. posito  $q = (n+1)M$ , ut sit  $d = 2(1-nM)$  et  $M = \frac{2}{m+1}$ , habebimus

$$p' = \frac{2}{n+1} \alpha; \quad AB = \alpha$$

$$p'' = \frac{1}{n} \alpha \quad BC = \frac{1}{n} \alpha$$

$$p''' = \frac{2(1-nM)}{2-nM} M \alpha; \quad CD = \frac{2(1-nM)}{n(2-nM)} \alpha$$

$$p'''' = \frac{2(1-nM)}{(1-nM)(2-nM)} M \alpha; \quad DE = \frac{2(1-nM)}{(1-nM)(2-nM)} M \alpha.$$

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Quod-



Quod si ista ponamus  $m = 28$ ,  $n = 6$ , ut sit  $M = n$  erit

$$P = \frac{1}{2}a; P' = \frac{1}{10}a; P'' = \frac{1}{10}a; P''' = \frac{1}{10}a$$

$$AB = a; BC = \frac{1}{2}a; CD = \frac{1}{2}a; DE = \frac{1}{10}a$$

Vnde sumto  $a = 45$  dig: longitudo tantum fit 56 $\frac{1}{2}$  dig. cum ante esset 65 dig. Poterat ergo  $n$  minus accipi, ideoque campus ampliari.

23. Haecenus sumsi  $r = 0$ , neque etiam hoc sentium factu huic litterae notabilem valorem positivum dare licet, ut inde maior campus obtineatur, cum tamen vnam lentem superaddendo iure haud mediocriter maiorem campum expectare queamus.

Quare secundam lentem ultra focum primae removituri conveniet, neque parvam campum augere licebit, si etiam litterae  $d$  valor negativus tribuatur, tum enim ipsi  $r$  maximus adeo valor scilicet  $r = 1$  tribui poterit. Posito autem  $b = -b$ ,  $d = -d$  et  $r = 1$  habebimus:  $\Phi = \frac{1}{m} - \frac{1}{n} \omega$  et  $M = \frac{1}{m} - \frac{1}{n}$  tum vero.

$$P = \frac{b}{bq - M} a; \quad AB = \frac{b}{bq - M} a$$

$$P' = \frac{bc}{b-1} \frac{1}{q-c-M} a; \quad BC = \frac{bc}{b-1} \frac{1}{(bq-M)(q-c-M)} a$$

$$P'' = \frac{bcd}{(b-1)(c)} \frac{1}{d+1-q+M}; \quad CD = \frac{bcd}{(b-1)(c)} \frac{1}{(q-c-M)(d+1-q+M)} a$$

$$P''' = \frac{bcd}{(b-1)(c)(d-1)} \frac{1}{s-q+M} a; \quad DE = \frac{bcd}{(b-1)(c)(d-1)} \frac{1}{(d+1-q+M)(s-q+M)} a$$

item EO =  $\frac{1}{s-q+M}$  et

$$\frac{1}{bq-M} - \frac{1}{q-c-M} + \frac{1}{d+1-q+M} - \frac{1}{s-q+M} = 0.$$

24. Hic

24. Hic primum observandae sunt istae conditiones, ut sit  $b > 1$ ,  $c < 1$ ,  $bq > M$  et  $q > c+M$ , tum vero in id est incumbendum, ut ipsi  $q$  minimus valor concilietur. Hunc in finem ponamus  $c = q$ , et  $b = 1$  ita ut  $b^2 = f$ , debeatque esse

$$\frac{1-q}{q-M} = \frac{1}{d+1-q+M} + \frac{1}{s-q+M}$$

vnde  $q$  eo minus prodit, quo minus accipiat  $d$ , at  $d > 2$  faciamus ergo  $d = 1 - q + M = \frac{1}{2}(3 - q + M)$  seu  $d = 3 - \frac{1}{2}(q - M)$  ut prodcat  $\frac{1-q}{q-M} = \frac{1}{\frac{1}{2}(3-q+M)}$ . Sit iam brevitatis gratia  $q - M = z$  ideoque  $\frac{1-q}{q-M} = \frac{1-z}{z}$  seu  $1z - 1zq - 1z3 + 4qz = 0$ . Verum ob  $M = \frac{1}{m} - \frac{1}{n}$  est  $q - M = \frac{mq - 1}{m - 1}$ , quo valore substituto prodit  $1z(m-1)(1-q) = (1-4q)(mq-3)$  et radice extracta

$$q = \frac{1z(m-1)\sqrt{1z(m-1)}}{m} = \frac{1z - \sqrt{1z^2}}{m} + \frac{1z}{m\sqrt{1z^2}}$$

seu  $q = 0$ ,  $58 + \frac{1}{7m}$ . Pater ergo  $q$  superare debere  $\frac{1}{7}$ , nisi multiplicatio  $m$  sit praegravandis, vnde campi apparentis semidiameter fit  $\Phi = \frac{2}{m-1} \omega$ , qui notabiliter maior est, quam casu praecedente.

25. Operae pretium videtur hunc casum penitus evolvere, et cum sit  $b = 1$ ,  $c = 0$ ,  $b^2 = f$ , quia postremaae aequationi proxime satisficisse sufficit, sit  $q = 1$  et  $d = 3$ , habebimusque sequentes determinationes; vbi  $M = \frac{1}{s(m-1)}$

$\rho$

$$\begin{aligned}
 p' &= \frac{5M}{2-5M} \alpha & AB &= \frac{1}{2-5M} \alpha \\
 p'' &= \frac{5/M}{5-5M} \alpha & BC &= \frac{5M(5+5f)}{(2-5M)^2} \alpha \\
 p''' &= \frac{15/M}{17+5M} \alpha & CD &= \frac{100f/M}{(5-5M)(17+5M)} \alpha \\
 p'''' &= \frac{15f/M}{24+10M} \alpha & DE &= \frac{72f/M}{1(17+5M)(13+5M)} \alpha
 \end{aligned}$$

vbi numerus  $f$  arbitrio nostro relinquatur, quem ergo ita paruum accipi conveniet, vt postrema lens distantiam focalem obtineat quasi vnius digiti: quo minor enim haec admittitur, eo magis tubus contrahitur.

26. Vel sumatur  $q = M = \frac{1}{2}$ , qui casus ad precedentem redit, si multiplicatio sit  $m = 25$ , et maneat  $d = 3$ ; cum ergo sit  $\frac{mq}{m-1} = \frac{1}{2}$  erit  $q = \frac{m+5}{2m}$  et  $M = \frac{5}{2m}$ , ideoque  $\Phi = \frac{5}{2m} \omega$ , et reliquae determinationes erunt:

$$\begin{aligned}
 p' &= 2M\alpha; & AB &= (1+2M)\alpha \\
 p'' &= 2fM\alpha; & BC &= 2(1+2f+2M)M\alpha \\
 p''' &= \frac{6}{5}fM\alpha; & CD &= \frac{12}{5}fM\alpha \\
 p'''' &= \frac{6}{5}fM\alpha; & DE &= \frac{6}{5}fM\alpha \\
 & & EO &= \frac{6}{5}p'''' = \frac{6}{5}fM\alpha.
 \end{aligned}$$

27. Si potuissemus ipsi  $d$  minorem tribuere valorem, maius lucrum in campo assequi liceret; quod vt fieri queat, quantitatem  $e$  negativae capiamus, prodibunt hae formulae

$p'$

$$\begin{aligned}
 p' &= \frac{b}{bq-M} M\alpha & AB &= \frac{b^2}{bq-M} \alpha \\
 p'' &= \frac{bc}{1-b} \frac{M\alpha}{q+M} & BC &= \frac{b}{1-b} \frac{(c+(1-5b)M)\alpha}{(bq-M)(c+q+M)} \\
 p''' &= \frac{bcd}{(1-b)(1+q)} \frac{M\alpha}{d+1-q+M} & CD &= \frac{b^2}{(1-b)(1+q)} \frac{(c+q-M)(d+1-q+M)\alpha}{(d+1+q+M)} \\
 p'''' &= \frac{bcd}{(1-5b)(1+q)(d-1)} \frac{M\alpha}{2-q+M} & DE &= \frac{bcd}{(1-5b)(1+q)(d-1)} \frac{(d+1-q+M)(c+q+M)\alpha}{(d-2)M}
 \end{aligned}$$

At pro coloribus iridis tollendis statui oportet Evidens autem est esse debere  $b < 1$ ,  $bq > M$ , et  $d > 2$ .

Sit  $m = 10$ ; et  $q = \frac{1}{2}$  erit  $M = \frac{1}{2}$  et  $\Phi = \frac{5}{2}$  hincque sumto  $\omega = \frac{1}{2}$  erit  $\Phi = 3, 35'$  et diameter campi apparentis  $= 7^\circ, 10'$ . Tum vero pro coloribus discernendis erit

$$\begin{aligned}
 \frac{1}{c+\frac{1}{2}} &= \frac{3}{3b-1} + \frac{1}{d+\frac{1}{2}} + \frac{1}{2}. & \text{Sit iam } b=1, c=0, \\
 \text{at } \frac{1}{1-\frac{1}{2}b} &= f, \text{ erit} \\
 2 &= \frac{1}{2} + \frac{1}{2} - \frac{1}{d+\frac{1}{2}} \text{ seu } \frac{1}{2} = \frac{1}{d+\frac{1}{2}} \text{ hincque } d = 9\frac{1}{2}; \\
 & \text{vnde telescopium ita erit comparatum:}
 \end{aligned}$$

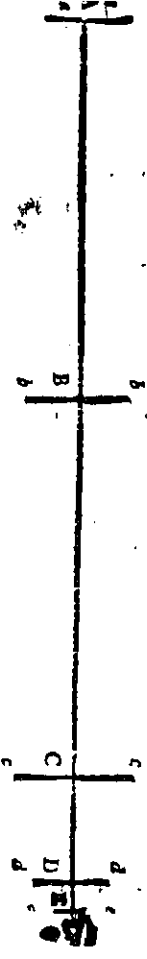
$$\begin{aligned}
 p' &= \frac{1}{4}\alpha; & AB &= \frac{1}{4}\alpha & \text{vbi levis obiectivae distantia fo-} \\
 p'' &= \frac{1}{2}\alpha; & BC &= (\frac{1}{2}+f)\alpha & \text{calis summi potest } \alpha = 12 \text{ dig.} \\
 p''' &= \frac{10}{10}f\alpha; & CD &= \frac{10}{10}f\alpha & \text{hinc cum sit } p'''' = \frac{1}{10}f, \text{ vt} \\
 p'''' &= \frac{10}{10}f\alpha; & DE &= \frac{10}{10}f\alpha & \text{haec distantia focalis fiat tere} \\
 & & EO &= \frac{1}{10}p'''' & \text{vnius digiti, summi debet } f = \frac{1}{10}.
 \end{aligned}$$

Tom. XII. Nou. Comm. H h Lentii

Lenti autem obediunt aperture tubi debet, cuius  
 semidiameter = 4 dig. et diameter = 8 dig. ex quo  
 constructo huius telescopii ita se habebit

in A	12 dig.	7 dig.	AB = 18 dig.
in B	6	2 1/2	BC = 1 1/8
in C	4 1/2 = 4,5000	2 1/2	CD = 4 1/2 = 4,725
in D	2 1/2 = 2,1375	1,07	DE = 1 1/2 = 0,754
in E	1 1/4 = 1,0059	0,50	EO = 1/2 = 0,402

Tota ergo longitudo huius tubi erit fere 42 dig. seu  
 3 1/2 pedum et figura huius instrumenti erit:



28. Ut vero isti aequationi in genere satisfaciam, ponam:

$$b = \frac{M}{g} = \frac{1-g+M}{s+\mu} \text{ et } d+1-q+M = \frac{1-g+M}{1-\nu}, \text{ unde fit}$$

$$b = \frac{M}{g} + \frac{1-g+M}{s+\mu} \text{ et } d = \frac{1-g+M}{1-\nu} - \frac{1-g+M}{s+\mu} (q-M)$$

tum vero erit

$$\frac{1}{c+d-M} = \frac{s+\mu}{s-g+M}, \text{ hincque } c = \frac{1}{s+\mu} \frac{s-g+M}{1-\nu} = \frac{(s+\mu-v)(s-g+M)}{s+\mu-v}$$

At quia  $b < 1$  oportet sit  $\frac{M}{g} < \frac{s+\mu}{s-g+M}$ , ideoque  $q > M$ .

Ponamus ergo  $q = (1+n)M$ , ut sit  $M = \frac{1}{1+n}$ , et postremam conditionem dat  $\frac{1}{1+n} < \frac{s+\mu}{s-g+M}$  seu  $\mu n + n(s+1)M > g$

et

et quia numerus  $n$ , quantum fieri potest, minui debet, numerum  $\mu$  ita accipi oportet ut fiat  $\mu n > 3$ ; tum ergo habebimus:

$$b = \frac{1-g+M}{(1+n)(s+\mu)} - \frac{nM}{s+\mu}; \quad c = \frac{1-(s+\mu-v)nM}{s+\mu-v}; \quad d = \frac{s+\mu-vnM}{1-\nu}$$

$$1-b = \frac{1}{(1+n)(s+\mu)} + \frac{nM}{s+\mu}; \quad 1+c = \frac{s+\mu-v-(s+\mu-v)nM}{s+\mu-v}; \quad d-1 = \frac{s+\mu-vnM}{1-\nu}$$

et  $d-2 = \frac{s+\mu-vnM}{1-\nu}$

29. Maximum ergo campum obtinebimus, si firmamus  $n = 0$ , unde valor ipsius  $\mu$  ita debet esse infinitus, ut fiat  $\mu n > 3$ . Sit igitur  $\mu n = 3 + f$ , erique  $b = 1$ ,  $c = 0$ , at ob  $1-b = \frac{f}{\mu}$  et  $c = \frac{1-(s+f)M}{s+\mu}$  fiet  $\frac{1}{1-b} = \frac{s+\mu}{s-(s+f)M}$  tum vero  $d = \frac{s+\mu}{1-\nu}$ ;  $d-1 = \frac{1+\mu}{1-\nu}$  et  $d-2 = \frac{1+\mu}{1-\nu}$ . Hoc modo obtinebimus telescopium, in quo ob  $M = \frac{1}{n}$ , erit semidiameter campi conspici cui  $\Phi = \frac{1}{n}$ , ideoque triplo maior quam in tubis vulgaribus astronomicis. Verum hinc altera lens in B focum sortitur infinite remotum, et distantia AB sit infinite longa, ita ut in praxi hunc casum assequi nequeamus. Quare pro  $n$  valores aliquanto maiores accipiamus.

30. Casus I. Sit  $n = 1$ , ideoque  $q = 2M$ ,  $M = \frac{1}{m+1}$ , et  $\Phi = \frac{1}{m+1}$ . Deinde ob  $\mu n > 3$  ponatur  $\mu = 3 + f$ , eritque

$$b = \frac{1+1-f-2M}{s+(3+f)}; \quad c = \frac{1-(s+f-v)M}{s+f-v}; \quad \text{et } d = \frac{s+\mu-vnM}{1-\nu}$$

H h 2

P

$$\begin{aligned}
 p' &= \frac{b}{b-a} a; & AB &= \frac{b}{b-a} a \\
 p'' &= \frac{bc}{b^2} \frac{M^2}{c+M}; & BC &= \frac{b}{b^2} \frac{(a(1-b)M+c)a}{(1-b)(c+M)} \\
 p''' &= \frac{bcd}{(1-b)(1+c)} \frac{M^2}{d+M}; & CD &= \frac{bcd}{(1-b)(1+c)} \frac{(d+1+c)M^2}{(c+M)(1+M)} \\
 p'''' &= \frac{bcd}{(1-b)(1+c)(d-1)} \frac{M^2}{e-M}; & DE &= \frac{bcd}{(1-b)(1+c)(d-1)} \frac{(d-1)M^2}{(d+1-M)(1-M)}
 \end{aligned}$$

et pro loco oculi EO =  $\frac{1}{2} p''''$ .

Fit ergo AB =  $\frac{11+f-2M}{6-2M} a$ , ideoque AB > 2a, et ob  $r-b = \frac{f+2M}{2(6+f)}$  et  $c+M = \frac{2-M}{6+f-v}$  erit  $p'' = \frac{f+2M}{2-M} M^2$ .

quam ergo lentem, vt et reliquas, pro lubitu ad praxin accommodare licet; at vero multiplicatio m maior esse debet quam 8+f-v.

31. *Exempl.* Ob enormem tubi longitudinem hic casus tantum ad exiguas multiplicationes accommodari potest. Sumatur ergo f=0; v=1 et multiplicatio m=8, vnde fit M=1 et q=1, atque  $\Phi = i\omega$ . Deinde ob  $b = \frac{1}{11}$ ,  $c = \frac{1}{21}$  et d=∞ sequentes habebimus determinaciones:

$$\begin{aligned}
 p' &= \frac{1}{11} a; & \theta' p' &= \frac{1}{11} a \omega; & AB &= \frac{1}{7} a \\
 p'' &= \frac{1}{21} a; & \theta'' p'' &= \frac{1}{21} a \omega; & BC &= \frac{1}{7} a \\
 p''' &= \frac{1}{17} a; & \theta''' p''' &= \frac{1}{17} a \omega; & CD &= \frac{1}{17} a \\
 p'''' &= \frac{1}{17} a; & \theta'''' p'''' &= \frac{1}{17} a \omega; & DE &= \frac{1}{17} a
 \end{aligned}$$

et pro loco oculi EO =  $\frac{1}{2} p'''' = \frac{1}{34} a$

tota vero tubi longitudo =  $\frac{1}{7} a$ . Quodsi ergo capiatur a=10 dig. tubus habebitur 7a dig. seu 6 pedum,

dum, qui quidem tantum octies auget, sed triplo maiorem campum patfacit, quam tubi ordinarii.

32. *Casus II.* Sit n=2, seu q=3M, et M=μ+1; iam ob  $\mu n > 3$  ponatur  $\mu = 1+f$  eritque

$$b = \frac{1+f-12M}{16+17}; \quad c = \frac{6-11(1+f-12)M}{11+17-11v}; \quad d = \frac{1+11-12M}{1-11}$$

$$\text{hinc } 1-b = \frac{1+f+11M}{16+17}$$

ideoque M <  $\frac{15+f-11v}{15}$  seu m > 13+2f-2v. Determinaciones vero erunt

$$\begin{aligned}
 p' &= \frac{b}{b-a} a; & AB &= \frac{2b}{b-a} a \\
 p'' &= \frac{bc}{b^2} \frac{M^2}{c+2M}; & BC &= \frac{b}{b^2} \frac{(1(1-b)M+c)a}{(1-b)(c+2M)} \\
 p''' &= \frac{bcd}{(1-b)(1+c)} \frac{M^2}{d+M}; & CD &= \frac{bcd}{(1-b)(1+c)} \frac{(c+1+c+d)M^2}{(c+2M)(d+1+M)} \\
 p'''' &= \frac{bcd}{(1-b)(1+c)(d-1)} \frac{M^2}{e-2M}; & DE &= \frac{bcd}{(1-b)(1+c)(d-1)} \frac{(d-2)M^2}{(d+1-M)(1-M)}
 \end{aligned}$$

vbi notetur esse

$$3b-1 = \frac{6(1-2M)}{9+17}; \quad c+2M = \frac{6(1-2M)}{11+17-11v}; \quad \text{et } d+1 = \frac{1-2M}{1-11}$$

33. *Exempl.* Applicemus hunc casum ad multiplicationem aliquanto maiorem, sitque m=16, hinc M=1 et q=1, tum vero capiatur v=1, vt fit d=∞, quia hoc commode fieri licet, atque habebimus:

$$\begin{aligned}
 b &= \frac{11+17}{16+17}; & 1-b &= \frac{1+17}{16+17}; & 3b-1 &= \frac{16}{9+17} \\
 c &= \frac{5-17}{11+17}; & 1+c &= \frac{11+17}{11(1+17)}; & c+2M &= \frac{16}{11(1+17)}
 \end{aligned}$$

H h 3 hincque

hincque sequentes mensuras :

$$\begin{array}{l}
 p' = \frac{25+2f}{4} \alpha \\
 p'' = \frac{25+2f}{2+3f} \cdot \frac{2-2f}{6} \alpha \\
 p''' = \frac{25+2f}{2+3f} \cdot \frac{5-2f}{22+4f} \alpha \\
 p'''' = \frac{25+2f}{2+3f} \cdot \frac{5-2f}{22+4f} \cdot \frac{11+2f}{22} \alpha \\
 \end{array}
 \quad \left| \quad \begin{array}{l}
 AB = \frac{25+2f}{10} \alpha \\
 BC = \frac{25+2f}{2+3f} \cdot \frac{2+2f}{22} \alpha \\
 CD = \frac{25+2f}{2+3f} \cdot \frac{5-2f}{22+4f} \cdot \frac{11+2f}{22} \alpha \\
 DE = \frac{25+2f}{2+3f} \cdot \frac{5-2f}{22+4f} \cdot \frac{11+2f}{22} \alpha
 \end{array}
 \right.$$

et pro loco oculi  $EO = \frac{1}{2} p''''$ ; Vbi notandum pro lente obiectiva, si fuerit simplex capi, oportere fere  $\alpha = 24$ . dig.

34. Ne hic lens ocularis nimis fiat exigua ponere debemus  $f = 1$  vel adhuc minus, ut  $f = \frac{1}{2}$ , vnde pro hac duplici hypothefi habebimus has de terminationes :

$  \begin{array}{l}  \text{I. } f = \frac{1}{2} \\  p' = \frac{9}{2} \alpha; \quad AB = \frac{1}{18} \alpha \\  p'' = \frac{9}{8} \alpha; \quad BC = \frac{1}{24} \alpha \\  p''' = \frac{9}{16} \alpha; \quad CD = \frac{1}{36} \alpha \\  p'''' = \frac{9}{24} \alpha; \quad DE = \frac{9}{48} \alpha \\  AE = 3 \frac{9}{108} \alpha.  \end{array}  $	$  \begin{array}{l}  \text{II. } f = \frac{1}{4} \\  p' = \frac{11}{4} \alpha; \quad AB = \frac{1}{16} \alpha \\  p'' = \frac{11}{16} \alpha; \quad BC = \frac{1}{32} \alpha \\  p''' = \frac{11}{32} \alpha; \quad CD = \frac{1}{64} \alpha \\  p'''' = \frac{11}{64} \alpha; \quad DE = \frac{11}{128} \alpha \\  AE = 3 \frac{11}{320} \alpha  \end{array}  $
--	--

Si lens obiectiva composita adhibeatur, ut  $\alpha$  vnius tantum pedis accipi queat, hypothefis  $f = \frac{1}{2}$  egregium telescopium suppeditare videtur.

35. *Cafus III.* Sit  $n = 3$  seu  $q = 4$  M et  $M = \frac{m}{m+3}$ ; ob  $\mu^n > 3$  ponatur  $\mu = 1 + f$  erique

$$\begin{array}{l}
 b = \frac{16+f-12M}{4(4+f)}; \quad c = \frac{6-8f+f^2-M}{6+f-v} \\
 4b-1 = \frac{2(1-M)}{4+f}; \quad c+q-M = \frac{5(1-M)}{6+f-v}; \quad d+1-q+M = \frac{1-M}{1-v}
 \end{array}$$

vbi

vbi esse debet  $m > 18 + 3f - 3v$ . Sumamus ergo  $v = 1$ , ac reperimus

$$\begin{array}{l}
 p' = \frac{16+f-12M}{4(1-M)} \alpha; \quad AB = \frac{16+f-12M}{11(1-M)} \alpha \\
 p'' = \frac{16+f-12M}{5f+4M} \cdot \frac{1-6M-fM}{1-M} \cdot M \alpha; \quad BC = \frac{16+f-12M(1-6M-fM)}{20(1-M)(1+4M)} \alpha \\
 p''' = \frac{16+f-12M}{5f+4M} \cdot \frac{1-6M-fM}{4+f-5(6+f)M} \cdot M \alpha; \quad CD = \frac{(16+f-12M)(1-6M-fM)(1+4M)}{(5f+4M)(4+f-5(6+f)M)(1-M)} M \alpha \\
 p'''' = \frac{16+f-12M}{5f+4M} \cdot \frac{1-6M-fM}{4+f-5(6+f)M} \cdot \frac{M \alpha}{1-M}; \quad DE = \frac{(16+f-12M)(1-6M-fM) M \alpha}{2(5f+4M)(4+f-5(6+f)M) \cdot 1-M}
 \end{array}$$

et pro loco oculi  $EO = \frac{1}{2} p''''$ ; vnde pro quantis multiplicatione huiusmodi telescopia confici possunt.

36. Exempl. Sit multiplicatio  $m = 33$ , ideoque  $M = \frac{1}{11}$  ac pro lente obiectiva simplici statui oportet  $\alpha = 96$  dig. circiter, erit

$$\begin{array}{l}
 p' = \frac{15+f}{11} \alpha; \quad AB = \frac{15+f}{11} \alpha \\
 p'' = \frac{15+f}{15} \cdot \frac{6-f}{132} \alpha; \quad BC = \frac{15+f}{15} \cdot \frac{2+3f}{132} \alpha \\
 p''' = \frac{15+f}{15} \cdot \frac{6-f}{12(6+3f)} \alpha; \quad CD = \frac{15+f}{15} \cdot \frac{6-f}{24(6+3f)} \cdot \frac{2+3f}{12} \alpha \\
 p'''' = \frac{15+f}{15} \cdot \frac{6-f}{24(6+3f)} \alpha; \quad DE = \frac{15+f}{15} \cdot \frac{6-f}{24(6+3f)} \cdot \frac{2+3f}{12} \alpha
 \end{array}$$

et pro oculo  $EO = \frac{1}{2} p''''$ .

Sumatur ergo  $f = 2$  ac prodibit

$  \begin{array}{l}  p' = \frac{17}{12} \alpha = 37,091 \\  p'' = \frac{17}{117} \alpha = 7,065 \\  p''' = \frac{17}{114} \alpha = 1,214 \\  p'''' = \frac{17}{114} \alpha = 0,883  \end{array}  $	$  \begin{array}{l}  \text{dig.} \\  AB = \frac{17}{11} \alpha = 148,364 \\  BC = \frac{17}{44} \alpha = 77,714 \\  CD = \frac{17}{114} \alpha = 6,182 \\  DE = \frac{17}{114} \alpha = 0,883  \end{array}  $
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longitudo  $EO = 233,143$

37. Po-

37. Potuiffemus quoque in formulis §. 27. quantitatem  $d$  negativè accipere, vt lens penultima ante focum lentis ocularis incidiffet, sed quia commode statui potest  $d = \infty$ , inde eosdem casus eliciuiffimus. Interim in hoc telescopiorum genere nimia longitudo imprimis ad praxin est inepta, vnde in hoc nobis, erit incumbendum, vt ea ad minorem longitudinem contrahamus, id quod sine notabili campi apparentis iactura fieri nequit. Verum lentium numerum augendo non solum idem campus seruari sed etiam vltra augeri poterit. Tum autem binas lentes B et C ita constitui oportet, vt ob eas campus adeo coarctetur, adfectione autem sextae lentis iterum dilatetur. Ex quo sex lentes adhibendo non maiorem campum, sed breuiores tuos assequi conabimur.

*De Telescopiis sex lentibus instructis.*

38. Pro quinque ergo lentibus post obiectivam collocandis ponamus:

$$B = \frac{b}{1+b}; C = \frac{c}{1+c}; D = \frac{d}{1+d}; E = \frac{e}{1+e}; F = \infty$$

$$g = -b; h = c; i = -d; k = e; l = 1.$$

tum vero

$$\Pi' = -b\theta' - \Phi; \Pi'' = c\theta'' + \theta' - \Phi; \Pi''' = -d\theta''' + \theta'' + \theta' - \Phi$$

$$\Pi'''' = e\theta'''' + \theta'''' + \theta'' + \theta' - \Phi; \Pi^V = \theta^V + \theta'''' + \theta'' + \theta' - \Phi.$$

Cum

Cum iam sit pro campo apparente  $\Phi = \frac{-\theta'''' - \theta'''' - \theta'' - \theta' - \theta}{m - 1}$  statumus:

$$\theta^V = q\omega; \theta'' = -r\omega; \theta''' = -\omega; \theta'''' = -\omega; \theta^V = -\omega$$

vt fiat  $\Phi = \frac{1+r-g}{m-1}\omega$ , et breuitatis ergo  $\Phi = M\omega$  posito  $M = \frac{1+r-g}{m-1}$  sicque habebimus

$$\Pi' = -(bq+M)\omega; \Pi'' = (q-cr-M)\omega; \Pi''' = +d-r+q-M)\omega$$

$$\Pi'''' = -(e+1+r-q+M)\omega; \Pi^V = -(3+r-q+M)\omega$$

satisfacereque debemus huic aequationi:

$$\frac{-q}{bq+M} - \frac{r}{q-cr-M} - \frac{1}{d-r+q-M} + \frac{e+1+r-q+M}{1+r-q+M} + \frac{1}{1+r-q+M} = 0.$$

39. Hinc autem pro determinatione Telescopii sequentes oriuntur formulae:

$$p' = \frac{bM}{b1+M} \alpha$$

$$p'' = \frac{bc}{1+b} \frac{q-cr-M}{M\alpha}$$

$$p''' = \frac{bcd}{bc} \frac{d-r+q-M}{M\alpha}$$

$$p'''' = \frac{bcde}{(1+b)(1+c)(1+d)} \frac{e+1+r-q+M}{M\alpha}$$

$$p^V = \frac{bcde}{(1+b)(1+c)(1+d)(1+e)} \frac{e+1+r-q+M}{M\alpha}$$

$$EF = \frac{1}{(1+b)(1+c)(1+d)(1+e)} \frac{e+1+r-q+M}{M\alpha}$$

et pro loco oculi  $FO = \frac{1}{1+r-q+M} p^V$  vnde patet has condiciones observari oportere, vt sit

$$(1+b)q > cr; d > (1-c)r; \text{ et } e > 2.$$

40. *Casus I.* Consideremus casum facillimum,

quo  $b = \infty; e = \infty$  et  $r = 0$

et aequatio adimplenda est  $\frac{d-r+q-M}{1+r-q+M} + \frac{1}{1+r-q+M} = 0$  vnde Tom. XII. Nou. Comm. I i

vnde fit  $d = 3 - 2(q \div M)$ . Staturatur ergo  $q = (1 + q)M$  vt fit  $d = 3 - 2nM$ , et formulæ nostræ adhibunt id has:

$$\begin{aligned}
 p' &= \frac{c}{1+n} & AB &= a \\
 p'' &= c \cdot \frac{a}{n} & BC &= \frac{a}{n} \\
 p''' &= \frac{c(1-2nM)}{1-c} \cdot \frac{M\alpha}{1-nM} & CD &= \frac{c}{1-c} \cdot \frac{a}{n(1-nM)} \cdot \frac{d\alpha}{M\alpha} \\
 p'''' &= \frac{c(1-nM)}{1-c} \cdot \frac{M\alpha}{1-nM} & DE &= \frac{c(1-2nM)}{(1-c)(1-2nM)} \cdot \frac{M\alpha}{1-nM} \\
 p''''' &= \frac{c(1-2nM)}{(1-c)(1-2nM)} \cdot \frac{M\alpha}{1-nM} & EF &= \frac{c(1-2nM)}{(1-c)(1-2nM)} \cdot \frac{M\alpha}{1-nM} \\
 p'''''' &= \frac{c(1-2nM)^2}{(1-c)(1-2nM)^2} \cdot \frac{M\alpha}{1-nM} & FO &= \frac{1}{1-c} \cdot \frac{M\alpha}{1-nM}
 \end{aligned}$$

cum ergo fit  $M = \frac{1}{n} = q = \frac{1}{m} = \frac{1}{m+n}$  erit  $M = \frac{1}{m+n}$  et semidiameter campi apparentis  $\Phi = \frac{1}{m+n}$ .

41. *Exempl. I.* Sit multiplicatio  $m = 10$ ,  $2c$  fumatur  $n = 2$  et  $c = 1$ , tum vero fit lentis obiectivæ distantia foci  $a = 16$  dig. erit ergo  $M = 1$ ,  $q = \frac{1}{2}$  et  $\Phi = \frac{1}{2}$  seu  $\Phi = 3^\circ, 35'$  et mensuræ pro telescopio construendo erunt

$p' = 5\frac{1}{2}$ dig.	AB = 16
$p'' = 4$	BC = 8
$p''' = 3\frac{1}{2}$	CD = 6 $\frac{1}{2}$
$p'''' = 2\frac{1}{2}$	DE = 4 $\frac{1}{2}$
$p''''' = 1\frac{1}{2}$	EF = 3 $\frac{1}{2}$
$p'''''' = 1\frac{1}{2}$	FO = 32 $\frac{1}{2}$

Hic ergo tubus circiter 33 dig. longus obiecta in ratione decupla multiplicabit, campum autem aperiet, cuius diameter 2 $\frac{1}{2}$  vicibus maior est quam in tubis constructis astronomicis.

42. Ex.

42. *Exempl. II.* Sit multiplicatio maior  $m = 25$ , maneatque  $n = 2$ , at capiatur  $c = 1$ , erit  $M = 1$ , et  $q = 1$ ; lentis autem obiectivæ distantia focalis sumi debet  $a = 54$  dig. vnde pro campo apparente  $\Phi = \frac{1}{2}$  seu  $\Phi = 1^\circ, 35'$ . Mensuræ autem pro constructione huius telescopii sunt:

$p' = 18$ dig.	AB = 54
$p'' = 10\frac{1}{2}$	BC = 27
$p''' = 3\frac{1}{2}$	CD = 16 $\frac{1}{2}$
$p'''' = 2\frac{1}{2}$	DE = 13 $\frac{1}{2}$
$p''''' = 1\frac{1}{2}$	EF = 10 $\frac{1}{2}$
$p'''''' = 1\frac{1}{2}$	FO = 99 $\frac{1}{2}$

ita vt hic tubus futurus fit 100 dig. seu 8 $\frac{1}{2}$  pedum.

43. *Exempl. III.* Vt tubus brevior reddatur fumatur  $n = 3$ , sitque multiplicatio  $m = 24$ , et  $a = 52$  dig. erit  $M = \frac{1}{3}$  et  $\Phi = \frac{1}{3}$  vt ante. Mensuræ autem pro constructione telescopii sunt

$p' = 13$ dig.	AB = 52
$p'' = 6\frac{1}{2}$	BC = 17 $\frac{1}{2}$
$p''' = 3\frac{1}{2}$	CD = 10 $\frac{1}{2}$
$p'''' = 2\frac{1}{2}$	DE = 7 $\frac{1}{2}$
$p''''' = 1\frac{1}{2}$	EF = 5 $\frac{1}{2}$
$p'''''' = 1\frac{1}{2}$	FO = 81 $\frac{1}{2}$

hic ergo tubus fessuquiped brevior est quam præcedens, et tamen eundem campum completitur, sed tantillo minus multiplicat.

44. *Casus II.* Propositus nunc fit ille casus  $b = \infty$  et  $d = \infty$  et quia  $e > 2$  ponamus  $e = 1 + r$  I i 2

$-q + M = \frac{r+r^2}{1-y} + \frac{q+M}{y}$  vt habemus  $e = \frac{r+r^2}{1-y} - \frac{y(q-r-M)}{1-y}$  atque

$$\frac{r}{q-cr-M} = \frac{1-y}{s+r-y} + \frac{y}{M} \text{ seu } \frac{q-M}{r} - c = \frac{s+r}{1-y} - \frac{(q-M)}{s-y}$$

unde fit  $q = M + \frac{r(1+2c+r^2y)}{s+r-y}$ . At est  $c < 1$  et  $q < 1$ , quare cum fit  $(m-1)M + q = 3+r$  erit

$$Mm = 3 - \frac{r(1+2c+y-yc)}{s+r-y} \text{ seu } M = \frac{(1-y)(s+r-cr)}{(s+r-y)/m}$$

Statuatur breuitatis gratia  $n = \frac{r(1+2c+r^2y)}{M(1+y-r-y)}$  vt fit  $q = (1+n)M$  eritque  $q-cr-M = \frac{r(1+r-cr)}{s+r-y}$  et  $q-r-M = \frac{r(1+y+2c-yc)}{s+r-y}$  atque

$$\begin{array}{l} p' = \frac{\alpha}{1+n} ; \\ p'' = \frac{q}{cM\alpha} ; \\ p''' = \frac{1}{c} \cdot M\alpha ; \\ p'''' = \frac{1}{c} \cdot \frac{(1-y)M\alpha}{c} ; \\ p^V = \frac{1}{c} \cdot \frac{(1-y)(e-1)}{c} \cdot \frac{1}{s-q+r+M} ; \end{array} \left| \begin{array}{l} AB = \alpha \\ BC = \frac{M\alpha}{q-cr-M} \\ CD = \frac{1}{c} \cdot \frac{q-cr-M}{M\alpha} \\ DE = \frac{1}{c} \cdot \frac{1}{s-q+r+M} \\ EF = \frac{1}{c} \cdot \frac{(1-y)(e-1)}{(s-q+r+M)^2} \\ \text{et FO} = \frac{1}{s-q+r+M} \end{array} \right.$$

45. Quo clarius indolem huius casus perspiciamus, primum obseruo ad tubum contrahendum necesse esse, vt  $q-cr > M$ . Statuamus ergo  $q-cr-M = kM$ , ac pro  $M$  introducto valore reperimus  $r = \frac{k(1-y)}{m}$ , hincque  $M = \frac{s+m+k^2-y(1-q)}{m(1+y+2c-yc)}$  et  $q = (1+k)M + cr$ , ac  $q-r-M = \frac{k(1+y+2c-yc)}{m+k}$ .

Ex his proposita multiplicatione  $m$ , sumtoque numero  $k$  sicut pro tubo contrahendo videbitur, adhuc litterae  $c$  et  $y$  arbitrio nostro relinquuntur, quarum

rum haec  $y$  ad neutrum suorum limitum 0 et 1 nimis prope accedere debet, ne intervalla lentium DE et EF minora euadant, quam earum crassities patitur; tum vero litteram  $c$  ita sumi conueniet, vt postrema lens non fiat nimis exigua, quod imprimis est cauendum, quia hinc noua confusio inueheretur.

46. Ponamus ergo  $k = 2$ , vt fiat  $BC = \frac{1}{2}AB$ , tum vero  $c = \frac{1}{2}$  vt fiat quoque  $CD = \frac{1}{2}BC$ ; eritque  $r = \frac{2(1-y)}{m}$ ;  $M = \frac{3m + \frac{1}{2}(2-y)}{m(m+2)}$  et  $q-r-M = \frac{2(5+3y)}{3(m+2)}$ ; hinc  $q = \frac{(31-3y)m + 16(1-y)}{3m(m+2)}$  et  $n+1 = \frac{q}{M} = \frac{(31-3y)m + 16(1-y)}{5m+4(1-y)}$ ; tum vero  $e = \frac{1}{1+y} - \frac{1}{2} \frac{y(5+2y)}{(1-y)(m+2)}$ . Ponatur breuitatis ergo  $\frac{2(5+2y)}{3(m+2)} = z$ , seu  $q-r-M = z$  erit:

$$\begin{array}{l} p' = \frac{\alpha}{1+n} \\ p'' = \frac{1}{2}\alpha \\ p''' = \frac{1}{2}M\alpha \\ p'''' = \frac{1}{2}c \cdot \frac{(1-y)M\alpha}{3} \\ p^V = \frac{1}{2} \cdot \frac{e}{1(e-1)^2} \cdot \frac{1}{s-z} \end{array} \left| \begin{array}{l} AB = \alpha \\ BC = \frac{1}{2}\alpha \\ CD = \frac{1}{2}\alpha \\ DE = \frac{1}{2} \cdot \frac{(1-y)M\alpha}{3} \\ EF = \frac{e}{2(e-1)^2} \cdot \frac{(1-y)(e-1)M\alpha}{(s-z)^2} \\ \text{et FO} = \frac{1}{s-z} p^V \end{array} \right.$$

47. Si ponamus insuper  $y = \frac{1}{2}$  habebimus:  $M = \frac{5m+2}{m(m+2)}$ ;  $z = \frac{2}{m+2}$ ;  $e = 5 - \frac{4}{m+2}$ ;  $n+1 = \frac{10m+8}{5m+4}$ ; tum vero  $q = \frac{10m+8}{m(m+2)}$  et  $r = \frac{1}{m}$ . Sit exempli gratia multiplicatio  $m = 30$ , eritque  $M = \frac{21}{10}$ ;  $n+1 = \frac{77}{5}$ ;  $z = \frac{1}{5}$ ;  $e = \frac{19}{5}$ ;  $q = \frac{77}{10}$  et  $r = \frac{1}{10}$ ; hincque

I i 3  $p^V$



$$\begin{array}{l}
 p' = \frac{1}{2} \alpha \\
 p'' = \frac{1}{3} \alpha \\
 p''' = \frac{1}{4} \alpha \\
 p^{IV} = \frac{1}{5} \alpha \\
 p^V = \frac{1}{6} \alpha
 \end{array}
 \left| \begin{array}{l}
 AB = \alpha \\
 BC = \frac{1}{2} \alpha \\
 CD = \frac{1}{3} \alpha \\
 DE = \frac{1}{4} \alpha \\
 EF = \frac{1}{5} \alpha
 \end{array} \right.$$

Longitudo AF =  $(1 + \frac{11}{15}) \alpha$ ,  
 et pro loco oculi FO =  $\frac{1}{5} \cdot p^V$

vbi ob  $a = 72$  dig. lens ocularis non fit nimis parva, atque adeo duplicata vt fit  $a = 48$  dig.

48. Vt magis contrahamus tubum, ponamus  $k = 3$ ,  $c = \frac{1}{2}$  et  $v = \frac{1}{2}$  et pro multiplicatione  $m$  in genere  $r = \frac{9}{2m}$  et  $q = \frac{15}{2m(m+3)}$  hincque porro has determinaciones:

$$\begin{array}{l}
 p' = \frac{3m+9}{5(7m+9)} \alpha \\
 p'' = \frac{1}{15} \alpha \\
 p''' = \frac{3m+9}{8m(m+3)} \alpha \\
 p^{IV} = \frac{5(3m+15)}{24m(m+3)} \alpha \\
 p^V = \frac{5(3m+15)}{3m(52m+51)} \alpha
 \end{array}
 \left| \begin{array}{l}
 AB = \alpha \\
 BC = \frac{1}{2} \alpha \\
 CD = \frac{1}{3} \alpha \\
 DE = \frac{1}{4} \alpha \\
 EF = \frac{1}{5} \alpha
 \end{array} \right.$$

et pro loco oculi FO =  $\frac{2(3m+15)}{3(52m+51)} p^V$ . Tota autem tubi longitudo fit quasi  $= \frac{1}{5} \alpha$ , et femidiameter campi  $\Phi = \frac{3(3m+9)}{8m(m+3)} \omega$ .

*De Telescopis septem lentibus infractis.*

49. Vt formulas nimis complicatas hic culitemus, ac statim insignem campum cum modica longi-

longitudine adipiscamur; lentem secundam  $bBb$  in ipso foco  $a$  lentis obiectivae constituamus, terram vero  $cC$  ibi, vbi obiectum in A positum per lentem B suam imaginem efficit profecturum. Quatuor autem reliquarum binas D, E ante imaginem erectam I possemus vero F et G pone eam collari sumamus. Habebimus ergo pro his lentibus:

$$\begin{array}{l}
 B = -1; C = \frac{c}{a}; D = \frac{d}{1+d}; E = \frac{e}{1+e}; F = \frac{f}{1+f}; G = \infty \\
 \mathcal{R} = \infty; \mathcal{E} = c; \mathcal{D} = -d; \mathcal{E} = -e; \mathcal{F} = f; \mathcal{G} = 1 \\
 \theta' = q\omega; \theta'' = c\omega; \theta''' = \omega; \theta^{IV} = -\omega; \theta^V = -\omega \\
 \text{hincque femidiameter campi } \Phi = \frac{1}{2} \omega. \text{ Ponatur} \\
 \frac{1}{m} = M \text{ ut sit } \Phi = M\omega \text{ erit} \\
 \Pi' = \infty\omega; \Pi'' = (q-M)\omega; \Pi''' = (d+q-M)\omega \\
 \Pi^{IV} = (e-1+q-M)\omega; \Pi^V = -(f+2-q+M)\omega \text{ et} \\
 \Pi^VI = -(4-q+M)\omega.
 \end{array}$$

50. His positis determinaciones telescopii sunt sequentes:

$$\begin{array}{l}
 p' = \frac{M\alpha}{q}; \\
 p'' = \frac{c}{qM}; \\
 p''' = \frac{1}{c} \frac{M\alpha}{d+1-M}; \\
 p^{IV} = \frac{cde}{cde} \frac{M\alpha}{e-1+q-M}; \\
 p^V = \frac{(1-c)(1+d)(f+2-q+M)}{(1-c)(1+d)(f+2-q+M)} \frac{M\alpha}{cde}; \\
 p^VI = \frac{(1-c)(1+d)(f+2-q+M)}{(1-c)(1+d)(f+2-q+M)} \frac{M\alpha}{cde}
 \end{array}
 \left| \begin{array}{l}
 AB = \alpha \\
 BC = \frac{M\alpha}{q} \\
 CD = \frac{c}{d} \frac{M\alpha}{(1-c)(1+d)(f+2-q+M)} \\
 DE = \frac{cde}{cde} \frac{M\alpha}{(1-c)(1+d)(f+2-q+M)} \\
 EF = \frac{(1-c)(1+d)(f+2-q+M)}{(1-c)(1+d)(f+2-q+M)} \frac{M\alpha}{cde} \\
 FG = \frac{(1-c)(1+d)(f+2-q+M)}{(1-c)(1+d)(f+2-q+M)} \frac{M\alpha}{cde} \\
 \text{et } GO = \frac{1}{4-q+M} \alpha
 \end{array} \right.$$

51. Destructio autem colorum iridis postulat vt sit:

$$\frac{1}{d+q-M} - \frac{1}{e-1+q-M} + \frac{1}{f+2-q+M} + \frac{1}{4-q+M} = 0$$

vbi cum sit  $e-1 > d$  et  $f > 2$  statuamus

$$e-1+q-M = \frac{d+q-M}{\mu} \text{ et } f+2-q+M = \frac{4-q+M}{\nu}$$

fiatque  $d+q-M = \frac{d+q-M}{\mu} (4-q+M)$  et  $e-1+q-M = \frac{4-q+M}{\nu} (4-q+M)$  unde quantitates  $d, e$  et  $f$  definiuntur, litterae autem  $\mu$  et  $\nu$  intra limites 0 et 1 sumendae arbitrio nostra relinquuntur.

Ab est  $4-q+M = Mm$ , hinc  $q-M = 4-Mm$ , et pro numeratoribus  $e-1-d = \frac{4-Mm}{\mu} - \frac{4-Mm}{\nu}$ ;  $f+e+1 = \frac{4-Mm}{\nu} + \frac{4-Mm}{\mu} + 1$  et  $f-2 = \frac{4-Mm}{\nu} - 1$  porro autem  $d = \frac{4-Mm}{\nu} Mm-4$ ;  $e = \frac{4-Mm}{\mu} Mm-4$ ;  $f = \frac{4-Mm}{\nu} Mm-3$  et erit  $q-M = nM$  et  $M = \frac{4}{m+n}$ .

52. His valoribus substitutis pro constructione telescopii hae habentur mensurae:

$p' = \frac{c}{1+i}$	$AB = \alpha$
$p'' = \frac{c}{n}$	$BC = \frac{c}{n}$
$p''' = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$	$CD = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$
$p'''' = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$	$DE = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$
$p^V = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$	$EF = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$
$p^{VI} = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$	$FG = \frac{c}{1-c} \frac{d(1-\nu)\alpha}{(1-\mu)m}$

et pro loco oculi erit  $GO = \frac{1}{m} p^{VI} = \frac{m+n}{4m} p^{VI}$ .

Hic

Hic ergo etiam littera  $c$  arbitrio nostro permittitur, qua effici potest vt vltima lens ad vsum sit maxime accommodata.

53. Exemplum afferamus sumendo  $\mu = \frac{16}{17}$ ;  $\nu = \frac{11}{12}$ ;  $n = 2$  sitque multiplicatio  $m = 10$ , ac sit  $M = \frac{1}{5}$ , tum vero

$d = \frac{17}{12}$ ;  $e = 38$ ;  $f = \frac{11}{12}$  vnde hae mensurae

$p' = \frac{c}{2}$	$AB = \alpha$
$p'' = c \cdot \frac{8}{5}$	$BC = \frac{8}{5} \alpha$
$p''' = \frac{c}{1-c} \frac{127\alpha}{2 \cdot 5 \cdot 5 \cdot 11}$	$CD = \frac{c}{1-c} \frac{127\alpha}{2 \cdot 5 \cdot 5 \cdot 11}$
$p'''' = \frac{c}{1-c} \frac{10 \cdot 127\alpha}{2 \cdot 5 \cdot 11 \cdot 89}$	$DE = \frac{c}{1-c} \frac{10 \cdot 127\alpha}{2 \cdot 5 \cdot 11 \cdot 89}$
$p^V = \frac{c}{1-c} \frac{19 \cdot 4 \cdot 1 \cdot 127\alpha}{9 \cdot 5 \cdot 11 \cdot 15 \cdot 19}$	$EF = \frac{c}{1-c} \frac{19 \cdot 4 \cdot 1 \cdot 127\alpha}{9 \cdot 5 \cdot 11 \cdot 15 \cdot 19}$
$p^{VI} = \frac{c}{1-c} \frac{19 \cdot 4 \cdot 1 \cdot 127\alpha}{9 \cdot 5 \cdot 11 \cdot 15 \cdot 61 \cdot 19}$	$FG = \frac{c}{1-c} \frac{19 \cdot 4 \cdot 1 \cdot 127\alpha}{9 \cdot 5 \cdot 11 \cdot 15 \cdot 61 \cdot 19}$

et  $GO = \frac{1}{5} p^{VI}$

quae ad praxin fatis videntur idoneae, atque adeo capere licet  $c = \frac{1}{2}$ , quo pacto tubus magis contrahitur.

54. Sequentes positiones  $\mu = \frac{1}{2}$  et  $\nu = \frac{1}{2}$  ad praxin viles videntur, quas ergo in genere praefere quae; primo autem praebent  $f = Mm+2$ ;  $e = 5Mm-3$ ;  $d = \frac{1}{2}Mm-4$  existente tum vero prodeunt sequentes mensurae:

$$M = \frac{4}{m+n}$$

Tom. XII. Non. Comm.

K k

$p'$

$$\begin{array}{l}
 p' = \frac{a}{1+n} \\
 p'' = \frac{ca}{n} \\
 p''' = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 p'''' = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 p^V = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 p^VI = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a}
 \end{array}
 \quad
 \begin{array}{l}
 AB = a \\
 BC = \frac{a}{n} \\
 CD = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 DE = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 E.F. = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 FG = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a} \\
 et GO = \frac{1}{c} \frac{1}{d} \frac{1}{m} \frac{1}{a}
 \end{array}$$

Deinde campi apparentis femidiameter est  $\Phi = \frac{1}{m+n}$ , circiter quadruplo maior quam in tubis visitatis; at est  $q = \frac{1}{m+n}$ , vnde apertura secundae lentis B sumi debet.

55. Circa numerum  $n$  evidens est, quo maior is accipitur, eo minorem prodire longitudinem, tum autem simul campus apprensus immittitur. Cum enim per formulas primum inventas fit  $\Phi = \frac{1}{m+n}$ , hic autem posuerimus  $q = \frac{1}{m+n}$ , vt fit  $n = \frac{1}{q}$ , patet aucto numero hoc  $n$ , etiam  $q$  augeri, ideoque campum minui in ratione numeri  $4-q$ . Postro autem  $n=1$ , fit  $q = \frac{1}{m+1}$ , et  $\Phi = \frac{1}{m+1}$ ;  $\omega$ ; tubus vero astronomicus vulgaris pro eadem multiplicatione praebet  $\Phi = \frac{1}{m+1}$ ;  $\omega$ , vnde hoc casu noster tubus quadruplo ampliosem campum detegit, sed ob  $n=1$ , plus quam duplo fit longior. Si ergo campus non 4 sed 3 $\frac{1}{2}$  partibus amplior esse debeat, sumi oportet  $n = \frac{m+1}{3}$ , sin autem 3 $\frac{1}{2}$  partibus, fit  $n = \frac{m+1}{15}$ , vnde patet admodum exigua campi

campi immittione longitudinem vehementer contrahi, idque eo magis, quo maior fuerit multiplicatio.

Exemplum I.

56. Sit multiplicatio  $m=10$ , et sumatur  $n=1$ , serque  $M = \frac{1}{1}$  et  $q = \frac{1}{1}$ , hinc femidiameter campi  $\Phi = \frac{1}{11}$ , qui sumto  $\omega = 1$  erit  $\Phi = 5^{\circ}, 12'$ , et diameter  $10^{\circ}, 24'$ . Tum ob  $Mm = \frac{10}{1} = 10$ , vnde fit  $d=2, 5455$ ;  $e=15, 1818$ ;  $f=5, 6364$  vnde sequentes prodeunt mensurae:

$$\begin{array}{l}
 p' = 0,5 \alpha \\
 p'' = c, \alpha \\
 p''' = \frac{1}{c} c, 3182 \alpha \\
 p'''' = \frac{1}{c} c, 2725 \alpha \\
 p^V = \frac{1}{c} c, 1898 \alpha \\
 p^VI = \frac{1}{c} c, 0819 \alpha \\
 et GO = \frac{1}{c} c, 0225 \alpha
 \end{array}
 \quad
 \begin{array}{l}
 AB = a \\
 BC = a \\
 CD = \frac{1}{c} c, 8750 \alpha \\
 DE = \frac{1}{c} c, 0718 \alpha \\
 EF = \frac{1}{c} c, 0505 \alpha \\
 FG = \frac{1}{c} c, 0409 \alpha
 \end{array}$$

Hinc tota longitudo  $AO = 2a + \frac{1}{c} c, 1, 0607 \alpha$  sumto hic  $a = 15$  dig. accipi poterit  $c = 1$ , vt prodeat  $p^VI = 1$  dig.

Exemplum II.

57. Sit multiplicatio  $m=15$ , et capiatur  $n=2$ , vt fiat  $M = \frac{1}{2}$  et  $q = \frac{1}{2}$ , ideoque  $\Phi = \frac{1}{17}$  seu  $\Phi = 3^{\circ}, 22'$ . Iam ob  $Mm = \frac{15}{2} = 7,5$ , erit  $d=2, 3530$ ;  $e=14, 6470$ ;  $f=5, 5294$  vnde sequentes mensurae obtinentur:

K k 2

$p' = 0,3333 \alpha$	$AB = \alpha$
$p'' = c, 0,500 \alpha$	$BC = 0,500 \alpha$
$p''' = \frac{c}{1-c} 0,1961 \alpha$	$CD = \frac{c}{1-c} 0,4167 \alpha$
$p'''' = \frac{c}{1-c} 0,1713 \alpha$	$DE = \frac{c}{1-c} 0,0468 \alpha$
$p^V = \frac{c}{1-c} 0,1211 \alpha$	$EF = \frac{c}{1-c} 0,0328 \alpha$
$p^{VI} = \frac{c}{1-c} 0,0535 \alpha$	$FG = \frac{c}{1-c} 0,0267 \alpha$
	$GO = \frac{c}{1-c} 0,0152 \alpha$

Hinc tota longitudo  $AO = 1,5 \alpha + \frac{c}{1-c} 0,5382 \alpha$ .

58. Litterae  $f, e, d$  eulenus tantum variantur, quatenus valor  $Mm$  mutatur, hic autem commode idem retineri potest. Quod si ergo secundum exemplum prius in genere statuamus  $n = \frac{m}{3}$ , fit  $M = \frac{42}{11m}$  et  $Mm = 11$  et  $q = \frac{c}{1-c} \frac{11}{m}$  atque  $\Phi = \frac{42}{11m} \omega$  vnde sequentes determinationes nascuntur:

$p' = \frac{m+10}{m} \alpha$	$AB = \alpha$
$p'' = c, \frac{19}{m} \alpha$	$BC = 10, \frac{\alpha}{m}$
$p''' = \frac{c}{1-c} 3, 1819, \frac{\alpha}{m}$	$CD = \frac{c}{1-c} 8, 7500, \frac{\alpha}{m}$
$p'''' = \frac{c}{1-c} 2, 7249, \frac{\alpha}{m}$	$DE = \frac{c}{1-c} 0, 7179, \frac{\alpha}{m}$
$p^V = \frac{c}{1-c} 1, 8983, \frac{\alpha}{m}$	$EF = \frac{c}{1-c} 0, 5052, \frac{\alpha}{m}$
$p^{VI} = \frac{c}{1-c} 0, 8189, \frac{\alpha}{m}$	$FG = \frac{c}{1-c} 0, 4095, \frac{\alpha}{m}$
	$GO = \frac{c}{1-c} 0, 2252, \frac{\alpha}{m}$

Hinc tota longitudo  $AO = \alpha + \frac{10c}{m} + \frac{c}{1-c} 10,6078, \frac{\alpha}{m}$ .

Hic debet sumi pro apertura  $Bb = \frac{10}{m} \alpha$  dig. et  $Cc = \frac{10}{m} A \alpha$ .

59. Sin autem in genere secundum alterum exemplum ponatur  $n = \frac{e}{11}$ , vnde fit  $M = \frac{11}{1-c}$  et  $\Phi = \frac{11}{1-c} \omega$  atque  $q = \frac{c}{1-c} \frac{11}{m}$  determinationes pro constructione Telescopii erunt:

$p' = \frac{m+11}{m} \alpha$	$AB = \alpha$
$p'' = c, 7, 5 \frac{\alpha}{m}$	$BC = 7, 5, \frac{\alpha}{m}$
$p''' = \frac{c}{1-c} 2, 9412, \frac{\alpha}{m}$	$CD = \frac{c}{1-c} 6, 2500, \frac{\alpha}{m}$
$p'''' = \frac{c}{1-c} 2, 5695, \frac{\alpha}{m}$	$DE = \frac{c}{1-c} 0, 7017, \frac{\alpha}{m}$
$p^V = \frac{c}{1-c} 1, 8162, \frac{\alpha}{m}$	$EF = \frac{c}{1-c} 0, 4927, \frac{\alpha}{m}$
$p^{VI} = \frac{c}{1-c} 0, 8019, \frac{\alpha}{m}$	$FG = \frac{c}{1-c} 0, 4010, \frac{\alpha}{m}$
	$GO = \frac{c}{1-c} 0, 2272, \frac{\alpha}{m}$

Hinc tota longitudo  $AO = \alpha + \frac{11c}{m} + \frac{c}{1-c} 8, 0726, \frac{\alpha}{m}$  quae notabiliter minor est quam casu precedente, sed campus apprensus aliquanto est minor in ratione 34:33. Sumto  $\omega = \frac{1}{3}$ , lentis in B<sup>2</sup> femidiameter aperturae est  $Bb = \frac{11}{m} \alpha$  dig. at lentis in C capi debet  $\frac{11}{m} A \alpha$ , nempe semper  $= \frac{B}{A} B, A \alpha$ .

60. Adungamus tertium casum, quo  $n = \frac{m}{5}$ , et qui in maioribus multiplicationibus insignem usum praestabit. Erit ergo  $M = \frac{10}{5m}$  hinc  $\Phi = \frac{10}{5m} \omega$ , qui valor ad praecedentem est vt 17 ad 18; tum  $q = \frac{c}{1-c} \frac{10}{5m}$ , et reliquae determinationes:

$p' = \frac{m+5}{m} \alpha$	$AB = \alpha$
$p'' = c, 5 \frac{\alpha}{m}$	$BC = 5, \frac{\alpha}{m}$
$p''' = \frac{c}{1-c} 2, 5000, \frac{\alpha}{m}$	$CD = \frac{c}{1-c} 3, 7500, \frac{\alpha}{m}$
$p'''' = \frac{c}{1-c} 2, 2778, \frac{\alpha}{m}$	$DE = \frac{c}{1-c} 0, 6667, \frac{\alpha}{m}$
$p^V = \frac{c}{1-c} 1, 6566, \frac{\alpha}{m}$	$EF = \frac{c}{1-c} 0, 4659, \frac{\alpha}{m}$
$p^{VI} = \frac{c}{1-c} 0, 7645, \frac{\alpha}{m}$	$FG = \frac{c}{1-c} 0, 3823, \frac{\alpha}{m}$
	$GO = \frac{c}{1-c} 0, 2293, \frac{\alpha}{m}$

Longitudo tubi  $= \alpha + 5 \frac{\alpha}{m} + \frac{c}{1-c} 5, 4942, \frac{\alpha}{m}$   
 Perforo  $Bb = \frac{5}{m} \alpha$ , et  $Cc = \frac{5}{m} A \alpha$ .  
 K k 3

61. Quod ad numerum  $c$  attinget, cum in genere ita definire possumus, ut  $\frac{c}{m} = \frac{a}{m}$  accipatur quantitati datæ veluti vni digito, eritque tum  $c = \frac{a+m}{m}$ , at tum pro tribus hypothesebus habebimus sequentes mensuras in digitis expressas.

HYP. I. $\Phi = \frac{10}{11m} \omega$		HYP. II. $\Phi = \frac{62}{17m} \omega$
$p = \frac{10}{m+10} a$ ; AB = $\alpha$		$p' = \frac{62}{m+62} a$ ; AB = $\alpha$
$p' = \frac{10}{m+10} a$ ; BC = $\frac{10}{m} a$		$p'' = \frac{62}{m+62} a$ ; BC = $\frac{62}{m} a$
$p'' = 3,1819$ ; CD = 8,7500		$p''' = \frac{62}{m+62} a$ ; CD = $\frac{62}{m} a$
$p''' = 2,7249$ ; DE = 0,7179		$p'''' = 2,9412$ ; CD = 6,2500
$p^{IV} = 1,8983$ ; EF = 0,5052		$p^{V} = 2,5695$ ; DE = 0,7017
$p^{VI} = 0,8159$ ; FG = 0,4095		$p^{VI} = 1,8162$ ; FF = 0,4927
et GO = 0,2252		et GO = 0,4010
AO = $\frac{10}{m+10} a + 10,6078$		AO = $\frac{62}{m+62} a + 8,7226$

HYP. III.  $\Phi = \frac{10}{m} \omega$

$p' = \frac{5}{m+5} a$ ; AB = $\frac{4}{m} a$
$p'' = \frac{10}{m+10} a$ ; BC = $\frac{10}{m} a$
$p''' = 2,5000$ ; CD = 3,7500
$p^{IV} = 2,2778$ ; DE = 0,6667
$p^{V} = 1,6566$ ; FF = 0,4659
$p^{VI} = 0,7645$ ; FG = 0,3523
et GO = 0,2293
AO = $\frac{10}{m+5} a + 5,4942$

sequæ quatuor postremæ lentes, in quælibet hypothese manent eadem vna cum suis intervallis pro omnibus multiplicationibus.

Con-

CONCLUSIO.

62. Telescopia hæc omnino singulare genus constituunt, quod profus discrepat a telescopiis vulgaribus quatuor lentibus instructis; horumque character possimum in tertia lente C consistit, quæ ram exiguam aperturam postulat, cuiusque propterea ope radii peregrini commode excluduntur. Hæc autem Telescopia septem lentium isto fundamento nuntur, quod sit  $b = \infty$  et  $r = 0$ , seu quod secundum lens B in ipso foco lentis obiectivæ, tertia vero C in eo loco, vbi ipsius obiectivæ imago per lentem B projecta cadit, collocetur. Qua positione cum etiam in casibus quinque ac sex lentium viti licuerit, ea, quæ quinque lentibus sunt instructa, speciem quasi principalem huius generis telescopiorum exhibere est censenda, vnde reliqua sex et septem lentium multiplicatione lentium ocularium ad campum dilatandum facta sint natae. Quare hæc species ad idem genus referendas simili forma aspectui exposuisse iuvabit.

Species principalis V lentibus constans.

63 Si ponamus  $n = \frac{m}{f}$ , vt sit  $\Phi = \frac{2k\omega}{m(k+1)}$ , tum vero  $\frac{c}{1-c} = \frac{a}{m} = 2$ , ideoque  $c = \frac{m}{2} \frac{2}{a}$ , mensuræ pro constructione horum telescopiorum ita se habebunt:

Lentis

Lentis dif. foci femid. apert. Internallum.

in A . . . . .  $\alpha$ ;  $AA = \alpha$   $AB = \alpha$   
 in B . . . . .  $\frac{k}{k+1}\alpha$ ;  $Bb = \frac{k}{m(k+1)}\alpha$ ,  $BC = \frac{k}{m}\alpha$   
 in C . . . . .  $\frac{m+1}{m}\alpha$ ;  $Cc = \frac{m}{m}\alpha$ ;  $CD = (k-1)\alpha$   
 in D . . . . .  $\frac{2(k-1)}{k+1}\alpha$ ;  $Dd = \frac{2(k-1)\omega}{k+1}\alpha$ ;  $DE = \frac{4(k-1)}{k+1}\alpha$   
 in E . . . . .  $\frac{2(k-1)}{2k-1}\alpha$ ;  $Ee = \frac{2(k-1)\omega}{2k-1}\alpha$ ;  $EO = \frac{k}{k(2k-1)}\alpha$ .

Hypoth. I.  $m > 4$

Hyp. II.  $m > 3$

$k=2$ ;  $\alpha = \frac{2}{3}\alpha$ ;  $AA = \frac{2}{3}\alpha$ ;  $AB = \alpha$   $k=3$ ;  $\alpha = 2$ ;  $AA = \frac{2}{3}\alpha$ ;  $AB = \alpha$   
 $p' = \frac{m+1}{m+2}\alpha$ ;  $Bb = \frac{1}{3}\alpha$ ;  $BC = \frac{2}{m}\alpha$   $p' = \frac{m}{m+1}\alpha$ ;  $Bb = \frac{2}{3}\alpha$ ;  $BC = \frac{1}{m}\alpha$   
 $p'' = \frac{12}{5m+6}\alpha$ ;  $Cc = \frac{3}{5}\alpha$ ;  $CD = \frac{1}{5}\alpha$   $p'' = \frac{m}{m+1}\alpha$ ;  $Cc = \frac{2}{5}\alpha$ ;  $CD = \frac{1}{5}\alpha$   
 $p''' = \frac{3}{5}$ ;  $Dd = \frac{2}{5}\alpha$ ;  $DE = 2$   $p''' = \frac{m}{m+1}\alpha$ ;  $Dd = \frac{2}{5}\alpha$ ;  $DE = 4$   
 $p'''' = 1$ ;  $Ee = \frac{1}{5}$ ;  $EO = \frac{1}{5}$   $p'''' = 1$ ;  $Ee = \frac{1}{5}$ ;  $EO = 2$   
 $\Phi = \frac{1}{5m}$  feu  $\Phi = \frac{1216}{5m}$  min.  $\Phi = \frac{1}{5m}$  feu  $\Phi = \frac{1216}{5m}$  min.

Hypoth. III.  $m > 3^2$

Hyp. IV.  $m > 2^2$

$k=4$ ;  $\alpha = \frac{4}{5}\alpha$ ;  $AA = \frac{4}{5}\alpha$ ;  $AB = \alpha$   $k=5$ ;  $\alpha = \frac{4}{5}\alpha$ ;  $AA = \frac{4}{5}\alpha$ ;  $AB = \alpha$   
 $p' = \frac{m+1}{m+4}\alpha$ ;  $Bb = \frac{2}{5}\alpha$ ;  $BC = \frac{1}{m}\alpha$   $p' = \frac{m}{m+1}\alpha$ ;  $Bb = \frac{4}{5}\alpha$ ;  $BC = \frac{1}{m}\alpha$   
 $p'' = \frac{11m+6\alpha}{10}$ ;  $Cc = \frac{4}{10}\alpha$ ;  $CD = \frac{1}{5}\alpha$   $p'' = \frac{m}{m+1}\alpha$ ;  $Cc = \frac{3}{10}\alpha$ ;  $CD = \frac{1}{5}\alpha$   
 $p''' = \frac{3}{5}$ ;  $Dd = \frac{2}{5}\alpha$ ;  $DE = 2$   $p''' = \frac{m}{m+1}\alpha$ ;  $Dd = \frac{2}{5}\alpha$ ;  $DE = 7$   
 $p'''' = 1$ ;  $Ee = \frac{1}{5}$ ;  $EO = \frac{1}{5}$   $p'''' = 1$ ;  $Ee = \frac{1}{5}$ ;  $EO = 2$   
 $\Phi = \frac{2}{5m}$  feu  $\Phi = \frac{1375}{5m}$  min.  $\Phi = \frac{1}{5m}$  feu  $\Phi = \frac{1375}{5m}$  min.

Hypoth. V.  $m > 2^2$

Hyp. VI.  $m > 2^2$

$k=6$ ;  $\alpha = \frac{6}{13}\alpha$ ;  $AA = \frac{6}{13}\alpha$ ;  $AB = \alpha$   $k=7$ ;  $\alpha = \frac{6}{13}\alpha$ ;  $AA = \frac{6}{13}\alpha$ ;  $AB = \alpha$   
 $p' = \frac{m}{m+6}\alpha$ ;  $Bb = \frac{2}{13}\alpha$ ;  $BC = \frac{6}{m}\alpha$   $p' = \frac{m}{m+1}\alpha$ ;  $Bb = \frac{7}{16}\alpha$ ;  $BC = \frac{2}{m}\alpha$   
 $p'' = \frac{102}{17m+10\alpha}\alpha$ ;  $Cc = \frac{6}{17}\alpha$ ;  $CD = \frac{6}{17}\alpha$   $p'' = \frac{m}{m+1}\alpha$ ;  $Cc = \frac{7}{16}\alpha$ ;  $CD = \frac{2}{m}\alpha$   
 $p''' = \frac{2}{7}$ ;  $Dd = \frac{15}{18}\alpha$ ;  $DE = 2$   $p''' = \frac{m}{m+1}\alpha$ ;  $Dd = \frac{7}{8}\alpha$ ;  $DE = 10$   
 $p'''' = 1$ ;  $Ee = \frac{4}{13}$ ;  $EO = \frac{2}{13}$   $p'''' = 1$ ;  $Ee = \frac{4}{13}$ ;  $EO = 2$   
 $\Phi = \frac{2}{7m}$  feu  $\Phi = \frac{1475}{m}$  min.  $\Phi = \frac{7}{16m}$  feu  $\Phi = \frac{1505}{m}$  min.

I.  $AE = \frac{m+1}{m}\alpha + 4$  III.  $AE = \frac{m+1}{m}\alpha + 7$  V.  $AE = \frac{m+1}{m}\alpha + 10$  dis.  
 II.  $AF = \frac{m+1}{m}\alpha + 6$  IV.  $AE = \frac{m+1}{m}\alpha + 9$  VI.  $AE = \frac{m+1}{m}\alpha + 12$  dig.

Species secundaria VI lentibus constans.

64. Factis jisdem denominationibus, primo erit femidiameter campi apparentis  $\Phi = \frac{2k}{k+1}$ ; liquae vero mensurare.

Lentis dif. foci. femid. apert. Internallum  
 in A . . . . .  $\alpha$ ;  $AA = \alpha$ ;  $AB = \alpha$   
 in B . . . . .  $\frac{k}{k+1}\alpha$ ;  $Bb = \frac{k}{m(k+1)}\alpha$ ;  $BC = \frac{k}{m}\alpha$   
 in C . . . . .  $\frac{k+1}{m+1}\alpha$ ;  $Cc = \frac{k}{m+1}\alpha$ ;  $CD = (k-1)\alpha$   
 in D . . . . .  $\frac{2(k-1)}{k+1}\alpha$ ;  $Dd = \frac{2(k-1)\omega}{k+1}\alpha$ ;  $DE = \frac{4(k-1)}{k+1}\alpha$   
 in E . . . . .  $\frac{2(k-1)}{2k-1}\alpha$ ;  $Ee = \frac{2(k-1)\omega}{2k-1}\alpha$ ;  $EO = \frac{k}{k(2k-1)}\alpha$   
 in F . . . . .  $\alpha$ ;  $Ff = \omega$  dif. foci  $FO = \frac{k-1}{2k-1}\alpha$

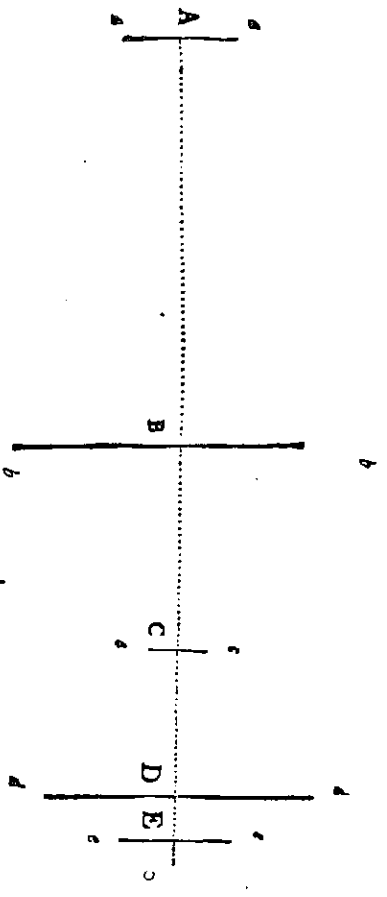
Hypoth. I.  $m > \infty$  Hyp. II.  $m > 9$

$k=2$ ;  $\alpha = 2$ ;  $AA = 2$ ;  $AB = 3$ ;  $\alpha = 3$ ;  $AA = 2$ ;  $AB = \alpha$   
 $p' = \frac{m+1}{m+2}\alpha$ ;  $Bb = \frac{1}{3}\alpha$ ;  $BC = \frac{2}{m}\alpha$   $p' = \frac{m}{m+1}\alpha$ ;  $Bb = \frac{2}{3}\alpha$ ;  $BC = \frac{1}{m}\alpha$   
 $p'' = \frac{12}{5m+6}\alpha$ ;  $Cc = \frac{3}{5}\alpha$ ;  $CD = \frac{1}{5}\alpha$   $p'' = \frac{m}{m+1}\alpha$ ;  $Cc = \frac{2}{5}\alpha$ ;  $CD = \frac{1}{5}\alpha$   
 $p''' = 2$ ;  $Dd = 1$ ;  $DE = 1$   $p''' = 2$ ;  $Dd = 1$ ;  $DE = 1$   
 $p'''' = 1$ ;  $Ee = 1$ ;  $FO = 1$   $p'''' = 1$ ;  $Ee = 1$ ;  $FO = 1$   
 $\Phi = \frac{2}{m}$  min.  $AF = \frac{m+1}{m}\alpha + 4$ , impoff.  $\Phi = \frac{1}{m}$  min.  $AF = \frac{m+1}{m}\alpha + 5$

Hypoth. III.  $m > 6$  Hyp. IV.  $m > 5$   
 $k = 4; a = \frac{1}{3}; Aa = \frac{m}{3}; AB = a; k = 5; a = \frac{1}{3}; Aa = \frac{m}{3}; AB = a$   
 $p' = \frac{m+1}{m} a; Bb = \frac{1}{m}; BC = \frac{1}{m} a; p' = \frac{m+1}{m} a; Bb = \frac{1}{m}; BC = \frac{1}{m} a$   
 $p'' = \frac{14m+2a}{56} a; Cc = \frac{1}{16}; CD = 4; p'' = \frac{14m+2a}{56} a; Cc = \frac{1}{16}; CD = 6$   
 $p''' = \frac{14}{14}; Dd = \frac{1}{14}; DE = 1; p''' = \frac{14}{14}; Dd = \frac{1}{14}; DE = 1$   
 $p'''' = \frac{14}{14}; Ee = \frac{1}{14}; EF = 1; p'''' = \frac{14}{14}; Ee = \frac{1}{14}; EF = 1$   
 $p^v = 1; Ff = \frac{1}{14}; FO = \frac{1}{14}; p^v = 1; Ff = \frac{1}{14}; FO = \frac{1}{14}$   
 $\Phi = \frac{306}{m} \text{ min. AF} = \frac{m+1}{m} a + 6; \Phi = \frac{316}{m} \text{ min. AF} = \frac{m+1}{m} a + 8$

Hypoth. V.  $m > 4\frac{1}{2}$  Hyp VI.  $m > 4\frac{1}{2}$   
 $k = 6; a = \frac{1}{3}; Aa = \frac{m}{3}; AB = a; k = 7; a = \frac{1}{3}; Aa = \frac{m}{3}; AB = a$   
 $p' = \frac{m+6}{6} a; Bb = \frac{1}{6}; BC = \frac{1}{6} a; p' = \frac{m+7}{7} a; Bb = \frac{1}{7}; BC = \frac{1}{7} a$   
 $p'' = \frac{23m+15a}{115} a; Cc = \frac{1}{15}; CD = 7; p'' = \frac{23m+15a}{115} a; Cc = \frac{1}{15}; CD = 8$   
 $p''' = \frac{23}{23}; Dd = \frac{1}{23}; DE = 1; p''' = \frac{23}{23}; Dd = \frac{1}{23}; DE = 1$   
 $p'''' = \frac{23}{23}; Ee = \frac{1}{23}; EF = 1; p'''' = \frac{23}{23}; Ee = \frac{1}{23}; EF = 1$   
 $p^v = 1; Ff = \frac{1}{23}; FO = \frac{1}{23}; p^v = 1; Ff = \frac{1}{23}; FO = \frac{1}{23}$   
 $\Phi = \frac{2310}{m} \text{ min. AF} = \frac{m+6}{m} a + 9; \Phi = \frac{2316}{m} \text{ min. AF} = \frac{m+7}{m} a + 10$

Tabula



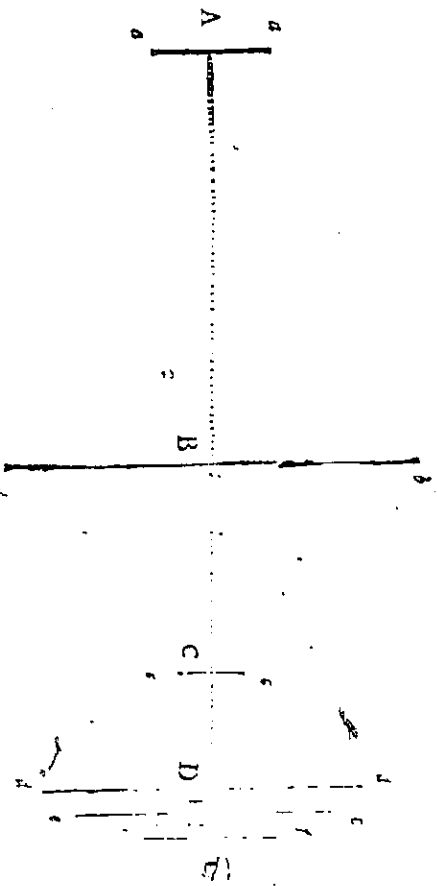
Tabula Telescopiorum ex quinque lentibus compositorum.

Multi-Lentis plicatio focus.	A	A	B	B	B	C	C	D	D	D	E	Longit. tubi.	femid. campi.
	A	A	B	B	B	C	C	D	D	D	E		
5	8	0,1	8	4,cc	5,67	8,50c	4,18	7	2,33	2,58	2	25	4° 46'
10	18	0,2	18	6,00	0,75	9,0c	4,44	7	2,33	2,58	2	36	2. 23
15	30	0,3	30	7,50	0,83	10,3c	4,66	7	2,33	2,58	2	49	1. 35
20	42	0,4	42	8,40	0,87	0,50	4,77	7	2,33	0,58	2	61,5	1. 11
25	56	0,5	56	9,33	0,93	14,20	4,91	7	2,33	0,58	2	76,5	20. 57
30	70	0,6	70	10,0	0,97	11,67	5,00	7	2,33	0,58	2	90,67	0. 47
35	85	0,7	85	10,62	1,01	12,14	5,09	7	2,33	0,58	2	106,14	0. 41
40	100	0,8	100	11,11	1,04	12,55	5,15	7	2,33	0,58	2	121,50	0. 36
45	120	0,9	120	12,00	1,11	13,33	5,22	7	2,33	0,58	2	142,33	0. 32
50	140	1,0	140	12,75	1,17	14,0c	5,38	7	2,33	0,58	2	163,	0. 28
60	180	1,2	180	13,85	1,25	15,0c	5,53	7	2,33	0,58	2	204,	0. 24

Hic lentis vltimae E distantia foci est 1 dig. femid. aperturae Ee = 1 et post eam distantia oculi EO = 1 dig.

L 1 a

Tabula

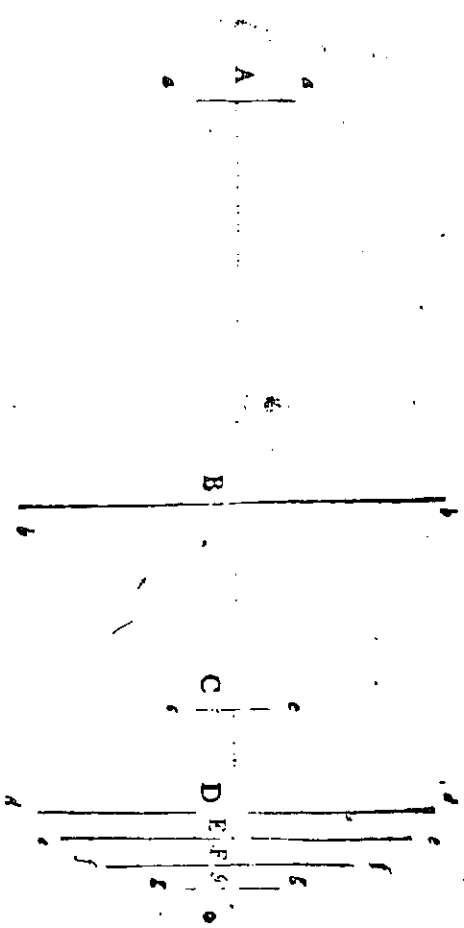


Tabula Telescopiorum sex lentibus constructum.

Multi-Lentis A	Dist Lentis B	Dist Lentis C	Longitudo internodi AF	apertura			
plicatio focus Aa	AB focus Bb	BC focus	ubi AF	angustia			
5	8 2,1	8	4,2061,00	8,22	3,87	42,50	7,11
10	18 0,2	18	6,221,14	9,00	4,29	35,00	3,55
15	30 0,3	30	7,521,25	10,00	4,28	48,00	2,83
20	42 0,4	42	8,421,31	10,50	4,37	60,50	1,47
25	56 0,5	56	9,331,40	11,20	4,44	75,20	1,26
30	70 0,6	70	10,001,46	11,67	4,57	89,67	1,11
35	85 0,7	85	10,621,51	12,14	4,64	105,14	1,11
40	100 0,8	100	11,111,56	12,50	4,69	120,50	0,54
45	120 0,9	120	12,021,60	13,33	4,82	141,67	0,48
50	140 1,0	140	12,731,64	14,00	4,88	162,00	0,43

Lentis C aperturæ semidiameter est 1 dig. et distantia CD . . . 6 dig.  
 Lentis D focus est 3 dig. semid. apert. DD . . . 1 dig. et dist. DE . . . 1 dig.  
 Lentis E focus est 2 1/2 dig. semid. apert. EE . . . 1 dig. et dist. FE . . . 1 dig.  
 Lentis F focus est 1 dig. semid. apert. FF . . . 1 dig. et oculi dist. FO . . . 1 dig.





Tabula Telescopiorum ex septem lentibus compositorum.

Multi plicat.	Lentis A focus.	Aa	A B focus.	Bb	B C focus.	Diff. Longid. tubi A F camp.	Lentis C focus.	Diff. BC	Lentis D focus.	Diff. DE	Lentis E focus.	Diff. EF	Lentis F focus.	Diff. FG	Lentis G focus.	
5	8 0,1	8	4,20	1,33	8,00	3,63	23,33	9,32	18,02	1,50	9,00	3,83	34,33	4,46	47,33	3,10
10	18 0,2	18	6,00	1,50	9,00	3,83	34,33	4,46	47,33	3,10	59,80	2,22	74,53	1,54	89,00	1,34
15	30 0,3	30	7,50	1,66	10,00	4,00	47,33	3,10	59,80	2,22	74,53	1,54	89,00	1,34	104,47	1,22
20	42 0,4	42	8,40	1,74	10,50	4,08	59,80	2,22	74,53	1,54	89,00	1,34	104,47	1,22	119,83	1,12
25	56 0,5	56	9,33	1,86	11,20	4,18	74,53	1,54	89,00	1,34	104,47	1,22	119,83	1,12	140,67	1,4
30	70 0,6	70	10,00	1,94	11,67	4,24	89,00	1,34	104,47	1,22	119,83	1,12	140,67	1,4	161,33	0,56
35	85 0,7	85	10,62	2,02	12,14	4,30	104,47	1,22	119,83	1,12	140,67	1,4	161,33	0,56		
40	100 0,8	100	11,11	2,08	12,50	4,35	119,83	1,12	140,67	1,4	161,33	0,56				
45	120 0,9	120	12,00	2,22	13,33	4,44	140,67	1,4	161,33	0,56						
50	140 1,0	140	12,73	2,31	14,00	4,51	161,33	0,56								

Lentis C: apert. semid. est constanter C. i. 0 dig. et dist. CD . . . 5 dig.  
 Lentis D: focus est 3i. dig. semid. ap. Dd. i. dig. et dist. DE. 0,89 dig.  
 Lentis E: focus est 3,04 dig. sem. ap. Ee. 0,76. et dist. EF. 0,62 dig.  
 Lentis F: focus est 2,21 dig. sem. ap. Ff. 0,55 et dist. FG. 0,51 dig.  
 Lentis G: focus est 1,02 dig. semid. apert. Gg. 0,26 et dist. oculi GO . . . 0,30 dig.

DE