This excerpt is from Tycho Brahe, *De mundi aetherei recentioribus phaenomenis* (Uraniborg: Christophorus Weida, 1588). It is taken from chapter 6, where Tycho argues for the supralunary nature of comets.

Original Text

pp. 89-92

Caput sextum. De situ huius cometae, quo ad mundi diametrum, ex ipsius parallaxibus; et an is in Aetherea, an vero Elementari regione extiterit, demonstrative concludere.

Paravimus in omnibus antecedentibus viam ad investigandum demonstrandumque id, quod tantopere, tot iam elapsis seculis, ab omnibus pene philosophis, in varias sententias disceptatum est, et a nullo hactenus penitus decisum. Utrum videlicet possible sit, cometas in Aetherea mundi regione, intra orbes coelestes generari, an vero iuxta Peripateticorum placita, omnes infra Lunam, in suprema Aeris regione necessario versentur. Est sane hoc negotium, ut praecipuum inter ea, quae de cometis dici inquirique merito debeant, et sine quo caetera omnia, quae in medium adferuntur, manca existunt, ita etiam omnium difficilimum, et non solum labore, sed etiam magna subtilitate industriaque indiget: adeo ut vulgares astrorum observatores, cum suis puerilibus et ludicris instrumentis, prorsus respuat. Res enim versatur hic circa minima, ex quibus maxima concluduntur, cum illi ut plurimum circa maxima etiam caecutiant et aberrent. Ut ob id non usque adeo mirum sit, tantam esse discrepantiam inter philosophos hac de re, et tam diversas etiam neotericorum ex observationibus erroneis petitas sententias; adeo ut quamplurimi, qui de hac materia aliquid in medium protulerunt, etiam inter eos, qui non vulgares haberi volunt, longissime (quod salvo uniuscuiusque honore dictum volo) a scopo petito aberrarint, ut suo loco singulis satis evidenter demonstrabimus. Neque sane ulterius admiror, tot praestantes astronomos etiam hallucinatos esse circa parallaxin huius cometae indagandam demonstrandamque, cum non pauci ex iis parallaxin sensibilem Stellae Novae attribuerint, adeo ut quidam non dubitarint, Elementarem eam extitisse, pronuntiare. Cum tamen facilime, etiam absque ullo pene instrumento, depraehendi poterat, illam circa verticem aeque ac iuxta horizontem, eandem exquisite a vicinis fixis

obtinuisse distantiam, quod fieri nequaquam potuisset, si adeo vicina nobis fuisset, ut Terrae semidiameter sensibilem parallaxin, cui ipsa etiam Luna obnoxia est, induxisset; Verum stella illa revera omnem aspectus diversitatem excludebat, et non aliter quam affixa Sidera, se respectu Terrae revolvebat; ut in priori libro, ubi de hac ex professo egimus, infallibili ratione aliquoties demonstratum reliquimus. Facilitatem autem huius rei observandae pervestigandaeque, peperit tum situs huius stellae semper aspectabilis, eo quod circulum circa Polum magnum quidem, sed cuius pars nulla occideret, motu primi mobilis designaret, neque adeo declivis in minima altitudine fieret, ut vapores circa horizontem, per radium refractum, locum eius aliorsum visui insinuarent, perpetuoque in eodem loco fixa stetit; unde motus proprius nullam in indaganda parallaxi difficultatem causari poterat. At in hoc cometa, quo ad parallaxes enucleandas, maior longe inest laboris perplexitas, et subtiliori opus erit pervestigationis methodo, neque etiam adeo simplici, eo quod is nec in meridiano aspectabilis fuerit, nedum ut non occideret, et motum etiam proprium obtinuerit, eumque non semper aequalem, sed successive se remittentem. Nos tamen certis et diversis rationibus, omnibus his difficultatibus praevenientes, liquido demonstrabimus, hunc cometam minime in Elementari regioni extitisse, sed longe supra Lunae sphaeram in ipso Aethere cursum suum absolvisse; Contra quam Peripatetici, Stagiritae illius authoritati insistentes, hactenus subtilibus suis argumentationibus, nulli tamen experientiae vel demonstrationi certae innixis, nobis persuadere conati sunt. Idque nunc eo audentius contra eos, eorumque asseclas asserere licebit, quod in Nova illa, de qua modo diximus Stella, in ipso Aethere insolitas generationes nonnunquam existere, adeo manifeste apparuit, certoque demonstrabatur, ut qui de hoc amplius haesitare velit, deridendus potius, et tanquam sensu communi carens, a veritatis schola explodendus merito veniat, quam ut responsione dignus censeatur. Cum itaque ratio investigandi parallaxin in hoc cometa, non usque adeo simplex et facilis (ut diximus) existat, qualis in Stella illa Nova sese obtulit, et multae viae alias a mathematicis praestantibus repertae sint ad parallaxium demonstrationem perveniendi; primum quidem ab eximio illo artifice Johanne Regiomontano Franco, edito de hac materia peculiari libello, tum etiam a quibusdam recentioribus non vulgaribus mathematicis: tamen cum nulla earum mihi satisfacere videatur, ad huius cometae parallaxes enucleandas, eo quod maxima pars transitum per meridianum aspectabilem praesupponat, et omnes illae viae, cometae motum nullum alium quam primi mobilis admittant, quae duo in hoc neutiquam locum obtinebant, adde, quod ut plurimum illae rationes, temporis exquisitissimam notitiam requirant, qua in parte quam facile aberrari possit, norunt, qui in hoc pulvere diligentius versati sunt; et ob id illae inductiones ex minimis, quorum parva aberratio, quae vix caveri potest, in maximam

crescit deviationem, mihi semper suspectae fuerunt. Idcirco, ut nos in praesenti negotio, omnes a certitudinis scopo abducentes labyrinthos evitemus, et difficultatibus sese ingerentibus oportune occurramus, superatisque errorum scopulis ad veritatis planiciem exoptatam, conscendamus, tribus potissimum modis demonstrabimus, quod cometa hic Elementaris nequaquam extiterit.

Primum, et quasi generali ratione, ex ipso ductu et motu, quem toto durationis tempore observavit, circulique tramite et declinatione, quem suo curso designavit.

Secundo, particularius idem pervestigabimus ostendemusque ex distantiis a quibusdam peculiaribus fixis sideribus, viae cometae vicinis, quas interlapsis aliquot horis observavimus, cum altior decliviorque ipsius supra horizontem positus conspiceretur.

Tertio, ex collatione observationum in semotis Sphaerae inclinationibus, ab aliis mathematicis exquisite deprehensis, et cum nostris, habita ratione interjectae Telluris portionis, diligenter collatis, idem enucleare conabimur. Confidoque his tribus comprobationibus certo convinci posse, cometam hunc supra Lunam, in ipso Aethere locum obtinuisse; quibus tamen, quasi appendicis loco, subjungamus aliqua exempla Regiomontanicae ratiocinationis, quae ex duabus datis altitudinibus et azimuthis, cum intervallo temporis cognito, parallaxin indagare docuit; ne veterum inventa vel ignorasse, vel neglexisse videamur, et ut id, quod prius innuimus, eiusmodi inductiones non ita bene in praxi atque speculatione locum obtinere, manifestum reddatur.

Translation

pp. 89-92

Chapter 6. To conclude demonstratively on the position of this comet, with respect to the diameter of the World; and whether indeed the comet appeared in the Aether or in fact in the region of the Elements.

We have provided in everything that has gone before a way for investigating and demonstrating the question which has, over so many ages, been so much split by almost all philosophers into different opinions, and so far has not been completely settled by anyone:

namely, whether it would be possible for comets to be generated in the aethereal region of the World, among the celestial orbs, or whether, instead, according to the views of the Peripatetics, all things under the Moon necessarily dwell in the uppermost region of the Air. Indeed, this issue is chief among those that should deservedly be discussed and inquired into regarding the comet, for without it, all the rest that have been brought forth would remain imperfect, so also it is the most difficult of all, and requires not only labour but also great subtlety and industry, to the extent that the question utterly spurns the common observers of the stars with their puerile and playful tools. For here the matter turns on very small things from which very great ones are concluded, whereas those [common observers] are usually blinded and also go astray regarding very great things. So that because of this, it is not surprising that so far there is such a discrepancy among philosophers on this matter and so many different claims on the basis of erroneous observations of the moderns, such that very many of those who have published something on this matter, even among those who do not want to be regarded as common (because I want what I say to respect everyone's honour), have strayed far from [their] intended target, as in due course, we shall demonstrate sufficiently clearly in the proper place. Nor indeed am I amazed that so many excellent astronomers have also hallucinated in investigating and demonstrating the parallax of this comet, since not a few of them have attributed a detectable parallax to the New Star, to the extent that some people have not hesitated to declare that the star appeared in the [region of the] Elements. But it could be grasped easily, even without any instrument whatsoever, that [the New Star] near the vertex and likewise near the horizon had maintained exactly the same distance from the neighbouring fixed stars, which could never have happened if [the New Star] had been so close to us that the radius of the Earth would have brought about the detectable parallax to which even the Moon is subject; hence that star truly excluded every difference in aspect [i.e. parallax] and carried itself around the Earth, just as a fixed star [does]; as in the former book where I dealt with this explicitly, we have shown demonstrated several times with infallible reasoning. But the position of this always visible star permitted this matter to be easily observed and investigated thoroughly, because the star described with the motion of the Prime Mover a large circle around the pole, no part of which set, nor did its declination come to a sufficiently small altitude for the vapours near the horizon to make its position appear differently to the eye through a refracted ray. And as it (the star) stayed fixed in the same position constantly, no proper motion could present difficulty in detecting parallax. But in the case of this comet, the difficulty of the labour involved for establishing parallaxes is far greater, and there will be a need for a more subtle and not so simple method

of thorough investigation, because [the comet] was not visible in the meridian, still less did it fail to set, and also it maintained a proper motion, not constant, but progressively decreasing. But we, with certain and varied reasons, pre-empting all these difficulties, will demonstrate clearly that this comet was by no means situated in the region of the Elements, but completed its own path far above the sphere of the Moon, in the Aether itself. Against this, the Peripatetics, clinging to the authority of the Stagirite have until now tried to persuade us with their subtle arguments, though supported by no experience or certain demonstration. And now therefore it is appropriate to argue more boldly against those and their lackies that, in relation to the New Star about which we have just spoken, it has become quite clear that unusual births [of new stars] sometimes happen in the Aether itself and that it has been demonstrated with certainty, so that he who wants to keep on dithering on this matter should justly be scoffed at and expelled from the school of truth, as lacking in common sense, rather than being regarded as worthy of a reply. Since therefore the method for investigating the parallax in this comet has not emerged as simple and easy (as we have said), as when it presented itself in the case of the New Star, and many ways have been found on other occasions by excellent mathematicians for achieving demonstration parallaxes: first, indeed by that extraordinary master, Johannes Regiomontanus the Franconian, his own book on this matter having been published; but also by some more recent, decent mathematicians. But since none of them [i.e. these methods] appeared satisfactory to me for clarifying the parallaxes of this comet, because the majority of these methods presuppose that [its] transit through the meridian was visible, and all allow the comet no other motion than [that] of the Prime Mover, which two [conditions] never obtained in this case. Besides, normally those calculations require very precise knowledge of time, in which matter they who have exercised diligently in this arena know how easily one can be led astray, and because of this, those inferences from the smallest things in which a very small discrepancy (which can scarcely be avoided) grows to the greatest deviation seemed always suspect to me. Accordingly, in our present business, in order to avoid all labyrinths leading away from the aim of certainty, and to attack their inherent difficulties as the occasion demands, and to climb to the hoped-for plateau of truth, with the cliffs of errors having been surmounted, we shall demonstrate by three most powerful methods that this comet in no way was situated in the region of the Elements.

Firstly, and as if by a general reasoning, from [the comet's] path and motion, which it kept for its whole period of duration, by its circular path and its declination, which it defined by its course.

Secondly, we shall investigate more specifically the same and we shall show it from the distances from certain particular fixed stars close to the path of the comet, which we have observed in intervals of a few hours, when it was observed at a higher and at a lower position above the horizon.

Thirdly, from the collation of observations in separate latitudes [*inclinationibus*] of the Sphere, established precisely by other mathematicians, and, having taken into account the portion of the Earth between them, and having collated them diligently with ours, we shall try to reveal the same. I trust that with these three proofs it is possible to be assured that this comet kept its place above the Moon, in the Aether itself, but to which, as if in place of an appendix, we shall add some examples of Regimontanian calculation, which taught how to find the parallax from two given altitudes and azimuths, with the interval of time known, in order that we should not be seen to be either ignorant of, or to have neglected the discoveries of the Ancients. And (we shall do this as well) in order to make clear what we had suggested before, [namely that the above-mentioned] inferences of the same kind are not successful in obtaining the position either in practice or in theory.

Original Text

pp. 92-102

Quod cometa hic non in Elementari mundo, sed in ipso altissimo Aethere extiterit, ex ductu circuli, quem motu proprio designavit, comprobatio prima.

Cometa hic, motu sibi proprio, ab initio suae apparitionis usque ad finem ultimum, exquisitissime portionem circuli in Sphaera maximi designavit, medius inter duos opposites polos ubique incedens, neque unquam sensibiliter ab eius circuli maximi orbita, in hanc vel illam partem deflectebat, non aliter quam Sol, motu suo proprio, eclipticam, Sphaeram in duo aequalia dividentem, describit, et Luna suo circulo sub quo movetur, etiam totum coelum bifariam aequaliter partitur. Quapropter cometam hunc, non minus quam Sol vel Luna,

caeteraeque errantes stellae, in ipso Aethere locum obtinuisse, satis probabiliter convincitur. Qui enim fieri poterat, si in Elementari regione flagrans aliquod igneum metheoron, prout volunt Peripatetici, extitisset, ut tam regulari et constanti ductu, portionem circuli maximi, Sphaeram in duo aequalia dispartientis, exactissime designasset. Consentaneum enim erat, vagabundo et irregulari motu erroneum descripsisse ductum, sive quo materia ipsa pabulum quaerens affectaret, sive quo violenter, vel vi siderum aut ventorum (si tam declivis esset) impelleretur, in quorum neutro, regularem et uniformem ductum circuli in Sphaera exquisite maximi, ubique et toto durationis tempore, retinere potuerat. Nam licet vi alicuius sideris raperetur, tamen si in Elementari regione existeret, propter materiae fluxibilitatem, et a coelesti perpetuitate ingentem differentiam, non ita exacte ubique sequi poterat, quin aliquando nonnihil ab exquisitissimo circuli maximi ductu exorbitaret. Cum ipsi etiam planetae quinque, a quorum aliquo impelli deberet, non exacte semper suo motu circulum describant maximum, ob eum qui sit in latitudinem digressum, qui varius et diversimodus, praesertim in iis quos inferiores vocant, existit.

Quare, cum hae ipsae coelo congenitae stellae non designent circulum exquisite maximum, multo minus efficere poterant, ut aliud quoddam corpus, praesertim in Elementari regione positum, ipsarum vi, regularem circuli maximi ductum perpetuo observaret. Nam a Sole et Luna, quae duo sidera circulos polis suis ubique intermedios notant, non tractum esse cometam, ob luminis quantitatem, et quod nullus consensus fuerit inter illorum motus et cometae proprium cursum apparentem, nemo facile inficiabitur.

Fixa insuper sidera, cum perpetuo in uno orbe quasi quiescere appareant, non poterant aliquem motum, nedum tam perfectum et regularem, extraneo corpori attribuere. Restat itaque, ut rationabiliter concludamus, cometae huic scientiam motus per se ingenitam fuisse, quam si in Elementari regione extitisset, fluxam et vagam, pro materiae instabilitate, exercuisset. At cum ordinarium et regularem, sub circulo perfectissimo et in Sphaera maximo, observaverit, necessarium esse, ipsum in altissimo Aethere hunc cursum absoluisse, ubi omnia sunt regularia, perfecta, et instabilitati minime obnoxia, et ubi circuli suos polos exquisite respiciunt, motumque circa illos constanter absoluunt.

Adde, quod in hoc ipso circulo, etsi inaequaliter, prout ipsi etiam planetae in suis orbibus, moveri visus est cometa, tamen inaequalitatem inordinatam, utpote, quae subito a tardiore in celeriorem, et rursus ab hoc in illum vago ductu prosiliret, minime admittebat, prout meteora,

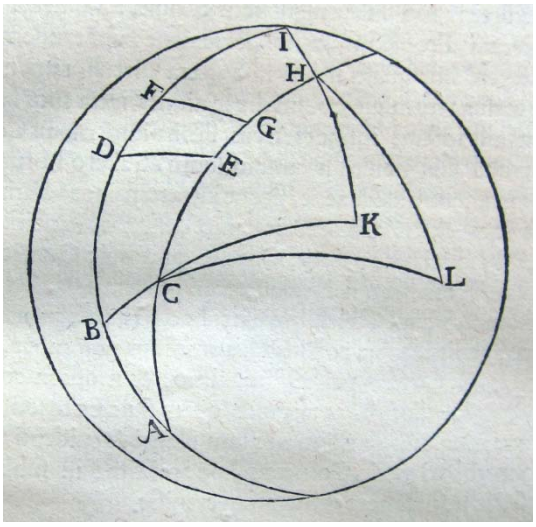
quae in Elementari regione generantur, talem disparem et inconstantem motum obtinere animadvertuntur. Verum cometa hic, sub portione illa circuli maximi, a velociore apparente motu in tardiorem, successive et proportionaliter, simili inhibitionis servato ductu, ferebatur; ut non minus quam planetae alterationem cohibitionis motus ordinarii, cum a celeriori cursu in stationes desinant, obtinere deprehensus sit. Nusquam enim sequentibus diebus celerior factus est, sed semper simili quasi ductu motum retardabat, donec ultimis diebus singulis, vix tertiam partem unius Gradus absolveret, cum in prioribus quinos integros conficere animadverteretur, servata interea defectionis ordinaria (ut dixi) proportione, sub eodem ductu praescriptae portionis circuli maximi. Quod alicui Elementari corpori, vel flammanti materiae, in superiore Aeris regione, vel in ipso elemento Ignis (si id sub Luna locum habere Peripateticis concesserimus) cursum aliquandiu absolventi, competere, nemo nobis persuadebit.

Demum et hoc non obscure argumento est, minime sublunarem fuisse hunc cometam, quod motus diurnus proprius, nunquam tantus fuerit, ut Lunae cursum diurnum, vel tardissimum adaequarit, Luna emin cum lentissima apparet, plus denis Gradibus, una die absolvit, cum cometa hic nobis in initio, quando velocissimus existeret, non multum ultra quinos Gradus, intra unicam primi mobilis revolutionem, progredi deprehensus sit; ut ob id longe supra Lunae sphaeram cursum suum absolvisse, una hinc satis manifeste comprobari possit. Quo enim remotiora existunt a Terra sidera, et octavae sphaerae proximiora, eo tardiores motus, proprios obtinere nobis apparent, et econtra, quo propriores, eo celerius agitari conspiciuntur, ideoque cometam, non saltem proxime supra sphaeram Lunarem extitisse convincitur, sed non longe ab orbibus, quos [Venus] et [Mercurius] circa Solem describunt, ductum suum absolvisse.

Tandem et hoc accedit non obscuri indicii loco, cometam hunc in coelesti mundo sedes suas obtinuisse, quod adeo notabiles et illustres initii et finis sui motus sub primo mobili sortitus sit terminos. Nam ab ipso tropico Capricorni ascendens per aequatorem, suo ductu regularem cursum absolvebat, donec ad alterum tropicum Cancri pervenisset, ubi tandem evanuit. Licet vero imaginarii sint hi in Sphaera circuli, tamen cum eclipticae versus utrumque polum divagationes, intra suos limites cohibeant, admodum insignes arcus, limitationem motus cometae definierunt. Cum enim is cursum suum ab altero horum inchoarit, et in alterum deduxerit, sicque intra terminos Solaris motus, quos parallelos aequatori toto anno designat, exquisite cohibuerit, quis inficias ire poterit, coeleste quid huic cometae insitum fuisse. Non

enim si in Elementari sphaera extitisset, tantam in motu suo cum coelestibus circulis etiam imaginariis obtinuisset convenientiam; ut ob id ex his omnibus rationibus, motus cometae sub circulo perfecte maximo, et motu in eodem regulari et proportionali, ac tardiore, quam Lunae remotissimae est, locoque initii et finis sui motus tam illustri et evidenti, sufficienter comprobari possit. Cometam hunc minime in sublunari mundo, sed in ipso Aethere, generatum extitisse.

Verum plerique non facile assentientur, motum eius talem, sub ea quam diximus portione circuli fuisse, qualem nunc asservimus. Utquamvis ex supradictis, ubi locus eius ad singulas observationes demonstratus est, facile a peritis id colligi potest, tamen quia non omnes statim huic rei fidem adhibebunt, cum iis non subito in oculos incurrat, et mathematici sit non solum asserere, verum etiam demonstrare, ne dubium aliquod relinquatur veritatis metam affectantibus. Idcirco certioris demonstrationis causa eorum quae diximus, ex singulis et omnibus observatis cometae locis, superius ad certa tempora demonstratis, qualem in suo circulo motum habuerit, et an is ubique Sphaeram in duo aequalia diviserit, demonstrabimus, collatione primum facta ad eclipticam, in hunc modum.



Sit eclipticae portion ABDFI, cuius polus sit K, arcus vero circuli cometae sit ACEGH, contingens eclipticam in puncto A, cuius polus sit L. Si itaque demonstraverimus ex praecedentibus observationibus, et longitudinibus cometae demonstratis in ecliptica ABDFI, cum latitudinibus adhaerentibus, repraesentatis per BC, vel DE, vel FG, aut IH (loco omnium aliarum) eandem semper manere inclinationem arcus HEA ad eclipticam IDA, satis persuasum esse arbitror, iis qui mathematica intelligunt, dictum arcum AEH esse portionem

circuli maximi, non minus quam arcus eclipticae ADI, et aeque respicere suum polum L, atque hic polum K. Atque ob id totam Sphaeram, non minus quam ipsa ecliptica, bifariam in duas aequales portiones dividere, et esse arcus HL atque CL, omnesque alios intermedios, ad cometae locum in suo arcu HA imaginarie conceptos, quartam circuli partem, non aliter quam illi, qui a polo eclipticae K, in eclipticam IBA descendere ad loca cometae praesupponuntur. Non enim omnes in figuratione, ad quaevis observata cometae loca, delineare placuit, ne nimis intricata et confusa fieret designatio; intelligentibus rei cardinem satis hoc modo indicatum est.

Sit itaque locus intersectionis viae cometae cum ecliptica in puncto A, quem ex superioribus patet deprehensum fuisse in G20 M55 [Sagittarius], sit B primus observatus locus cometae, die XIII Novembris in G7 M15 [Capricorn], cum latitudine BC Borea, P8 M59, locus autem cometae verus in suo circulo sit in puncto C. Quapropter in triangulo ABC, cum detur latus BA, differentia longitudinis cometae ab intersectione A, P16 M20, et latus BC sit 9 Partium minus uno Scrupulo, angulus vero ad B necessario sit rectus, dabitur per triangulorum placita, latus AC, P18 M35, atque tantum eo tempore erat cometa remotus a loco, in quo eius arcus eclipticam pertransivit; datur insuper angulus CAB, P29 M20, quinis saltem Scrupulis excedens, qui nihil important, praesertim in tam angusto trigono, ubi unum vel alterum Scrupulum mutationis lateris BC latitudinis, plurimum angulum ad A variat; sed cum non sit maior quam quinque Scrupulorum differentia ab angulo inclinationis circuli cometae ad eclipticam superius constituto, P29 M15, pro nihilo et insensibili reputandam intelligentes facile concedent.

Dehinc ad diem XIIII Novembris, constituamus cometam in suo circulo progressum ad locum E, ut sit longitudo eius in ecliptica D, in P10 M42 [Capricorn], et latitudo DE, P10 M42 Borea, prout haec superius in eum modum deprehensa indicavimus. Erit itaque ut prius, in triangulo rectangulo DAE, latus DA, P19 M47. Quare ex dato DE, provenit per operationem latus EA, P22 M23, et angulus EAD, P29 M12, Scrupulis saltem tribus ab eo, quem designavimus, deficiens. Cumque EA modo inventum, superet CA prius quaesitum in arcu EC, P3 M48, manifestum est, tantum eo die fuisse motum diurnum cometae in suo circulo.

Die XV Novembris, rursus fingatur locus cometae in puncto E quo ad suum circulum, et in D quo ad eclipticam, ut sit latitudo observata DE (lubet enim per totum Novembrem, observationes in eo habitas, accommodare ad triangulum DEA, ne per copiam locorum

promotionis cometae intricatior reddatur delineatio). Quare cum eo die D sit in P13 M47 [Capricorn], et DE, P12 M16, erit latus AD, P22 M52, et EA, P25 M48, atque angulus EAD, P29 M14, uno solummodo Scrupulo deficiens ab illo, quem designavimus; cumque latus EA, nunc sit longius factum quam prius, G3 M25, manifestum est cometam hoc diurno spatio totidem Gradus absolvisse, et ob id 23 min. esse tardiorem, quam praecedenti die deprehensus est.

Die XX Novembris, est D, P26 M59 [Capricorn], DE, P18 M15. Quare DA, P36 M4, sed AE, P39 M51, angulus vero IAH, P29 M15, in ipso Scrupulo consentiens cum iis, quae prius inventa sunt. Ita ut EA nunc longior facta sit P14 M3 intervallo quinque dierum; ita ut singulis diebus, si aequaliter promotus fuisset, nunc non integre tres Gradus, deficiente quasi sexta parte, absolvere deprehensus sit, quod successive, uti par erat, a superioribus motibus diurnis deficit.

Pari ratione die sequente ex D, in P29 M14 [Capricorn], et DE, P19 M9, datur DA, P38 M19, et EA, P42 M10, duobus Gradibus cum ⅓ fere priori maior existens, quantus est motus diurnus cometae in suo circulo etiam successive decrescens, angulus vero EAD manet P29 M15. Unde cometa nec hoc die a sui circuli arcu quicquam deviat.

Die XXIII Novembris, ex longitudine D, P3 M31 [Aquarius], et latitudine DE, P20 M45, datur latus DA, P42 M36, et EA, P46 M30. Ut sit ob id cursus cometae, per hoc biduum, in suo circulo, P4 M20, et diurnus P2 cum $^{1}/_{6}$ adhuc successive deficiens, angulus vero EAD inclinationis, manet ut supra, P29 M14.

Die XXV Novembris, ex longitudine D in P7 M24 [Aquarius]. Latitudine DE, P22 M6, datur DA, P46 M29, et EA, P50 M22 fere. Unde motus diurnus per hoc biduum fuit, P3 M52, ut quasi 1 Gradus, et 56 Minuta, uni diei competant, angulus vero inclinationis EAD, invenitur exquisite P29 M15.

Die XXIX Novembris, ex D, P13 M45 [Aquarius], et DE, P24 M0, datur DA, P52 M50, et EA, P56 M30. Unde motus diurnus his quattuor diebus mutatus est G6 M8, competente singulis diebus quasi sesquialtero Gradu; quare adhuc successive decrescit eius motus, angulus vero EAD, P29 M12, tribus saltem Scrupulis insensibilibus a praesupposito deficiens.

Die XXX Novembris, ex longitudine D, in G15 M3 [Aquarius], et latitudine DE, P24 M29, provenit DA, P54 M8, et EA, P57 M47, quae cum sit saltem uno Gradu, et 17 Scrupulis antecedente maior, tantum etiam tunc fuisse cometae motum diurnum indicat, adhuc successive decrescentem, angulus vero EAD, procreatur P29 M20, quinis saltem Scrupulis praesupposito maior, quae differentia apud intelligentes tolerabilis est, et suam facile meretur excusationem.

Absolutis itaque et examinatis omnibus observationibus mense Novembri habitis, procedemus ad illas, quas Decembri insequenti nacti sumus, in quibus omnibus utemur eadem ratione, triangulo AFG, innuente quasi ulteriorem cometae promotionem, sub quo tamen omnes diversas illas digressiones hoc mense observatas, intelligi volumus.

Decembris die I, ex longitudine F, P16 M22 [Aquarius], et latitudine FG, P24 M47, datur FA, P55 M27, et GA, P59 M1, praeterea EG, P1 M14, quantus hoc die erat motus diurnus cometae in suo circulo, angulus vero inclinationis GAF, manet P29 M15½, dimidio saltem Scrupulo eum, quem designavimus, exuperans.

Die X Decembris, fuit F in P25 M47 [Aquarius], FG, P26 M50. Quapropter FA, P64 M52, et GA, P67 M44, in 8 Partibus et 43 Scrupulis priorem excedens, adeo ut his novem diebus intermediis, si aequalitas motus retineretur, singulis quasi 58 Scrupula, pro motu diurno cometae in suo circulo competerent, eo adhuc successive et ordinarie deficiente, angulus vero inclinationis circuli cometae GAF, manet P29 M12, tribus Scrupulis insensibilibus praefinito minor.

Die XII, longitudo F, P27 M21 [Aquarius], latitudo FG, P27 M8. Hinc FA, P66 M26, GA, P69 M9⅓. Unde motus diurnus his duobus diebus est 1 Gradus, 25 Scrupulorum, competuntque uni quasi diei 43 Scrupula, angulo inclinationis manente P29 M13, duobus saltem Scrupulis assignato minore.

Die XIII, F, P28 M10 [Aquarius], FG, P27 M18, FA, P67 M15, GA, P69 M54. Quare motus diurnus fere ut prius, nam pauculorum Scrupulorum differentia hic intra unum diem discerni non poterit, angulus GAF, P29 M14 satis conveniens ipsi primo invento.

Die XIIII, F, P28 M55 [Aquarius], FG, P27 M26, latus AF, P68 M0, AG, P70 M35. Ergo motus diurnus in suo circulo est Scrupulorum 41, similis quasi prioribus, sed adhuc decrescens, angulus vero inclinationis FAG, P29 M14½, dimidio saltem Scrupulo ab assignato deficiens.

Die XVII, longitudo F, in P1 M17 [Pisces], latitudo FG, P27 M46, latus FA, P70 M22, GA, P72 M42. Ut de motu, his tribus interjectis diebus, competant singulis quasi 42 Minuta, fere ut prius. Videtur enim circa hosce et antecedentes dies, cometa quasi eundem tenorem in motu suo diurno obtinuisse, angulus vero inclinationis FAG est P29 M13, duobus saltem Scrupulis praesupposito arctior.

Die XXIII Decembris, longitudo F, P5 M23 [Pisces], latitudo FG, P28 M24½, latus FA, P74 M28. Latus GA, P76 M22½. Quare intra hos sex dies progressus fuit Part. $3^{2}/_{3}$ pene, et ob id singulis diebus debentur quasi 37 Scrupula, si aequalitas motus admitteretur, angulus vero inclinationis est P29 M18, tribus Scrupulis insensibilibus constituto maior.

Die XXX Decembris, F in P9 M14 [Pisces], FG, P28 M42, latus FA, P78 M19, GA, P79 M46. Quare motus diurnus intra hoc septiduum fuit 3 Partium 24 Scrupulorum, adeo ut singulis diebus, facta aequali distributione, dimidius Gradus competat, et angulus inclinationis est P29 M12, tribus saltem Scrupulis praesupposito minor.

Die ultima Decembris ex longitudine F, in P9 M54 [Pisces], et latitudine FG, P28 M46, datur primum FA, P78 M59, et deinde GA, P80 M22. Unde motus diurnus a praecedente die paulo maior semisse Gradus; ubi aliquid forte in observatione desideratur. Angulus vero intersectionis perpetuo manet P29 M12 a praefinito insensibiliter differens.

Sed adhibebimus etiam in consilium observationes mense Januario factas, etsi exilis admodum erat tunc cometa, et in his utemur triangulo IHA, procedentes plane ut in praecedentibus.

Januarii calendis in triangulo IAH, longitudo I, in P10 M22 [Pisces], latitudo IH, P28 M49, quare latus IA, P79 M27, et HA, P80 M46. Quod si conferatur cum differentia GA intra biduum, dat motum diurnum in hisce duobus diebus unius exquisite Gradus, ita ut singulis

adhuc dimidius Gradus respondeat, angulus vero inclinationis manet P29 M14, per HAI repraesentatus, qualis fere a nobis constitutus est.

Januarii die II, longitudo I, P10 M54 [Pisces], latitudo P28 M51, HI, latus IA, P79 M59, HA, P81 M14. Motum diurnum respectu antecedentis exhibens Minutorum 28, angulum vero inclinationis HAI, P29 M13½, sesquialtero saltem Scrupulo assignato minorem.

Die V Januarii, I, P12 M24 [Pisces], IH, P28 M57, IA, P81 M29, HA, P82 M33. Quare motus diurnus in hoc triduo est, quasi 26 Minutorum, angulus vero HAI inclinationis, manet P29 M13, ut prius.

Die IX Januarii, longitudo I, P14 M15 [Pisces], latitudo IH, P29 M3, latus IA, P83 M20, latus AH, P84 M10½. Quare motus diurnus intra hoc quatriduum est 24 Minutorum, angulus vero inclinationis HAI, manet P29 M13.

Die XII Januarii, longitudo I, est in P15 M37 [Pisces], latitudo IH, P29 M10, latus IA, P84 M42, HA, P85 M23. Unde motus diurnus, per hoc triduum, existit fere ut prius 24 Scrupulorum, angulus vero inclinationis HAI, P29 M16, unico saltem Scrupulo assignato maior.

Die XXVI Januarii, quo ultimo cometam hunc videre licuit, ex loco eius qui tunc erat in P20 M55 [Pisces], cum latitudine, P29 M18 Borea, facile est angulum inclinationis ad eclipticam cognoscere, siquidem hic locus per quadrantem circuli exacte distat ab intersectione in A. Manifestum itaque est, quod ipsa latitudo angulum inclinationis metiatur, ut ulteriori indagine hic non opus sit. Quapropter cum latitudo hoc ultimo tempore reperta sit, P29 M18, saltem ternis Scrupulis omnem sensum effugientibus, ab assumto inclinationis angulo abundans, liquidum evadit, cometam hunc, usque in ultimum suae apparitionis terminum, circuli maximi exactum ductum constanter observasse. Motum vero proprium in hoc suo cursu, intervallo 14 dierum interlapsorum, obtinuit P4 M37, qui si per 14 aequaliter distribueretur, singulis diebus tertia fere parte unius Gradus promotus censeretur, sed verosimile est, eum primis diebus celeriorem, utpote 24 proxime Scrupulorum, in sine vix quartam partem Gradus diurno itinere absolvisse; ut hinc etiam pateat, cometae motum proprium, usque in ultimum finem, proportionaliter et ordinarie sine intermissione decrevisse.

Translation

pp. 92-102

First proof, from the course of the circle that it traced with its proper motion, that this comet was not in the elemental world but in the highest Aether itself.

From the beginning of its appearance to the very end, this comet most accurately described in its proper motion a circle in the great Sphere, everywhere falling midway between the two opposite poles, nor did it ever deviate detectably in one direction or the other from the path of that great circle, just as the Sun in its proper motion describes the ecliptic, dividing the Sphere into two equal parts, and the Moon in its circle in which it is moved also divides the whole heaven equally into two parts. On this account it is quite credibly proved that this comet, no less than the Sun and the Moon and the other wandering stars, held its place in that Aether. For how could it have come about if, as the Peripatetics suppose, it was in the elemental region blazing with some meteoric fire, that with so regular and constant a path it should have most exactly described a portion of a great circle, dividing the Sphere into two equal parts? For it would have been proper for it to have described an errant path with wandering and irregular motion, either one in which its matter strove to obtain food or in which it was violently impelled by either the force of the stars or of the winds (had it been so low down), in neither of which cases could it have maintained everywhere and for the whole extent of time its regular and uniform path of a great circle in the Sphere. For even were it impelled by the force of some star, nevertheless, were it located in the elemental region, on account of the changeability of matter and the immense difference from the celestial permanence, it would not be able to follow [the star] everywhere so precisely as not on occasion to deviate from the most precise course of the great circle. Moreover, given that the five planets, by one of which it would have to be driven, do not in their motion always describe precisely a great circle, because of that deviation that occurs in latitude, which happens variously and diversely, especially in the [planets] that they call ‘inferior’.

It follows that, since these same stars coeval with the heaven do not describe precisely a great circle, far less could they bring it about through their force that some other body, especially one placed in the elemental region, should constantly observe the regular course of a great circle. For on account of the amount of light and because there was no agreement between their motion and the evident proper path of the comet, no one will easily deny that the comet

was not drawn by the Sun and Moon, two stars that mark out circles that are everywhere half way between their poles.

In addition, the fixed stars could not confer any motion, not even one so perfect and regular, on an extraneous body, since they show themselves to be as if perpetually at rest in a single orb. It remains therefore for us to conclude reasonably that this comet had in itself innate knowledge of motion, which it would have employed changeably and inconstantly on account of the instability of matter had it been in the elemental region. But since it maintained regular and orderly [motion] in a most perfect great circle in the Sphere, it is necessary that it completed this course in the highest Aether, where all things are regular, perfect and not in the least liable to instability, and where the circles have precise regard to their poles and steadily complete their motion around them.

Consider also that even though the comet is seen to be moved unevenly in this very circle, as are the planets themselves in their orbs, nevertheless it in no way allowed disorderly unevenness, like that which would leap suddenly in a wandering path from slower to faster and back again, as [do] meteors, which are generated in the elemental regions, [and] are observed to have such disparate and inconstant motion. Truly, this comet was carried in that portion of a great circle from a faster apparent motion to a slower one gradually and proportionately, with a similar process of restraint [to that of the planets] being maintained, so that it was observed to maintain a change by way of restraint of ordinary motion, no less than [do] the planets when they desist from a faster course at [their] stations. For in the following days it was on no occasion moved faster, but it always as if with a similar process slowed [its] motion, until on each of the final days it completed hardly a third part of one degree, when in the preceding five it was seen to complete five whole ones, with the regular proportion of falling back being (as I have said) maintained in the same course of the above-mentioned portion of a great circle – something [that] no one will persuade us to be appropriate for any elemental body, flaming matter running its course for a while, whether in the upper region of the Air or in the element of Fire itself (if we concede with the Peripatetics that it is located beneath the Moon).

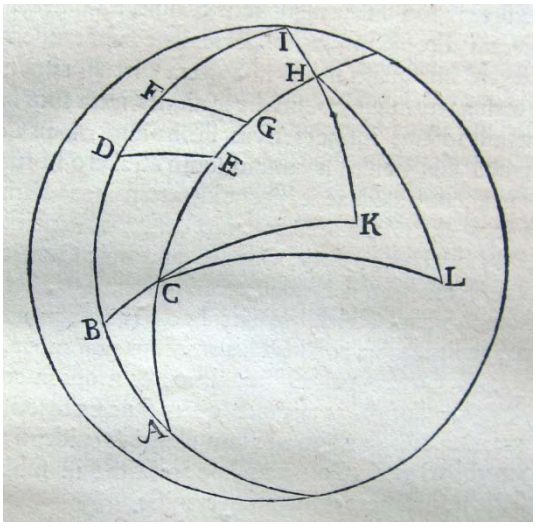
Finally, this too clearly serves as an argument that this comet was certainly not sublunar, namely that [its] proper diurnal motion was never great enough to equal the daily course of the Moon, even at [its] slowest. For the Moon when it appears slowest completes more than

ten degrees in a single day, while this comet at the outset, when it showed itself fastest, was seen by us to advance by not much more than five degrees within a single revolution of the Prime Mover, so that from this alone it can quite clearly be proved that on that account it completed its course far above the sphere of the Moon. For the farther stars are from the Earth and the nearer to the eighth sphere the slower their proper motions appear to us to be, and, on the contrary, the nearer [they are] the faster they are seen to be driven; and for that reason it is clearly shown that the comet was not merely immediately above the lunar sphere, but completed its course not far from the orbs that Venus and Mercury described around the Sun.

Finally, this too occurs by way of a clear sign that this comet had its abode in the celestial world, namely that it happened that the limits of the beginning and end of its motion under the Prime Mover were so very remarkable and renowned. For ascending through the equator from the tropic of Capricorn itself, it completed in its path a regular course until it reached the other tropic, that of Cancer, where it finally vanished. Granted, indeed, that these circles in the Sphere are imaginary, nevertheless since the divergences of the ecliptic towards the two poles remain within their limits, very significant circles define the limitation of motion of the comet. For since it began its course at one of these and withdrew at the other, and thus precisely confined itself between the limits of solar motion, these being parallels to the equator that it marks out over the whole year, who could deny that something celestial was implanted in this comet. For had it been in the elemental sphere, there would not have been so great an agreement in its motion with the celestial circles, albeit imaginary; and so for all these reasons – the motion of the comet in a perfect great circle, and with the motion in the same regular and proportional, and slower than is that of the Moon at its most remote, with the places of the beginning and end of its motion so remarkable and clear – it can be sufficiently proved that this comet was certainly not generated in the sublunary world but in the Aether itself.

In fact, many will not readily agree that its motion in the above mentioned portion of a [great] circle was such as we have just maintained. For although it can easily be gathered by the skilled from the things said above where its place is indicated with regard to particular observations, nevertheless, given that all will not at once put their trust in this matter, since it does not immediately strike them as obvious, and it is proper for mathematicians not only to assert but also, indeed, to demonstrate the truth, lest any doubt should remain for those

striving towards the goal of truth, accordingly, for the sake of more certain demonstration of the things we have said, we shall demonstrate from each and every one of the observed places of the comet, demonstrated above at particular times, what motion the comet had in its circle and whether it everywhere divided the Sphere into two equal parts. [We shall do so], after first presenting a disposition [*collatio*: i.e. the diagram and accompanying text, which set things up for the demonstrations] with respect to the ecliptic, in this way.



Let the portion of the ecliptic be ABDFI, with its pole being K, [and] let the arc of the circle of the comet be ACEGH, touching the ecliptic at point A, with its pole being L. So if we demonstrate from the preceding observations and longitudes of the comet shown in the ecliptic ABDFI and the associated latitudes represented by BC or DE or FG or IH (standing for all the others) that the inclination of the arc HEA to the ecliptic IDA always remains the same, I think that those who understand mathematics will be amply persuaded that the said arc AEH is a portion of a great circle, no less than [is] the arc of the ecliptic ADI, and respects its pole L just as much as the former [respects] its pole K; and that the whole Sphere is therefore divided into two equal parts no less than by the ecliptic itself, and on that account [they will be persuaded] that the imaginatively conceived arcs HL and CL, and all the other intermediate ones [running from the pole L] to the place of the comet in its arc HA , are a quarter of the circle, just like those which are supposed to descend from the pole of the ecliptic to the ecliptic in accordance with the places of the comet. For it was not appropriate to depict in the figure everything with respect to every observed place of the comet; [and] what the matter hinges on is sufficiently indicated to discerning persons in this manner.

So let the place of intersection of the path of the comet with the ecliptic be at point A, which, as is evident from the things said above, was observed at 20 degrees 55 minutes in Sagittarius, let B be the first observed place of the comet on 13 November at 7 degrees 15 minutes in Capricorn with latitude BC 8 degrees 59 minutes north, and let the true place of the comet in its circle be at point C. On this account, since in the triangle ABC the side BA, the difference of the longitude of the comet from the intersection A, is given as 16 degrees 20 minutes, the side BC as 9 degrees less one minute, and the angle at B is necessarily a right angle, it is given by the laws of triangles that the side AC is 18 degrees 35 minutes, and at that time the comet is by that amount remote from the place in which its arc passed through the ecliptic; there is given in addition the angle CAB as 29 degrees 20 minutes, only five minutes too much, which are of no significance, especially in so narrow a triangle, where a change in the side BC, the latitude, of one or two minutes greatly alters the angle at A. But since there is no more than five minutes difference from that angle of incidence of the circle of the comet to the ecliptic established above, namely, 29 degrees 15 minutes, persons of discernment will readily grant it to be of no account and insignificant.

Next on the 14th day of November let us place the comet advanced in its course at point E, so that its longitude in the ecliptic at D is 10 degrees 42 minutes in Capricorn and its latitude DE 10 degrees 42 minutes north, these things being found out in the way we have indicated above. So, [proceeding] as before, in the right-angled triangle DAE the side DA will be 19 degrees 47 minutes. So, from the given DE, the side EA comes out by means of the operation at 22 degrees 23 minutes and the angle EAD at 29 degrees 12 minutes, falling short of that which we have assigned by only [here and elsewhere Tycho uses *saltem* to mean only, at odds with modern dictionaries] three minutes. And since EA just established exceeds CA found before by the arc EC of 3 degrees 48 minutes, it is clear that on that day that was the amount of the daily motion of the comet in its circle.

On the 15th day of November, let the place of comet be again represented at point E with regard to its circle and at D with regard to the ecliptic, so that the observed latitude is DE. (For it is appropriate to confine the observations made through the whole of November to the triangle DEA, lest the delineation of the advance of the comet should be rendered too intricate through an abundance of places.) So since on that day D is at 13 degrees 47 minutes in Capricorn and DE at 12 degrees 16 minutes, the side AD will be 22 degrees 52 minutes, EA 25 degrees 48 minutes, and the angle EAD 29 degrees 14 minutes, just one single minute

short of the one we have assigned; and since the side EA has now become longer than before, it is clear that in the space of that day the comet completed that same number of degrees and is, therefore, slower by 23 minutes than was observed on the previous day.

On the 20th day of November, D is at 26 degrees 59 minutes in Capricorn, DE is 18 degrees 15 minutes, so DA is 36 degrees 4 minutes, AE is 39 degrees 51 minutes, and the angle IAH 29 degrees 15 minutes, agreeing to the very minute with the things that were found before. So EA has now become larger by 14 degrees 3 minutes in the space of five days, so that on each day, if it had been moved on by the same amount, it would now be seen not to have completed three whole degrees, falling short by approximately a sixth part; and this falls short sequentially, as was appropriate, from the earlier daily motions. [Tycho seems to have difficulty in conveying the notion of decrease in average amount of motion per day, and this clumsy phrasing is at least partly his fault rather than ours!]

By the same reasoning on the following day, from D at 29 degrees 14 minutes in Capricorn and DE being 19 degrees 9 minutes there is given DA as 38 degrees 19 minutes and EA as 42 degrees 10 minutes, being two degrees and nearly a third more than the one before, which is the amount of the daily motion of the comet, still sequentially decreasing; and the angle EAD remains 29 degrees 15 minutes. Hence the comet on this day too does not deviate at all from its arc of the circle.

On the 23rd day of November, from the longitude D, 3 degrees 31 minutes in Aquarius, and the latitude DE, 20 degrees 45 minutes, DA is given as 42 degrees 36 minutes and EA as 46 degrees 30 minutes. So that on this account the path of the comet in its circle in these two days is 4 degrees 20 minutes, and on each day $2^{1}/_{6}$ degrees, still sequentially decreasing; and the angle of inclination EAD remains as above [*manet ut supra*: here, as elsewhere, Tycho treats amounts that do not differ '*sensibiliter*' as the same] 29 degrees 14 minutes.

On the 25th day of November, from the longitude D, 7 degrees 24 minutes in Aquarius, and the latitude DE, 22 degrees 6 minutes, DA is given as 46 degrees 29 minutes and EA as 50 degrees and nearly 22 minutes. Hence the daily motion over these two days is 3 degrees 52 minutes, so that approximately 1 degree and 56 minutes occur in one day; and the angle of inclination EAD is found to be precisely 29 degrees 15 minutes.

On the 29th day of November, from D, 13 degrees 45 minutes in Aquarius, and DE, 24 degrees 0 minutes, DA is given as 52 degrees 50 minutes and EA as 56 degrees 30 minutes. Hence the daily motion completed over these four days is 6 degrees 8 minutes, with approximately one and a half degrees occurring on each of the days, whence its motion is still decreasing; and the angle EAD [is given as] 29 degrees 12 minutes, falling short of the previous one by only three imperceptible minutes.

On the 30th day of November, from the longitude D, 15 degrees 3 minutes in Aquarius, and latitude DE, 24 degrees 29 minutes, DA comes to 54 degrees 8 minutes and EA to 57 degrees 47 minutes, and since this is more by only one degree and 17 minutes than the previous one, it indicates that this was then the daily motion of the comet, still successively decreasing; and the angle EAD is delivered as 29 degrees 20 minutes, only five minutes greater than that posited, a difference that is tolerable for persons of discernment and certainly deserves to be excused.

So, having finished with and examined all the observations made in the month of November, let as proceed to those that we made in the following December, in all of which we used the same method, with the triangle AFG indicating, so to speak, the further advance of the comet, by means of which triangle we wish to understand all the various movements observed in this month.

On the 1st day of December, from the longitude F, 16 degrees 22 minutes in Aquarius, and latitude FG, 24 degrees 47 minutes, FA is given as 55 degrees 27 minutes, GA as 59 degrees 1 minute, and also EG as 1 degree 14 minutes, and this was the amount of the daily motion of the comet in its circle; and the angle of inclination GAF remains 29 degrees 15½ minutes, exceeding that which we have indicated by only half a minute.

On the 10th day of December F was at 25 degrees 47 minutes in Aquarius and FG 26 degrees 50 minutes. On this account FA [was] 64 degrees 52 minutes and GA 67 degrees 44 minutes, exceeding the preceding one by 8 degrees and 43 minutes, so that in these nine intervening days if equality of motion had been maintained, for each day approximately 58 minutes would have accounted for the motion of the comet in its circle, with it still successively and regularly decreasing; and the angle of inclination of the circle of the comet GAF remains at 29 degrees 12 minutes, three imperceptible minutes less than the previously determined one.

On the 12th day the longitude F is 27 degrees 21 minutes in Aquarius, the latitude FG 27 degrees 8 minutes. Hence FA is 66 degrees 26 minutes, GA 69 degrees $9^{1}/_{3}$ minutes. Whence the daily motion over these two days is 1 degree 25 minutes, and in one day the minutes come to approximately 43, with the angle of inclination remaining 29 degrees 13 minutes, only two minutes less than that ascribed.

On the 13th day F is 28 degrees 10 minutes in Aquarius, FG 27 degrees 18 minutes, FA 67 degrees 15 minutes, GA 69 degrees 54 minutes. So the daily motion is almost as before, for the difference of a few minutes in one day could not be detected; the angle GAF is 29 degrees 14 minutes, closely agreeing with that first found.

On the 14th day F is 28 degrees 55 minutes in Aquarius, FG 27 degrees 26 minutes, the side AF 68 degrees 0 minutes, AG 70 degrees 35 minutes. So the daily motion in its circle is of 41 minutes, quite close to the earlier ones, but still decreasing. And the angle of inclination FAG is 29 degrees 14½ minutes, only half a minute short of the ascribed one.

On the 17th day the longitude F is 1 degree 17 minutes in Pisces, the latitude FG 27 degrees 46 minutes, the side FA 70 degrees 22 minutes, GA 72 degrees 42 minutes; so that in those three days 42 minutes occur in each, almost as before. For around these and the preceding days the comet seemed as if it stayed steady in its daily motion; and the angle of inclination FAG is 29 degrees 13 minutes, less by only two minutes than that set out above.

On the 23rd day of December the longitude F is at 5 degrees 23 minutes in Pisces, the latitude FG 28 degrees 24½ minutes, the side FA 74 degrees 28 minutes, the side GA 76 degrees 22½ minutes. So in those six days it advanced by almost $3^{2}/_{3}$ degrees, and therefore approximately 37 minutes are required on each day if steadiness of motion is assumed; and the angle of inclination is 29 degrees 18 minutes, three undetectable minutes greater than that established.

On the 30th day of December F is at 9 degrees 14 minutes in Pisces, FG is 28 degrees 42 minutes, side FA is 78 degrees 19 minutes, GA 79 degrees 46 minutes. So the daily motion over this seven-day period was 3 degrees 24 minutes, so that, making an equal distribution, on each day half a degree occurred; and the angle of inclination is 29 degrees 12 minutes, less by only three minutes than that posited above.

On the last day of December from longitude F, 9 degrees 54 minutes in Pisces, and latitude FG, 28 degrees 46 minutes, first FA is given as 78 degrees 59 minutes and then GA as 80 degrees 22 minutes. So the daily motion is a little more than half a degree greater than on the preceding day, where perhaps the observation leaves something to be desired. The angle of inclination remains as ever 29 degrees 12 minutes, differing undetectably from that established earlier.

But we shall take into account also the observations made in the month of January, even though the comet was then quite feeble, and in these we shall use the triangle IHA, proceeding exactly as in the preceding ones.

On the Calends of January in triangle IAH the longitude I is 10 degrees 22 minutes in Pisces, the latitude IH 28 degrees 49 minutes. So the side IA is 79 degrees 27 minutes and HA 80 degrees 46 minutes. And if this is compared with the difference GA over the two days, it gives a daily motion over these two days of precisely one degree, so that half a degree corresponds to each day; and the angle of inclination represented by HAI remains 29 degrees 14 minutes, almost as was established by us.

On the 2nd day of January the longitude I is 10 degrees 54 minutes in Pisces, the latitude HI 28 degrees 51 minutes, the side IA 79 degrees 59 minutes, HA 81 degrees 14 minutes; with the daily motion with respect to what came before being of 28 minutes, and the angle of inclination HAI 29 degrees 13½ minutes, only one and a half minutes less than the designated one.

On the 5th day of January I is 12 degrees 24 minutes in Pisces, IH 28 degrees 57 minutes, IA 81 degrees 29 minutes, HA 82 degrees 33 minutes. So the daily motion over this interval of three days is of approximately 26 minutes, and the angle of inclination HAI remains 29 degrees 13 minutes as before.

On the 9th day of January the longitude I is 14 degrees 15 minutes in Pisces, the latitude IH 29 degrees 3 minutes, the side IA 83 degrees 20 minutes, the side AH 84 degrees 10½ minutes. So the daily motion over the four-day stretch is of 24 minutes and the angle of inclination HAI remains 29 degrees 13 minutes.

On the 12th day of January the longitude I is 15 degrees 37 minutes in Pisces, the latitude IH 29 degrees 10 minutes, the side IA 84 degrees 42 minutes, HA 85 degrees 23 minutes. Whence the daily motion in the course of these three days stands as before at about 24 minutes, and the angle of inclination HAI at 29 degrees 16 minutes, only one minute more than that designated.

On the 26th day of January, the last on which it was possible to see this comet, from its position, which was then at 20 degrees 55 minutes in Pisces with latitude 29 degrees 18 minutes north, it is easy to ascertain its angle of inclination to the ecliptic, for indeed this position is distant from the intersection at A by exactly a quarter of the circle. So it is evident that that latitude is half the angle of inclination, so that there is no need for further investigation here. So, since the latitude at this final time was found to be 29 degrees 18 minutes, only three minutes, escaping any perception, from the assumed angle of inclination, it turns out quite clearly that this comet constantly adhered to the precise course of a great circle until the very end of its appearance. In this path it showed in the space of 14 days a proper motion of 4 degrees 37 minutes, and if that were equally distributed between the 14, it would be thought to have been advanced by approximately a third of a degree per day; but it appears to be true that in the first days it ran its daily course more quickly, covering very nearly 24 minutes, but at the end scarcely a quarter of a degree; so that it is evident from this that the proper motion of the comet decreased proportionately and steadily, without interruption, to the very end.

Original Text

pp. 103-5

Patet igitur et sufficienter comprobatum est, idipsum quod ab initio asservimus. Primum, cometam suo motu descripsisse circulum exquisite maximum, Sphaeram bifariam in duo aequalia dividentem. Nam ubique angulus inclinationis circuli cometae ad eclipticam, qui per HAI repraesentatur, permansit eiusdem quantitates, Partium videlicet 29¼. Nam quod aliquando duobus vel tribus, aut ad summum quinque Scrupulis (quod tamen raro accidit) variatus est, apud intelligentes facile excusationem impetrabit, et pro nihilo habebitur. Quapropter, cum inclinatio viae cometae ad eclipticam ubique eadem inveniatur, per totum suae apparitionis tempus, non difficile dubitantibus persuadebitur, modo circulorum Sphaerae

rationem intelligant, arcum cometae quem suo motu descripsit, portionem esse circuli in Sphaera maximi, non minus quam ecliptica, quam ubique per eiusdem anguli quantitatem respexit, et suos habuisse polos, ab iisque aequaliter distitisse, prout ecliptica a suis; pari ratione atque aequator cum ecliptica mutuum habent, quo ad suos polos, respectum, et licet sese invicem intersecent, uterque tamen ratione proprii poli circulum describit in Sphaera maximum.

Alterum, quod affirmavimus, motum cometae sub hoc ipso circulo maximo, non fuisse inordinarium, utpote interdum velociorem, deinde rursus remissum, aut subito varie sese alterantem, etiam liquido patet. Nam cum ex differentiis arcuum portionis circuli HA constet, quantum cometa sub proprio illo circulo, certo dierum intervallo, absolverit, et in antecedentibus declaratum sit, ipsum circa XIII diem Novembris, quo nobis primum apparuit, pene 4 Gradus, in motu diurno sub hoc circulo, absolvisse, paulo post iuxta diem 15, fere 3½, iuxta vero diem 20 saltem trinos, iuxta 24, Partibus proxime duabus, ultimis vero diebus Novembris, sesquialtero Gradu promotum esse; constet etiam quod in primis diebus Decembris, fuerit motus idem Partis unius cum quadrante, circa 10 diem quasi unius Gradus, iuxta 15 diem, 40 Scrupulorum proxime, circa ultimos vero dies Decembris, dimidii Gradus, deinde iuxta quintum diem Januarii, idem motus quasi quinis Scrupulis tardior, adeo ut ultimo quo conspectus sit, cursus diurnus vix extiterit quartae partis unius Gradus. Apparet itaque quomodo motum suum ordinarie et successive inhibuerit, nec a tardiore subito in velociorem, vel ab hoc in illum prolapsus sit, et veluti ab initio, cum celerior motu erat, varietatem alterationis magis sensibilem admissit, sic in fine, cum tardior fieri incaepit, diversitatem diurni motus non adeo subito immutavit, quo proprius motus ille quieti quasi applicare visus est; non aliter quam in quinque errantibus stellis observare licet, cum a cursu velociore, per suos circulos, ad apparentem stationem devolvuntur.

Tertium, etiam una satis inducitur, cometae motum diurnum proprium in suo ductu nusquam fuisse cursu diurno Lunae vel lentissimo tardiorem. Nam circa initia, quando mihi primum apparuit, non integre quattuor Gradus promotione diurna propria absolvebat, et licet prius a quibusdam, utpote ad diem decimum Novembris visus sit, vel etiam uno alterove die ante (quod difficulter fiebat ob vicinitatem Solis) tamen non multum ultra quinos vel senos Gradus in transitu diurno etiam velocissimus absolvere poterat, habita ratione proportionis subsequentis motus, quam ordinarie servavit. In caeteris vero diebus, tantum abest, ut motum hunc diurnum exuperarit, ut potius successive illum imminuerit, donec tandem in ultimo fine

non ultra partem quartam unius Gradus per 24 Horas absolvere visus sit, unde semper progressum proprium Luna tardiorem retinuit, et ob id longe remotiorem a nobis fuisse, quam Lunae orbis existit, circulorum coelestium et motuum postulat harmonia.

Ultimum, vero quod diximus, cometae principium et finem, in suo tramite, fuisse ab uno circulo tropico usque in alterum, etiam ex praemissis facile colligi poterit. Nam si tribus vel quattuor diebus, aut quinis priusquam nobis apparuit, revera extitit, prout verisimile est, iuxta eclipticam in loco intersectionis sui circuli cum via Solari primum exorsus est, non longe a tropico hyberno circa limites declinationis eclipticae maximae, et ob id prope ipsum circulum tropicum. Deinde ultimo apparitionis tempore, ad diem XXVI Januarii anni sequentis, rursus cum prope Scheat Pegasi conspiceretur, fuit iuxta limites declinationis maximae, quam admittit ecliptica, et ob id prope tropicum aestivum. Adde, quod hoc pacto, tam ratione eclipticae quam proprii ductus, quadrantem circuli in Sphaera maximi absolvisse videatur, quod etiam non parum facit ad persuadendum, coelestem non Elementarem naturam adfuisse huic cometae.

Quapropter, cum satis declaratum demonstratumque sit, cometam hunc suo motu proprio descripsisse circulum in Sphaera exquisite maximum, intra suos polos medio loco contentum et nusquam ab hoc, toto durationis tempore, in hanc vel illam partem deviasse, insuper sub hoc circulo, motum ordinarium nec instabilem reservasse, sed successive pedetentimque sese remittentem, prout in erraticis sideribus fieri consuevit, et hunc ipsum motum, nunquam Lunae motu diurno tardissimo celeriorem exhibuisse, imo longe tardiorem, et postremo, loca initii et finis motus sui, intra utrunque tropicorum, iuxta limites digressionis Solaris terminasse, eaque ratione quadrantem Sphaerae absolvisse; ideo concurrentibus tot rationibus et indiciis, ex ductu proprio cometae, quem toto durationis tempore observavit, desumtis, eum motum conformem Aethereae regioni obtinuisse, manifestum evadit, ipsiusque locum et cursum, in coelestis mundi immensa capacitate, et minime in sublunari et Elementari orbe extitisse, satis evidenter comprobatur; quod generaliori hac via primum demonstrare proposuimus.

Translation

pp. 103-5

Therefore, that very thing which we claimed initially is evident and sufficiently proved. First, that the comet by its motion described exactly a great circle dividing the complete Sphere into two equal [parts]. For everywhere the angle of the inclination of the circle of the comet to the ecliptic, which is represented by HAI, remained of the same quantity, that is, of 29¼ parts. For when sometimes it varied by two or three, or even at most by 5 minutes (which, however, happened rarely), it will easily be dismissed by those who understand, and it [this variation] will be held as nothing. Wherefore, when the inclination of the comet's path to the ecliptic is found to be everywhere the same, through the entire time of its appearance, doubters will be persuaded without difficulty, provided they understand the doctrine of the circles of the Sphere, that the arc of the comet, which it described by its own motion, is a portion of the great circle in the Sphere, no less than is the ecliptic, with respect to which [ecliptic] it [the comet] everywhere retained the same quantity of angle, and it had its own poles, being equally distant from them, just as the ecliptic is from its [poles]; for the same reason even the equator with the ecliptic has a mutual relation insofar as their poles are concerned, and given that they themselves intersect, and by reason of its proper pole, however, each describes a great circle in the Sphere.

Second, what we affirmed, that the motion of the comet under this great circle itself, was not irregular, that is, sometimes faster, then again, slower, or abruptly altering itself, as is also quite clear. For when from different portions of the arcs of the circle HA, it is established how much the comet completes under that circle of its own, for in a certain number of days; and earlier it was shown that around the 8th day of November, when it first appeared to us, it completed nearly four degrees in diurnal motion under this circle, a little later, close to the 15th day, it [completed] nearly 3½, near the 20th day, at least triple, nearly 24, almost two parts, in the last days of November indeed, it was moved one and a half times as many degrees; likewise it is established that in the first days of December, the same motion was of one part and a quarter, around the 10th day it was almost one degree, around day 15, it was nearly 40 minutes, and around the last days of December, it was half a degree, then around the 5th day of January, the motion was about five minutes slower, to such an extent that at the last point where it was seen, the diurnal course appeared scarcely of the fourth part of one

degree. Thus it is evident how it restrained its motion regularly and successively, not by a sudden slowing in velocity, nor skipping from this into that [speed]; and, just as from the beginning, when it was faster with respect to its motion, it admitted a sensible variation of greater alteration, so at the end, when it began to be slower, it transformed the difference of its diurnal motion, not suddenly, to the extent that its own motion was seen to be as if brought to rest; not otherwise than one can observe [in the case of] the five wandering stars when they fall to apparent rest from a faster course through their circles.

Third, one thing is also sufficiently inferred, that the characteristic diurnal motion of the comet in its path was always slower than even the slowest diurnal course of the Moon. For at the outset, when it first appeared to me, it was not completing four whole degrees in its own diurnal advance, and although it was seen earlier by certain [people], namely on the tenth day of November, or even one or two days before (which was difficult on account of the nearness of the Sun), however, even [at its most] rapid, it was not able to complete much beyond five or six degrees in its diurnal passage, having kept the kind of proportion of successive motion that it regularly maintained. However, on the other days, far from exceeding this diurnal motion, it rather successively diminished it, until eventually at its final end it was seen to complete no more than a fourth part of one degree per 24 hours, whence it always maintained its own progression slower than that of the Moon, and on account of this, the harmony of the celestial circles and of their motions require that it was far further from us than is the orb of the Moon.

Finally, however, what we said: that the beginning and end of the comet in its course was from one tropical circle to the other, and also it was possible to infer [this] easily from the previous [discussions]. For if it appeared to us three or four or five days before, then it actually arose, as is likely, near the ecliptic in the place of intersection of its circle with the path of the solar [circle] [where] it first began, not far from the stormy tropic around the bounds of the great ecliptic declination, and, on account of it, near the tropic circle itself. Then, in the last time of its appearance, on the 26th day of January of the following year, since it was again observed near the *Scheat* of Pegasus, it was very near to the limits of the greatest declination that the ecliptic permits, and on account of it, near the summer tropic. Add, with this agreed, both by the rule of the ecliptic and that of its proper path, that it appears to have completed a quadrant of a great circle in the Sphere, which does not a little to persuade us that this comet possessed a heavenly, not elemental, nature.

Wherefore, since it is sufficiently declared and demonstrated, that this comet described exactly with its own motion a great circle, maintaining itself in a middle place between its poles and never deviated from it this way or that, in the whole period of its duration. Moreover, under this circle, it maintained an orderly and not unstable motion, but successively and progressively slowing itself, just as customarily happens in the case of planets; and it exhibited this motion itself, never faster than the slowest diurnal motion of the Moon, but on the contrary, far slower; and finally, the places of the beginning and end of its motion were placed within each of the tropics, near the limits of solar digression, and it covered by this calculation ¼ of the Sphere. For that reason, with the confluence of so many arguments and indications taken from the path itself of the comet, which it observed for the whole time of its duration, it becomes clear that it maintained its motion in conformity with the aethereal region. And it is sufficiently and evidently proven that its place and course were in the immense largeness of the celestial world and that it had its place not at all in the sublunary and elemental orb. This we proposed to demonstrate first in this more general way.

Original Text

pp. 106-8

Ex distantiis cometae a quibusdam fixis sideribus eius viae vicinis, sub diversa altitudine habitis, hunc minime Elementarem fuisse particularius exactiusque demonstrare. Comprobatio secunda.

Etsi neminem rem ipsam penitius intelligentem, veritatisque sine praejudicio amantem, ire posse inficias arbitror, satis convenienter per antecedentia comprobatum esse, cometam hunc in coelesti mundi regione, inter regularia Aetheris ipsius sidera effulsisse, cum minime possibile sit, aliquod sublunare et Elementare corpus, tam directum, ordinarium, regularem et constantem ductum, suo motu, tanto temporis intervallo, describere, qualem hunc cometam perpetuo observasse, in antecedentibus demonstravimus: tamen ulterioris certitudinis indagandae gratia, si forte aliquibus paulo generalior videri possit haec praemissa persuadendi ratio, idipsum specialius et exactius ratum faciemus ex observatis quibusdam cometae, idque per aliquod temporis intervallum interea praeterlapsum, a nonnullis fixis sideribus distantiis, praesertim ipsius viae vicinis. Nam quotiescunque per serenitatis

oportunitatem haec scrutari licuit, cometae ab aliqua tali affixa stella distantiam, cum altior esset, minoremque ingerere possit parallaxin, indagavi, eandem interjectis aliquot Horis, cum declivior fieret, accurate repetii, sed nusquam inveni aliam differentiam harum intercapedinum, quam qualem ipse motus diurnus cometae proprius fere insinuare posset, et idipsum aliquoties magna diligentia exploravi. Inprimis vero die XXIII Novembris, quo vesperi admodum pura et diuturna, usque in occasum cometae, extitit serenitas, et ipse adhuc admodum magnus apparenter satis conspiciebatur, erantque instrumenta et omnia necessaria apprime correcta, et ad observationem exactam idoneae collocata. Tunc itaque ex duabus distantiis ad Os Pegasi factis rem omnem se ita habere evidenter deprehendi. Nam Hora 5 cum semisse, ipsius ab Ore Pegasi distantiam inveni, P21 M8, et dehinc H8 M35, interlapsis paulo plus tribus Horis, eandem comperi, P20 M56, duodecim videlicet Minutis minorem, quibus interea propior factus est cometa ipsi stellae in Ore Pegasi. At motus diurnus in suo circulo versus dictam stellam, ut ex praecedentis diei XXI et sequentis XXV observationibus colligi potest, et in superioribus satis declaratum est, fuit Partium exquisite duarum, ita intervallo temporis utrique observationi interjecti, competunt, iuxta proportionem motus diurni, Scrupula quindecim, ut tribus illis Horis, quibus cometa plurimum altitudinem versus horizontem inclinabat, saltem ternis Scrupulis primis pene insensibilibus, cursum suum ratione parallaxeos retardasse, habito respectu motus diurni, deprehendatur; cum tamen si vel in ipsa sphaera Lunae extitisset, multo plus motum suum per parallaxin inhibuisset, nedum si longe infra hanc in superioir Aeris regione (ut volunt Peripatetici) extitisset.

Idem eadem vespera, ex binis distantiis ad stellam in manu sinistra Antinoi factis, quae admodum vicina erat viae cometae, comprobare licuit. Nam Hora quinta cum ¾ distabat ab illa stella, P4 M38. Et deinde Hora 6 cum ½ interjectis tribus quartis unius Horae, eadem remotio inventa est, P4 M40, duobus Scrupulis maior, cum motus diurnus requirat, ut ternis quasi Scrupulis, cursum interea et distantiam variet; ut sit differentia unius saltem Minuti plane insensibilis, cum tamen maior longe fieret, si sensibilem aliquam parallaxin sub Lunae orbe, huic cometae attribuere liceret.

Verum ut evidentius demonstretur, quantum varietatem ab observatione, parallaxis cometae induxisset, si vel in infima convexitate orbis Lunaris extitisset, nedum si adhuc nobis proximiori loco collocaretur, paulo altius rem ipsam indagare, et sub accuratius examen revocare conabimur, idque praesertim in iis distantiis, quas ea vespera ad Os Pegasi diligenter

habuimus, eo quod illis plus temporis interjectum sit, et intermediae ad eandem habitae, satis exacte correspondeant.

At cum nec simpliciter, nec una figuratione, res haec demonstrari, et in apertum per numeros deduci possit; opus enim est primum cognitione alititudinis cometae, quam habuit in utriusque temporis observatione, siquidem illa tunc per instrumenta non est deprehensa; et deinde scire operaeprecium erit, qualem parallaxin in circulo altitudinis exhibuisset in utraque altitudine, si proxime infra orbem Lunae effulsisset; oportet insuper has parallaxes in longum et latum respectu ipsius circuli cometae discernere, ubi angulus quem facit utrobique cometae via, cum circulo verticali prior indagandus venit; tandem necessarium erit, locum Oris Pegasi, respectu viae cometae, quo ad longitudinem et latitudinem, cognitum constituere, ut demum ultimo ex his datis, et quibusdam prius notis, distantiae ipsius ab Ore Pegasi differentia, quam interlapsum tempus praeberet, si in convexitate orbis Lunaris extitisset, concludi demonstrarique evidentius possit, ut quantum observatio ipsa cum hac distantia concordet discrepetve cognoscatur, et utrum altior decliviorve cometae locus, respectu diametri mundi, constitudendus sit, liquido colligi et comprobari queat; idcirco ea, quae ad haec, eo ordine quo commemorata sunt, requiruntur, suis quaeque delineationibus (ne si multa in uno schemate demonstrarentur, confusio queadam rem potius obscurans, quam illustrans induceretur) ob oculos ponamus, et declarata demonstrataque, in numeros, per triangulorum leges, reducemus, ut ad scopum nobis propositum, per has vias intermedias, certa expeditaque methodo pertingere liceat.

Translation

pp. 106-8

Second proof, to show more specifically and more precisely from the distances of the comet from certain fixed stars near to its path, occuring at different altitudes, that it was not at all elemental.

Though I think that no one more deeply understanding the matter and loving the truth without prejudice can deny that it is quite adequately proved that this comet shone forth in the region of the celestial world among the regular stars of that firmament, since it is hardly possible for any sublunar and elemental body to describe such a straight, orderly, regular and constant

path for so great an interval of time as we have shown above that this comet constantly adhered to: nevertheless, in order to obtain further certainty in case perhaps the above means of persuasion might seem to some to be rather general, we shall render that very matter more specifically and precisely confirmed from certain things observed of the comet, and [shall do] that from [its] distances from several fixed stars, especially [ones] near to its path, through the considerable interval of time elapsed in the meanwhile. For as often as clear weather allowed these things to be examined, I have found the distance of the comet from one such fixed star when it was higher and could produce less parallax, [and] I have accurately sought the same again a few hours later when it became lower, but I have never found any other difference in these intervals than that of the kind which the comet's own diurnal motion could fully introduce, and I have investigated this matter several times with great diligence: in the first place, indeed, on the 23rd day of November, on which evening the fair weather was quite clear all day long until the setting of the comet, and it was still well perceived as large in appearance, and the instruments and everything necessary were all in order and properly set up for precise observation. So then from two distances that it held to the Mouth of Pegasus I found out that the whole business was evidently as follows: for at 5½ hours I found its distance from the Mouth of Pegasus to be 21 degrees 8 minutes, and afterwards at 8 hours 35 minutes, with a little more than three hours having elapsed, I found the same at 20 degrees 56 minutes, that is, less by twelve minutes, by which, meanwhile, the comet had become nearer to the Mouth of Pegasus. But the diurnal motion in its circle towards the said star, as can be gathered from the preceding observations of the 21st day and the following ones of the 25th and as has been declared sufficiently above, was of exactly two degrees. Thus 15 minutes occur in the interval of time between each observation according to the extent of the diurnal motion, so that in those three hours in which the comet most of all inclined its altitude toward the horizon, it is found that by reason of parallax its course was retarded with respect to the diurnal motion by almost three undetectable minutes. Since, however, should it have been in the lunar sphere itself, it would have held back its motion much more by parallax, or still more if it were far below this in the upper region of the Air (as the Peripatetics wish).

There was an opportunity to prove the same on the same evening from two distances to the star in the left hand of Antinous, which was very close to the path of the comet. For at the fifth and three quarters of an hour it was at a distance from that star of 4 degrees 38 minutes. And then at the sixth hour and a half, with three quarters of an hour having passed, the same separation was found, 4 degrees 40 minutes, greater by two minutes, while the diurnal motion

requires that it vary in the meantime the course and the distance by almost three minutes: as the difference of as much as one minute is clearly imperceptible, however, it would be much greater if it were possible to assign some perceptible parallax under the orb of the Moon to this comet.

Indeed, in order to demonstrate more clearly how much difference from the observation the parallax of the comet would have produced if either it had existed in the lowest convexity of the lunar orb, or, still more, had it been situated at a place closer to us, I will try to look into the matter itself more deeply and submit it more accurately to scrutiny, and this especially in the case of those distances that we had established diligently on that evening with respect to the Mouth of Pegasus, because more time passed between them, and those that occurred in between should correspond precisely to the same.

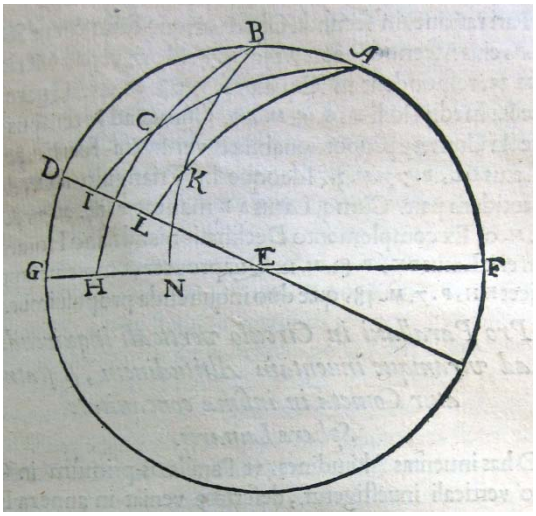
But since this matter could be demonstrated and brought into the open through numbers neither simply nor with a single diagram, it is necessary first to know the altitude that the comet had at each time of observation, if indeed that was then not discerned through instruments; and then it will be necessary to know how much parallax it would have exhibited in the circle of the altitude at each altitude, if it had shone closely under the orb of the Moon; moreover, it is necessary to distinguish these parallaxes in longitude and latitude with respect to the circle of the comet, where the angle which the path of the comet makes on each side with the vertical circle is the first thing to be sought out. Finally, it will be necessary to establish as known the place of the Mouth of Pegasus. [All these are needed] in order that, last of all, from these given things and certain things indicated earlier, the difference of its distances from the Mouth of Pegasus that the passage of time would have brought about had it been in the convexity of the lunar orb can be quite clearly established and demonstrated; so that the extent to which that observation agrees or disagrees with this distance may be known; and so that it may be plainly gathered and proved whether the place of the comet is to be determined as higher or lower with respect to the diameter of the World. Accordingly, let us place before the eyes, each with its own delineation (lest if many things should be demonstrated in a single diagram, a certain confusion obscuring rather than illuminating the matter should be brought about), the things that are required for these [purposes], in the order in which they have been mentioned, and let us reduce the things declared and demonstrated to numbers, by means of the laws of triangles, to make it possible to reach the goal proposed by us in a certain and expeditious way by those intermediate steps.

Original Text

pp. 108-10

Pro inquistione altitudinis cometae, ad utraque tempora observationis distantiae ab Ore Pegasi.

Prima observatio fuit (ut dixi) Hora 5 M30. Altera, Hora 8 M35. Quapropter in adjunctae figurae delineatione, ubi GDBAF intelligitur esse vice meridiani, et DILE aequatoris, cuius polus sit in A, et GEF horizon, polus eius B. Sit autem locus cometae in prima observatione in C, in altera vero in K; ducantur a polo aequatoris per haec duo loca, in ipsum aequatorem bini quadrantes ACI et AKL. Quapropter in primo tempore, cum locus Solis ex nostra restitutione sit in P11 M28 [Sagittarius], et eius ascensio recta, P249 M55, tempus vero post meridiem elapsum addat G82 M30 erit ascensio recta medii coeli D, G332 M25. Cumque ascensio recta cometae ad locum primae observationis, ex superioribus suo capite petita fuerit, P301 M5 in I, sublato hoc ab ascensione recta medii coeli erit DI, P31 M20. Quapropter in triangulo BAC, angulus ad A, quem DI metitur, erit totidem Partium, latus AB, est complementum elevationis poli, P34 M7, latus vero CA, est complementum declinationis, etiam superius in suo capite petitae, P89 M10. Quare per triangulorum placita erit BC, P60 M35½ et ob id HC complementum, ipsa videlicet altitudo quaesita, P29 M24½.



Pari ratione, in secunda observatione datur locus Solis, P11 M36 [Sagittarius], eius ascensio recta P250 M4 Horis vero a meridie elapsis 8 M35, respondent in aequatore, P128 M45. Quare ascensio recta medii coeli D, G18 M49. Cumque ad id tempus ascensio recta cometae

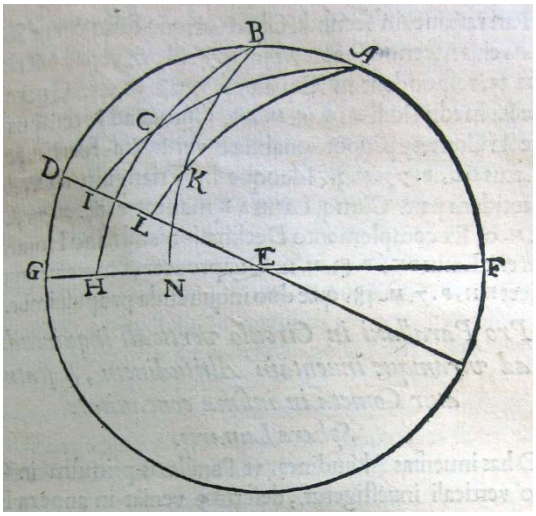
proportionabiliter verificata, fuerit P301 M18, erit latus DL, P77 M31. Ideoque in triangulo BAK, angulus BAK totidem Part. Cumque latus AB maneat P34 M7, et AK sit P89 M0, ex complemento declinationis ad hanc horam verificatae, erit latus BK, P82 M12. Quapropter complementum eius, videlicet KN, P7 M48, quae duo inquirenda proposuimus.

Translation

pp. 108-10

For the investigation of the altitude of the comet, at both times of observation of the distance from the Mouth of Pegasus.

The first observation was (as I have said) at 5 hours, 30 minutes. The second at 8 hours, 35 minutes. Wherefore in the delineation of the adjoined figure, where GDBAF is understood to stand for the meridian, and DILE for the [celestial] equator, the pole of which is in A, and GEF the horizon, the pole of it B. Let also the place of the comet in the first observation be in C, in the second [observation] however in K, and let a pair of quadrants ACI and AKL be drawn from the pole of the equator through these two places to the equator itself. Wherefore, at the first time, since the place of the Sun according to our reconstruction is at 11 degrees 28 minutes in Sagittarius, and its right ascension at 249 degrees 55 minutes, [and since] however the time elapsed after meridian adds 82 degrees 30 minutes, the right ascension of mid-heaven D will be 332 degrees 25 minutes. And since the right ascension of the comet at the place of the first observation has been derived above in the relevant chapter, [and is] 301 degrees 5 minutes at I, taking this away from the right ascension of the mid-heaven, DI will be 31 degrees 20 minutes. Wherefore in triangle BAC, the angle at A, which DI measures, will be of the same number of degrees; the side AB is the complement of the elevation of the pole, 34 degrees 7 minutes; the side CA, however, is the complement of the declination, also to be found above in the relevant chapter, 89 degrees 10 minutes. Hence, through the laws of triangles, BC will be 60 degrees 35½ minutes, and on account of that the complement HC, that is to say the very altitude sought, 29 degrees 24½ minutes.



By the same reasoning, in the second observation the place of the Sun is given as 11 degrees 36 minutes of Sagittarius, the right ascension thereof 250 degrees 4 minutes. To the 8 hours 35 minutes elapsed from midday, however, [there] correspond in the equator 128 degrees 45 minutes. Hence the right ascension of the mid-heaven D [will be] 18 degrees 49 minutes. And since at that time the right ascension of the comet proportionably verified will have been 301 degrees 18 minutes, the side DL will be 77 degrees 31 minutes. And therefore, in the triangle BAK, the angle BAK [will be] of the same number of parts [as DL]. And since the side AB remains as 34 degrees 7 minutes; and AK will be 89 degrees 0 minutes, from the complement of the declination verified at this hour; the side BK will be 82 degrees 12 minutes. Wherefore the complement of this, that is KN, [will be] 7 degrees 48 minutes. These are the two things we proposed to discover.

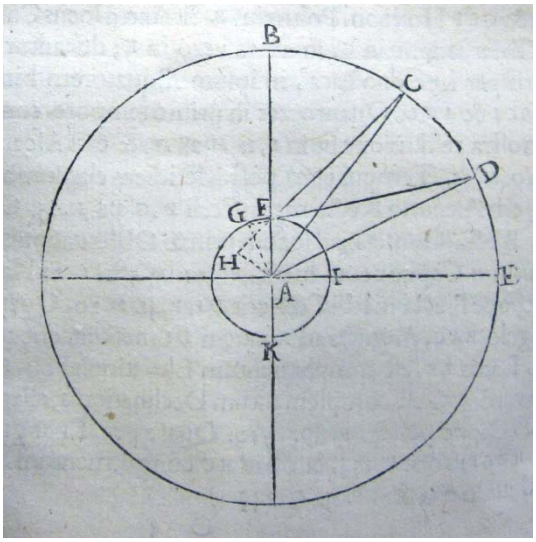
Original Text

pp. 110-12

Pro parallaxi in circulo verticali inquirenda ad utramque inventam altitudinem, si statuatur cometa in infima concavitate sphaerae Lunaris.

Ad has inventas altitudines, ut parallaxis primum in circulo verticali investigetur, descriptus veniat in annexa figura quadrans circuli altitudinis BCDE, proxime infra concavitatem orbis Lunae, supremam omnium Elementorum, cuius centrum sit A, circa quod etiam designatur circumferentia Terrae FIK, ducanturque ad F superficiem Terrae, et A centrum, ex C et D

lineae rectae. Manifestum est, quod angulus ad C, priorem parallaxin in circulo altitudinis, ad D, posteriorem determinet, qui duo ut inquirantur, producatur primum CF, donec ex A ipsi perpendicularis occurrat in H. Quapropter in triangulo FAH, cum angulus AFH, sit aequalis angulo CFB, complemento altitudinis prioris, utpote ipsi contrapositus, P60 M35½, et latus FA, semidiameter Terrae statuatur Partium 100000 (ut maioribus numeris negotium exquisitius absolvi possit) erit latus AH, Part. 87114. Deinde in triangulo etiam rectangulo per constructionem HAC, cum AC repraesentet distantiam infimae concavitatis orbis Lunae a centro Terrae, quam iuxta Copernici inventa statuimus semidiametrorum Terrestrium proxime quinquaginta duorum (cui etiam Lunares parallaxes saepenumero a nobis in trutinam ex observationibus certis vocatae, testimonium praebent; et si Ptolomaei aliorumque ipsum sequentium placitis fidendum esset, longe adhuc propior fieret convexitas orbis Lunae, utpote 33 saltem semidiametris remota, et ob id, idipsum quod circa parallaxin cometae demonstrare intendimus, longe maiorem differentiam ingereret, et in maius absurdum res ipsa devolveretur) erit itaque latus CA, respectu ipsius AF semidiametri Terrae, in maioribus numeris assumtae 5200000, et dabitur ob id angulus HCA, P0 M57 S36, parallaxin in circulo altitudinis, primae observationis, repraesentans.



Deinde ad alteram altitudinem in D, ducatur etiam DF, donec ex A ipsi occurrat perpendicularis in G, erit primum in triangulo GFA rectangulo, angulus AFG, complementum altitudinis secundo inventae, utpote aequalis BFD, latus vero FA semidiameter Terrae assumitur ut prius, P100000. Quare latus AG, P99075; dehinc in triangulo GAD, ex cognito GA, et DA ut prius, Part. 5200000, angulo ad G, per constructionem existente recto, dabitur

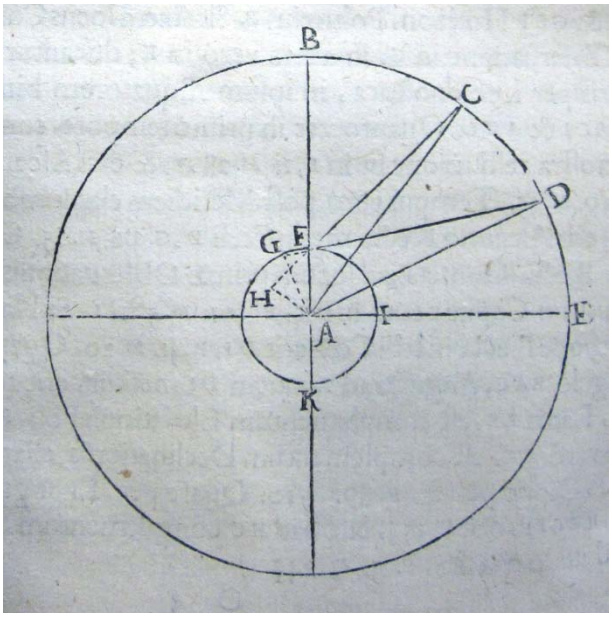
angulus GDA, P1 M5½. Qui parallaxin posterioris altitudinis nobis suppeditabit. Quare utraque parallaxis altitudinis, ad utrumque tempus, prout proposuimus, rite inventa est.

Translation

pp. 110-12

For seeking the parallax in the vertical circle at each of the found altitudes, if the comet were placed in the lowest concavity of the lunar sphere.

So that parallax may be established first in the vertical circle at these found altitudes, let the quarter of the altitudinal circle BCDE be described in the annexed figure, [the quarter circle BCDE being] just below the concavity of the lunar orb, the highest of the elemental [orbs], whose centre is at A, around which now is defined the circumference of the Earth FIK, and two straight lines are led to F, the surface of the Earth, and to A, its centre, from C and D. It is clear that the angle at C determines the first parallax in the altitudinal circle and [the angle] at D the second, which two, that they be sought, let first CF be extended until the perpendicular from A itself intersects at H. Wherefore, in triangle FAH, since angle AFH, 60 degrees 35½ minutes, is equal to angle CFB, the complement of the first altitude, in as much as it is opposite to it, and side FA, the radius of the Earth, is set at 100,000 parts (so that the task can be completed with greater numbers more precisely), the side AH will be of 87,114 parts. Then in the triangle, which is also a right triangle through the construction of HAC, since AC represents the distance of the lowest concavity of the lunar orb to the centre of the Earth, which according to the devices of Copernicus, we set at approximately 52 terrestrial radii (with respect to which also lunar parallaxes, having by us oftentimes carefully judged from certain observations, give witness; and if trust ought to be put in the teachings of Ptolemy and others following him, the convexity of the lunar orb would be very much nearer to here, seeing that [it would be] removed by at least 33 radii, and on account of this, the very same thing that we intend to demonstrate about the parallax of the comet in order to force out a far greater difference, and the thing itself will disintegrate into greater absurdity) therefore side CA will be 520,000, with respect to the radius of the Earth itself AF converted into greater numbers, and on that account, the angle HCA will be given as 0 degrees 57 minutes 36 seconds, representing the parallax in the altitudinal circle of the first observation.



Then let DF be drawn to the other altitude at D, until from A itself it meets at right angles at G. First, in the right-angled triangle GFA, the angle AFG, complement of the altitude found in the second instance, will be, as expected, equal to BFD. The side FA, indeed, the radius of the Earth, is taken as before to be 100,000 parts**.** So the side AG is 99,075 parts. So in triangle GAD, from GA and DA being known as above to be 5,200,000 parts, with the angle at G being right by construction, the angle GDA will be given as 1 degree 5½ minutes. This will provide us with that parallax of the latter altitude. From this the parallax at both the altitudes at the two times is correctly found.

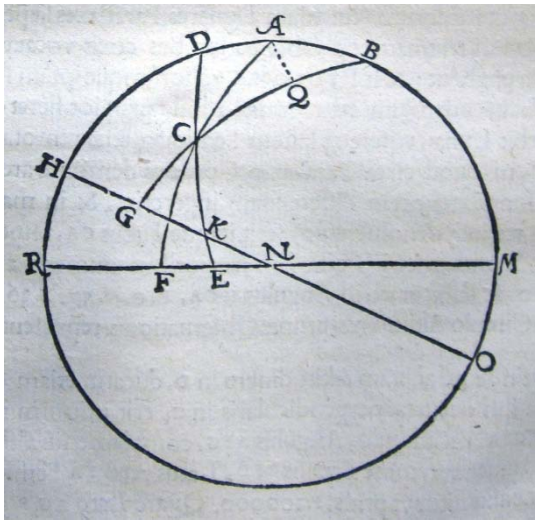
Original Text

pp. 112-15

Pro distinctione parallaxium inventarum in longum et latum, respectu circuli cometae; et primo, de inquisitione anguli, quem facit circulus verticalis, cum via cometae, ad utraque tempora observationis.

Sit in assignata figurae delineatione circulus meridianus BADHR, aequator HNO, cuius polus sit B, horizon vero RNM, cuius polus sit A, locus etiam cometae sit in C, portio autem arcus, quem suo motu proprio descripsit, sit EKCD, descendant vero a polo aequatoris et horizontis, per locum cometae, quadrantes ACF & BCG; erit itaque angulus ACD inclinationis circuli

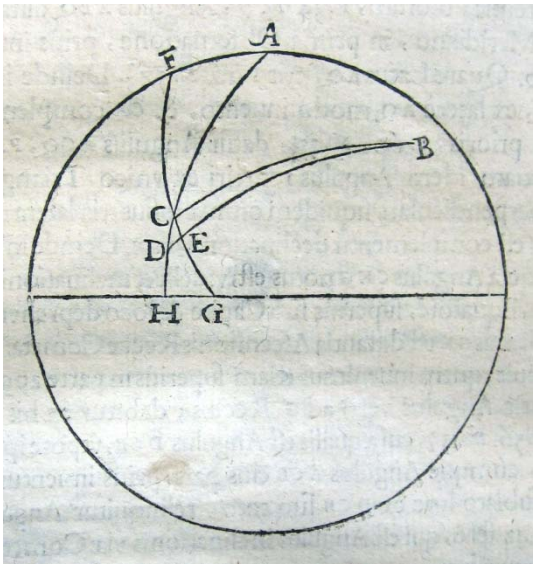
verticalis, quem ad ambo tempora inquirere decrevimus. Quapropter primum in triangulo ABQ, ducta videlicet perpendiculari AQ, erit latus AB, differentia polorum, P34 M7, angulus ABQ distantiae cometae a meridiano, in prima observatione, prius inventus est P31 M20.



Quare latus AQ, erit P16 M57⅗. Deinde in trigono CAQ, ex latere AQ modo invento, et CA complemento altitudinis prioris, P60 M35½, datur angulus ACQ, P19 M34. Poterit etiam idem angulus reperiri ex unico triangulo CAB, absque perpendiculari, siquidem omnia ipsius tria latera nota sunt; nam CB est complementum declinationis datae. Deinde in triangulo CGK, quia angulus CKG notus est, videlicet inclinationis viae cometae ad aequatorem, superius suo capite et loco deprehensus, P33 M45, et latus GK est distantia ascensionis rectae cometae a loco intersectionis, quem invenimus etiam superius in Parte 299 Min. 50 aequatoris, angulus vero ad G rectus; dabitur ex his angulus GCK, P56 M15½, cui aequalis est angulus DCB, utpote ipsi contrapositus, cumque angulus ACB eius pars, prius inventus sit P19 M34, sublato hoc ex DCB suo toto, relinquitur angulus DCA, P36 M42 fere, qui est angulus inclinationis viae cometae ad verticalem quaesitus.

Nec alia ratione ad posteriorem altitudinem observatam, dabitur primum AB, P34 M7, angulus ABG, P77 M31, latus itaque AQ, P33 M12¼. Et deinde in trigono CAQ, erit latus AC, P82 M12, angulus vero ob id ACQ, P33 M33⅓, qualis etiam alia via praedicta reperitur ACB angulus. Deinde in trigono CGK, angulus CKG ut prius, P33 M45, latus GK nunc P1 M28, angulus itaque GCK reperitur P56 M15¾, cui aequalis est DCB. Ab illo itaque si auferatur ACB prius repertus, relinquitur DCA, angulus inclinationis circuli cometae ad verticalem, posteriori observationi congruens, P22 M42½, qui quaerebatur.

Strata itaque nunc est via, ad inquirendum id, quod hoc loco principaliter proposuimus, videlicet utriusque parallexeos discretionem in longum et latum, respectu viae cometae. Sit enim in apposita figura, FEG portio circuli cometae, cuius polus sit in B, et ACH sit quadrans circuli verticalis; sitque in eo locus cometae visus, D. Manifestum est, quod in triangulo CED, latus CE, sit parallaxis longitudinis, DE latitudinis, respectu viae cometae, quae duo inquiruntur hoc modo: quia angulus DCE ad primam observationem inventus est, P36 M41$^{2}/_{3}$, est enim aequalis FCA inclinationis viae cometae ad verticalem circulum modo invento, latus vero DC, parallaxis altitudinis primae, fuit P0 M57 S36, dabitur latus DE, P0 M34 S25, parallaxis latitudinis, et CE, P0 M46 S42, parallaxis longitudinis, utraque primae observationi inservientia.



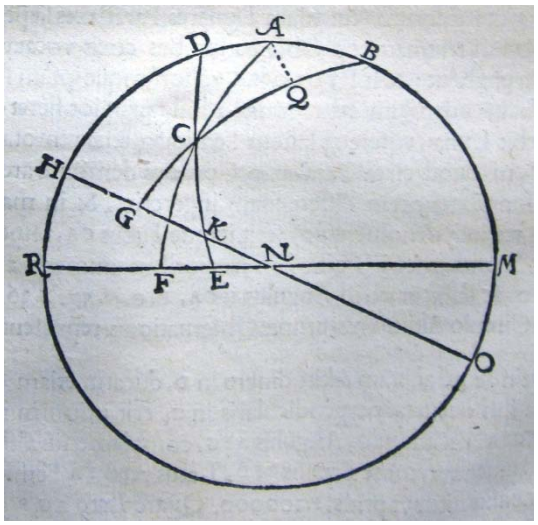
Ad posteriorem vero datur primum, ex praemissis, angulus inclinationis viae cometae ad circulum verticalem DCE, P22 M42½. Cumque parallaxis in circulo verticali tunc extiterit, P1 M5½, erit latus DE, P0 M25 S17, parallaxis latitudinis, et latus CE parallaxis longitudinis, P1 M0 S14. Quapropter cum longitudo cometae vera a puncto intersectionis praesupponatur ex antecedentibus, fuisse ad primam observationem H 5½ factam, P46 M30, subtracta parallaxi longitudinis ad hoc tempus modo inventa, provenit longitudo visa in Parte 45 M43 S18, latitudine existente versus Austrum, ex parallaxi latitudinis, P0 M34 S25. Sic ad secundam observationem, siquidem cometa interea motu proprio in suo circulo exquisite 15 Minuta absolvit, habita ratione cursus diurni, qui est Partium omnino duarum, provenit longitudo vera, P46 M45, et subtracta parallaxi visa, longitudo P45 M44 S46, latitudo vero visa existit, ex sua parallaxi prius inventa, P0 M25 S17, quod quaerebatur.

Translation

pp. 112-15

On the difference in length and breadth of parallaxes found with respect to the circle of the comet, and first on the investigation of the angle which the vertical circle makes with the path of the comet, with respect to both times of observation.

In the lines [*delineatione*] marked out in the figure, let the meridian circle be BADHR, the [celestial] equator HNO, whose pole is B, the horizon RNM, whose pole is A, while the place of the comet is at C, but the part of the arc which it describes with its own motion is EKCD. Let the quarter circles ACF and BCG descend from the pole of the equator and [that] of the horizon, through the position of the comet. Therefore ACD will be the angle of the inclination of the vertical circle, which we decided to investigate for both times. So, firstly in triangle ABQ, with AQ the perpendicular having been drawn, side AB will be the difference of the poles, 34 degrees 7 minutes. ABQ, the angle of the distance of the comet from the meridian in the first observation, was found before to be 31 degrees 20 minutes. Thus side

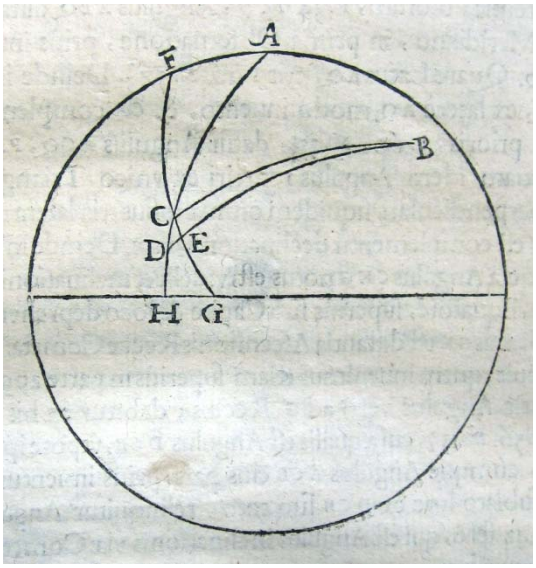


AQ will be 16 degrees 57⅗ minutes. Then, in the triangle CAQ, from the side AQ just found, and CA, the complement of the altitude of the first observation, 60 degrees 35½ minutes, angle ACQ is given as 19 degrees 34 minutes. For the angle could have been found to be the same from the one triangle CAB, without the perpendicular, if indeed all its three sides are known; for CB is the complement of the declination given. Then in triangle CGK, because angle CKG was known, namely [that] of the inclination of the path of the comet to the

equator, having been discerned in its chapter and place above, 33 degrees 45 minutes, and side GK is the distance of the right ascension of the comet from the place of intersection, which we have also found above, 299 degrees 50 minutes of the equator, while the angle with respect to G is a right angle; from these, angle GCK will be given as 56 degrees 15½ minutes, to which angle DCB is equal, seeing as it is opposite it, and since angle ACB, a part of it, was found before to be approximately 19 degrees 34 minutes, having subtracted this from DCB in its totality, angle DCA remains almost 36 degrees 42 minutes, which is the angle of the inclination of the path of the comet to the vertical [which was] sought.

In the same way, with respect to the latter observed altitude, first AB will be given as 34 degrees 7 minutes, angle ABG as 77 degrees 31 minutes, therefore its side AQ as 33 degrees 12¼ minutes. And then in the triangle CAQ, side AC will be 82 degrees 12 minutes, while ACQ, on that account 33 degrees 33⅓ minutes, of which amount angle ACB is also found by the other method mentioned above. Then in triangle CGK, angle CKG, as before, is 33 degrees 45 minutes, side GK then is 1 degree 28 minutes, therefore angle GCK is found to be 56 degrees 15¾ minutes, to which DCB is equal. From that, therefore, if ACB found before were taken away, DCA, the angle of inclination of the circle of the comet to the vertical corresponding to the latter observation, will remain as 22 degrees 42½ minutes, which is what was sought.

Therefore, the path is now open for inquiring into that which we proposed first in this section, namely the separation of each parallax in length and width, with respect to the path of the comet. For in the figure below let FEG be the portion of the circle of the comet, whose pole is at B, and ACH is the quarter of the vertical circle; and in it let the observed place of the comet be at D. It is clear that in triangle CED, side CE is the longitudinal parallax, DE the latitudinal [parallax], with respect to the path of the comet, which two are sought in this way: because angle DCE, to the first observation was found [to be] 36 degrees 41⅔ minutes, for it is equal to FCA, the [angle] of inclination of the path of the comet to the vertical circle just found, indeed side DC, the altitudinal parallax of the first [observation] was 0 degrees 57 minutes 36 seconds, side DE will be given as 0 degrees 34 minutes 25 seconds, the latitudinal parallax, both pertaining to the first observation.



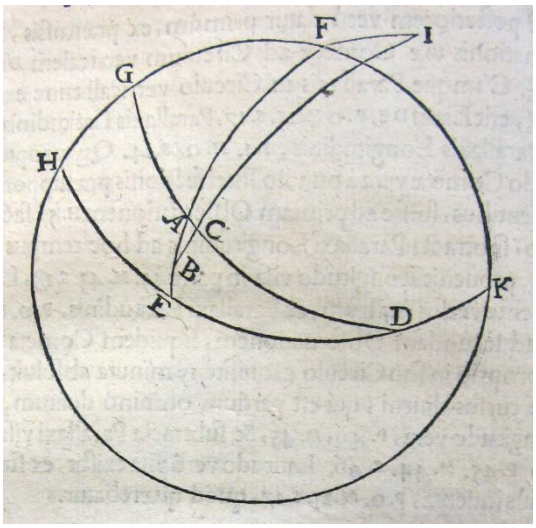
Indeed to the latter [observation] is given first, from those things said above, the angle of the inclined path of the comet to the vertical circle DCE, as 22 degrees 42½ minutes. And should the parallax in the vertical circle then be 1 degree 5½ minutes, the side DE would be 0 degrees 25 minutes 17 seconds, the latitudinal parallax, and side CE, the longitudinal parallax [would be] 1 degree 0 minutes 14 seconds. Wherefore, when the true longitude of the comet from the point of intersection is assumed from the above to have been at the first observation made at 5½ hours 46 degrees 30 minutes, having subtracted the longitudinal parallax found at this time, the observed longitude comes to 45 degrees 43 minutes 18 seconds, with the latitude being towards the south, from the latitudinal parallax of 0 degrees 34 minutes 25 seconds. Thus, at the second observation, since the comet in the meantime by its own motion completed exactly 15 minutes in its circle, taking into account its diurnal course, which is of two complete degrees, the true longitude comes to 46 degrees 45 minutes, and with the observed parallax having been subtracted, the longitude [is] 45 degrees 44 minutes 46 seconds, and the observed latitude is, from its parallax found before, 0 degrees 25 minutes 17 seconds, which is what was sought.

Original Text

pp. 115-16

Pro inquirendo situ stellae in Ore Pegasi, respectu viae cometae, in longum et latum ab intersectione eius cum ecliptica.

Nunc priusquam horum, quae modo invenimus, usus erit, inquiremus situm stellae in Ore Pegasi, quo ad viam cometae. Praesupponatur itaque in assignata figuratione HEDK portio eclipticae, cuius polus sit in F, GAD vero sit arcus circuli cometae, cuius polus sit in I, locus intersectionis utriusque sit in D, locus vero Oris Pegasi sit B. Quapropter primum in triangulo DAE, quia constat latus DE, distantia videlicet longitudinis Oris Pegasi a loco intersectionis D, superius invento, P65 M13, angulus vero ADE inclinationis, etiam superius innotuit, P29 M15, et is qui ad E, sit rectus, dabitur angulus DAE, P78 M11, et latus AE, P26 M57, latus vero AD una innotescet, P68 M3. Deinde in altero triangulo ABC, latus AB constat, si subduxeris EB latitudinem Oris Pegasi ab ecliptica, ab EA modo invento, estque P4 M50, angulus vero BAC iam innotuit; est enim idem cum angulo EAD prius invento, P78 M11. Cumque angulus ad C sit rectus, dabitur latus BC, P4 M44, videlicet differentia seu latitudo stellae in Ore Pegasi, respectu viae cometae, versus polum ipsius Australem, latus insuper AC prouenit, P0 M59, cumque AD prius inventum sit P68 M3, sublato hoc AC ab AD relinquitur CD, distantia loci longitudinis Oris Pegasi, ab intersectione circuli cometae cum ecliptica, secundum longitudinem, P67 M4. Quam longitudinem Oris Pegasi respectu viae cometae appellabimus, latitudine ipsius eodem respectu prius inventa, P4 M44 Austrina, quae duo in hunc modum indaganda proposuimus.

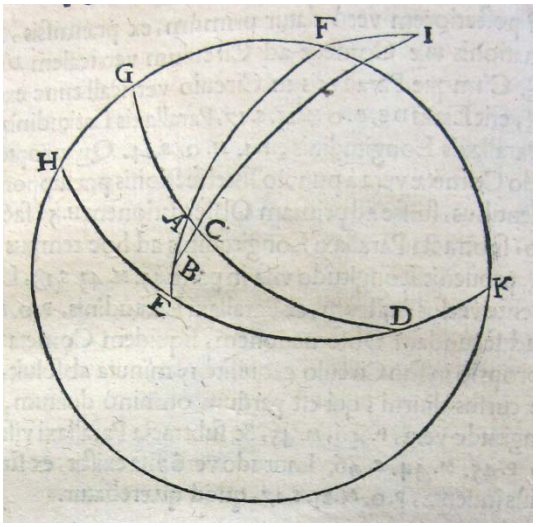


Translation

pp. 115-16

To investigate the site of the star in the Mouth of Pegasus with respect to the path of the comet, in longitude and latitude, from its intersection with the ecliptic.

Now before there will be a need for these things which we have just found, we will investigate the site of the star in the Mouth of Pegasus with respect to the path of the comet. In the assigned figure therefore, let there be presupposed HEDK a portion of the ecliptic, the pole of which will be in F; let GAD indeed be the arc of the circle of the comet, whose pole will be in I; let the place of intersection of the two be in D; let the place of the Mouth of Pegasus, indeed, be in B. Firstly, therefore, in the triangle DAE, because there is known the side DE (the distance that is to say of the longitude of the Mouth of Pegasus from the place of intersection D, found above), namely 65 degrees 13 minutes; the angle of inclination ADE, moreover, was also noted above as 29 degrees 15 minutes; and the one at E is right-angled; [hence] the angle DAE will be given as 78 degrees 11 minutes, the side AE as 26 degrees 57 minutes, [and] the side AD indeed becomes known at the same time as 68 degrees 3 minutes. Then in the second triangle ABC, the side AB is ascertained (if you subtract the latitude EB of the Mouth of Pegasus from the ecliptic from EA just determined) and it is 4 degrees 50 minutes; the angle BAC indeed is already known, for it is the same as the angle EAD found before, namely 78 degrees 11 minutes. And, since the angle at C is right-angled, the side BC (that is to say, the difference or latitude of the star in the Mouth of Pegasus, with respect to the path of the comet, towards its south pole) will be given as 4 degrees 44 minutes; in addition, the side AC turns out to be 0 degrees 59 minutes, and since AD found before is 68 degrees 3 minutes, taking this AC away from AD there remains CD, the distance of the place of the longitude of the Mouth of Pegasus from the intersection of the circle of the comet with the ecliptic with respect to longitude, namely 67 degrees 4 minutes. We will call this the longitude of the Mouth of Pegasus with respect to the path of the comet, the latitude of the same in the same respect having been found before to be 4 degrees 44 minutes south, which two [things] we proposed to be investigated in this way.

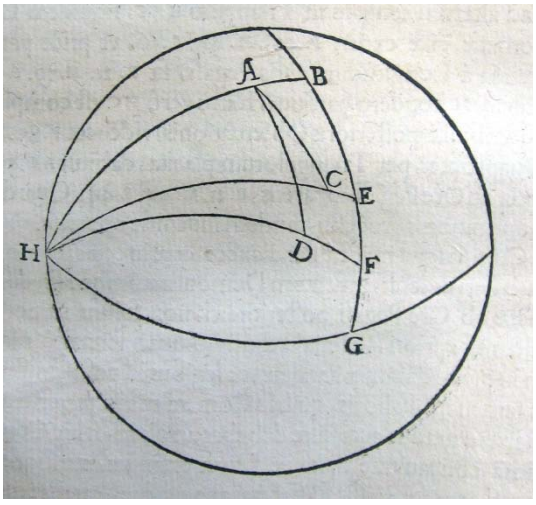


Original Text

pp. 117-23

Pro inquirenda differentia distantiarum cometae ab Ore Pegasi, ad diversas datas horas, ex parallaxeos mutatione proveniente.

Pervenimus nunc successivo ductu tanquam Thesei filo viam pedetentim inter anfractus obvios investigantes, ad ultimum scopum propositum rite attingendum, videlicet, ut utraque distantia ad diversa tempora ab Ore Pegasi cognoscatur, quam parallaxeos ratio in concavitate sphaerae Lunaris ingerere poterat. Sit itaque in assignata figuratione, arcus circuli cometae BEFG, cuius polus Australis sit in H, et intersectio ipsius cum ecliptica sit in G, in quo locus cometae ad primam observationem in F, ad posteriorem in E, quo ad veritatem, sed locus visus ex parallaxi prior praesupponatur in D, posterior in C, locus Oris Pegasi respectu viae cometae sit in A, ducanturque per haec tria loca quadrantes circuli ad viam cometae, prout in figura patet; Cupio scire arcum AD et AC distantias utrasque cometae ab Ore Pegasi, earumque differentias.



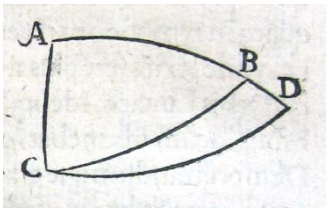
Cum itaque in triangulo HAD, angulus ad H constet, P21 M20 S42 (est enim differentia longitudinis visae cometae, a longitudine Oris Pegasi, respectu viae cometae, cumque longitudo Oris Pegasi sit prius data, P67 M4, et longitudo cometae visa, P45 M43 S18, provenit is, quem diximus, angulus). Cumque latus HD sit complementum latitudinis visae, P89 M25 S35, et AH complementum latitudinis Oris Pegasi, evadit per supputationem triangulorum, latus AD distantiae prioris, P21 M44 S16. Deinde ad alterum tempus in

triangulo HAC, siquidem longitudo cometae visa extitit P45 M44 S46, ut prius patuit, et differentia a longitudine Oris Pegasi, sit P21 M19 S14, erit angulus AHC totidem Partium, latus vero HC est complementum latitudinis visae posterioris observationis, videlicet P89 M34 S43. Quapropter, per triangulorum placita, dabitur AC, posterior distantia ab Ore Pegasi apparens, P21 M44 S44. Quae duo, hoc demonstrationis processu, tandem invenisse oportuit.

Cum itaque ratione parallaxeos, quae in concavitate sphaerae Lunaris fieri poterat, inventum demonstratumque sit, distantiam cometae ab Ore Pegasi posteriorem, non solum minorem, aut aequalem esse priori, sed etiam dimidio quasi Scrupulo maiorem, quam in priori distantia, parallaxeos legibus id postulantibus, interlapsis tamen tribus Horis, quibus cometa motu proprio ad quartam partem Gradus accessisse debebat; ut ob id, si hic cometa sub proxima concavitate sphaerae Lunae extitisset, cursuque suo ad Os Pegasi accedere visus fuisset, tamen ratione parallaxeos, motum illum, intervallo trium Horarum, adeo inhibuisset, ut non solum eandem distantiam utrobique retinuisset, sed etiam in posteriori observatione, quasi dimidio Scrupulo maiorem, cum revera minor esse debebat. Cumque observatio ipsa evidenter reclamitet, et aperte ostendat, non fuisse cometam, per parallaxin, eo intervallo temporis, intantum remoratum, imo ipsum per 12 Scrupula (prout superius annotatum est) ipsi stellae propius accessisse, quae fere cum ipso motu diurno consentiunt, manifeste convincitur, hunc cometam non fuisse in concavitate proxima orbi Lunae, nec in loco adhuc propriore (tunc enim parallaxis distantiam adhuc plus retardasset) sed in ipso Aethere longe supra Lunam locum obtinuisse, quod demonstrandum proposuimus.

Sed paulo collimatius rem omnem perpendentes, primum cometae motum proprium, versus stellam in Ore Pegasi, indagemus, siquidem ad hanc distantias nacti sumus, et stella illa aliquantulum extra cometae viam removeatur versus Austrum. Quapropter sit ABD portio viae cometae, C sit locus Oris Pegasi, A locus eius in via cometae, et AC distantia versus polum Australem, D sit cometa in prima observatione, B in posteriori, ambae vero distantiae ab Ore Pegasi CD et CB. Quare cum in trigono ACD, rectangulo ad A, detur latus AC, latitudo stellae in Ore Pegasi a via cometae, P4 M50, et AD differentia longitudinis prioris observationis cometae ad Os Pegasi, P20 M34, dabitur per triangulorum leges, latus CD, P21 M6 S18. Et deinde in triangulo ABC, ubi AB assumitur 15 Scrupulis minus, ut sit P20 M19, dabitur pari ratione BC, P20 M51 S36, quae minor est quam BD, M14 S42. Atque in tantum cometa spatio 3 Horarum, respectu motus diurni, promovebatur versus Os Pegasi. At per

observationes visus est promoveri M11½, deficientibus respectu itineris diurni, Scrupulis 3 Secundis 12. Tantum igitur retardari visus est cometa ratione parallaxeos, cum tamen per quartam Gradus partem fuisset eius motus apparens inhibitus, si in proxima concavitate orbis Lunaris extitisset. Quapropter non licebit propiorem locum ad Terram ipsi assignare, quam in distantia tanta, ut retardatio haec, quae sit per parallaxin, Scrupula trina non multum excedat, id quod in proxima remotione trecentorum semidiametrorum Terrae evenire colligitur. Illic enim (repetendo praecedentes figurarum delineationes, et servando similem demonstrationis tenorem) est parallaxis in circulo altitudinis ad primam observationem Hora 5½ factam, Minutorum praecise 10, in posteriori vero Hora 8 M35 fuit eadem M11 S21. Hinc colligitur parallaxis longtiudinis prima M7 S50, latitudinis M5 S58, posterior vero longitudinis M10 S27, latitudinis M4 S23. Quare si distantia prima, prout calculus exigit, ponatur P21 M12 S25, erit altera distantia, P21 M0 S44, ut sit differentia utriusque 11⅔, qualem observatio praebuit. Patet itaque quod proximior esse non poterit cometae situs ad illum diem, quam in remotione trecentorum circiter semidiametrorum Terrae, unde sexies fere plus a nobis distabat, quam promixa concavitas orbis Lunaris. Ideoque in ipso Aethere, no longe a Veneris orbibus locum obtinebat, quod hac ratione penitius enucleandum demonstrandumque erat. Consentit autem apte ipse motus diurnus, intra sphaeram Solis et Lunae fuisse hunc cometam; siquidem cursus eius diurnus, cum celerrimus esset, tardior multo erat Lunari, et celerior Solari, quemadmodum etiam in ea intermedia Aetheris regione fieri oportere consentaneum est.



Constat itaque, superque satis demonstratum est, cometam hunc non fuisse Terrae propiorem, quam est distantia 300 semidiametrorum, et ob id intra sphaeram Lunae et Solis extitisse. Utrum vero altior fuerit, quam tot Terrae semidiametri exigunt, non exactius licet concludere. Sunt enim parallaxes in tanta remotione admodum exiguae, et illarum differentiae ad motum ordinarium centro universi correspondentem, vix in sensus incurrunt, praesertim quando transitus per meridianum et 90 ab horizonte Gradum inobservabilis est, saltemque portio quaedam, quam motu primi mobilis describit, nobis conspicienda conceditur.

Sed adhibeamus praeterea in consilium alias etiam distantias, eadem ratione ad stellas fixas aliquot interlapsis horis habitas, ex quibus id, quod nunc dictum, demonstratumque est, adhuc copiosius comprobabitur.

Die itaque XXIX Novembris H6 M40, visus est cometa distare a Scheat Pegasi, per radium, P35 M45, et deinde Hora 9 M10 etiam per radium, ab eadem stella distabat P35 M36. Interlapsis itaque Horis 2½, propius accessit cometa ad Sheat Pegasi Scrupulis 9. Est autem motus diurnus cometae in suo circulo, prope quem etiam dicta fixa collocatur, P1 M20, prout ex superioribus colligi potest; adeo ut competant Horis sesquitribus in motu accessuque ad Scheat Pegasi, Min. 8⅓ differentia a prioribus non plene uno Scrupulo, in sensus non incurrente, ita ut parallaxis nihil pene de motu proprio detraxisse videatur. Unde cometa in tanta distantia a Terra extitit, ut semidiameter Terrae, ad ipsius remotionem, non habuerit proportionem in sensus incurrentem, ideoque longe supra Lunam in ipso Aethere huius cometae cursus absolvebatur.

Pari ratione die sequente, cum iuxta Horam sextam distaret cometa ab Ore Pegasi, P10 M25, et deinde Hora 9 M15, ab eadem P10 M14, interlapsis tribus Horis cum quadrante, propius accessit ad ipsam stellam Scrupulis 11. Cum autem praecedenti die, iuxta Horam sextam, distiterit ab Ore Pegasi, P11 M33, patet quod motus diurnus versus Os Pegasi, sit Partis unius, Min. 8. Unde interlapsis illis horis debebat promoveri Scrupulis 9½, quod sesquialtero Minuto plane insensibili ab observatione differt. Quare et hic patet, cometam ratione parallaxeos, nihil fere quod in sensus cadat, detraxisse motui suo ordinario, respectu centri universi, sed ob id in tanta fuisse distantia, ut Terra, eius respectu, vix perceptibiliem habuerit poportionem.

Quemadmodum etiam die sequente Hora 7⅙, distabat ab eadem stella in Ore Pegasi, P9 M17, Hora vero 9½, ab eadem, P9 M11. Ita ut intervallo Horarum 2⅓ promotus sit Scrupulis 6. Cumque motus diurnus ab eandem in Ore Pegasi, existat, ut ex distantiis praecedenti et hoc die observatis liquido patet, Partis exquisite unius, competit, ut intervallo dicti temporis moveatur Scrupulis proxime 6, quod exquisite cum observatione ipsa consentit, unde ea quae prius diximus, circa parallaxeos insensibilitatem, ulterius corroborantur.

Nec aliter die XIII Decembris, Hora 7 Min. 40, cum distaret cometa a Scheat Pegasi, P22 M18, et deinde Hora 9½, ab eadem P22 M14, interlapsa Hora una cum quinquaginta Scrupulis, propius accessit Scrupulis 4. Cumque motus diurnus sit quasi 42 Scrupulorum, competunt tempori intermedio Scrupula 3½, quod cum observatione ipsa in dimidio Scrupulo sensum omnem plane effugiente, consentit, unde et hic parallexeos variatio, nullam in motu

ordinario induxit discrepantiam. Quare aut ea nulla, aut pene insensibilis extitit. Cometam igitur hunc longe supra Lunam extitisse satis certo convincitur.

Rursus die ultimo Decembris, circa Horam sextam distabat cometa a Scheat Pegasi, P12 M0, et deinde iuxta Horam nonam, interlapsis tribus Horis, ab eadem, P11 M56, ita ut interea motu proprio accesserit Scrupulis quaternis, quemadmodum cursus ordinarius diurnus requirebat. Erat enim is quasi dimidii Gradus, competunt itaque tribus Horis, Scrupula fere quattuor. Patet ergo et hic parallaxin motum ordinarium non impedivisse, unde ea aut nulla aut pene insensibilis extitit.

Cum igitur tot diversis observationibus comprobatum sit cometam hunc cursum suum, versus fixas ipsius viae propinquas, non aliter direxisse, quam promotio diurna exigebat, adeo ut motus primi mobilis, per altitudinis variationem, aut nullum, aut admodum exiguum parallaxeos vestigium reliquerit, longe minus, ut tantum, quantum Luna in suo orbe in simili situ prae se ferre animadvertitur, diversitatis admitteret, quemadmodum ab initio, per distantiam ab Ore Pegasi reiteratam, sufficienter demonstravimus. Idcirco concludimus cometam hunc minime ortum fuisse infra sphaeram Lunarem, sed longe supra ipsam in Aethere liquido iter suum absolvisse, in tanta a Terra distantia, ut moles Terreni globi non obtinuerit ad istam intercapedinem sensibus admodum incurrentem magnitudinem, quod tot rationibus diversisque observationibus tandem certissime comprobatum, intelligentibusque evidenter demonstratum relinquimus.

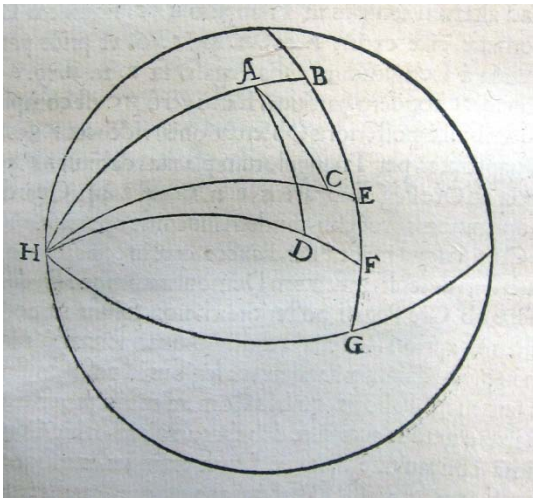
Translation

pp. 117-23

To seek the difference of distances of the comet from the Mouth of Pegasus, at the different hours given, from the change being produced of parallax.

Having, so to speak, followed the thread of Theseus, we attain the path step by step among the impeding circuitous routes for investigating, in order to reach the last goal solemnly proposed, namely, that each distance from the Mouth of Pegasus at the different times be known, which the calculation of parallax in the concavity of the lunar sphere was able to yield. Thus, in the figure provided, let the arc of the circle of the comet be BEFG, whose

southern pole is at H, and whose intersection with the ecliptic is at G, in which [arc] let the place of the comet at the first observation be at F, [and] at the second [observation] at E, in truth, but the place observed from parallax is assumed to be at D for the first [observation], and at C for the later [observation], [and] let the place of the Mouth of Pegasus with respect to the path of the comet be at A, and let quarter-circles to the path of the comet be drawn through these three places, just as is revealed in the figure. I want to know the arc AD and the [arc] AC and both distances of the comet from the Mouth of Pegasus, and their differences.



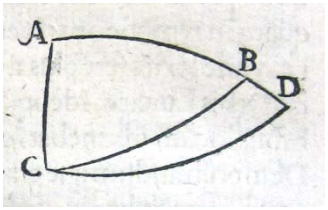
Since, therefore in triangle HAD, the angle at H is ascertained to be 21 degrees 20 minutes 42 seconds (for it is the observed longitudinal difference of the comet from the longitude of the Mouth of Pegasus, with respect to the path of the comet, and since the longitude of the Mouth of Pegasus was given previously as 67 degrees 4 minutes, and the observed longitude of the comet as 45 degrees 43 minutes 18 seconds, the angle we have just mentioned comes out). And since side HD is the complement of the apparent latitude 89 degrees 25 minutes 35 seconds, and AH the complement of the latitude of the Mouth of Pegasus, through the calculation of triangles the side AD of the first distance comes out as 21 degrees 44 minutes 16 seconds. Then at the second time in triangle HAC, since the observed longitude of the comet was 45 degrees 44 minutes 46 seconds, as was made clear earlier, and the difference from the longitude of the Mouth of Pegasus was 21 degrees 19 minutes 14 seconds, angle AHC will be of the same number of degrees, and the side HC is the complement of the observed latitude of the second observation, namely 89 degrees 34 minutes 43 seconds. Wherefore, through the laws of triangles, AC will be given, the second observed distance

from the Mouth of Pegasus, as 21 degrees 44 minutes 44 seconds. By means of this process of demonstration, at last, these two [distances] were found.

So since on the basis of the parallax that would occur in the concavity of the lunar sphere it has been found and demonstrated that the latter distance of the comet from the Mouth of Pegasus is not merely less than or equal to the former but greater even by half a minute than in the case of the former distance, the laws of parallax requiring this with three hours having passed in which the comet ought by its proper motion to have approached to the fourth part of a degree; so that on account of this, if the comet had been positioned under the nearest concavity of the Moon and were seen considered in its course to approach the Mouth of Pegasus, nevertheless in the space of three hours by reason of parallax that motion would have been held back to such an extent that it would not merely have preserved the same distance on both occasions, but in the latter observation even been as if half a minute more, when in fact it should have been less. And since that very observation proclaims and clearly shows that in that space of time the comet was not held back by parallax to such an extent—indeed, as was noted above, it came nearer to that star by twelve minutes, which almost matches the daily motion itself—it is clearly demonstrated that this comet was not in the nearest concavity of the orb of the Moon, nor in a place yet nearer (for then the parallax would have restrained the distance even more), but had its place in the Aether itself far above the Moon—as we set out to demonstrate.

But weighing up the whole matter more precisely, we should first investigate the proper motion of the comet towards the star in the Mouth of Pegasus, if indeed we have obtained the distances towards this [star] and that star had just moved away from the path of the comet to the south. Accordingly, let ABD be a portion of the path of the comet; let C be the position of the Mouth of Pegasus; A its place in the path of the comet and AC the distances towards the southern pole; let D be the comet in the first observation, and B in the second, [let] both [their] distances from the Mouth of Pegasus [be] CD and CB. Thus, since in the triangle ACD, with a right angle with respect to A, side AC, the difference in longitude of the star in the Mouth of Pegasus from the path of the comet should be given as 4 degrees 50 minutes, and AD the difference of the longitude of the first observation of the comet with respect to the Mouth of Pegasus, 20 degrees 34 minutes, by the laws of triangles, side CD will be given as 21 degrees 6 minutes 18 seconds. And then in triangle ABC, where AB is taken to be 15 minutes less so that it would be 20 degrees 19 minutes, by the same reason BC will be given

as 20 degrees 51 minutes 36 seconds, which is smaller than BD, namely 14 minutes 42 seconds. But the comet, in only a space of three hours, with respect to its diurnal motion, moved towards the Mouth of Pegasus. But by observations, it was seen to move 11½ minutes, decreasing with respect to the diurnal travel, by 3 minutes and 12 seconds. Therefore the comet was seen to be delayed just because of parallaxes, but since its apparent



motion would have been delayed by four degrees, if it had been in the nearest concavity of the lunar orb. Accordingly, it was not allowed to assign to it a place closer to the Earth than in such a great distance, so that this delay, which happened through parallax, should not exceed more than three minutes, that which is produced to occur in the closest distance of three hundred radii of the Earth. For there (having repeated the preceding delineations of the figures and following a similar process of demonstration) the parallax in the altitudinal circle with respect to first observation made at the 5½ hour is exactly 10 minutes, while in the latter [observation] at 8 hours 35 minutes, the same was 11 minutes 21 seconds. Hence the first parallax is obtained, longitude 7 minutes 50 seconds, latitude, 5 minutes 58 seconds, while the latter [parallax is] longitude 10 minutes 27 seconds, latitude 4 minutes 23 seconds. Therefore if the first distance, in so far as the calculation requires, should be established as 21 degrees 12 minutes 25 seconds, the other distance will be 21 degrees 0 minutes 44 seconds, so that the difference of both should be 11⅔, as the observation showed. Therefore, it is clear that with respect to that day, the position of the comet could not be closer than at the distance of around three hundred radii of the Earth, whence it would be almost more than six times further away than the closest concavity of the lunar orb, and so it was holding a place in the Aether itself, not far from the orbs of Venus, which by this reasoning, was explained more deeply and demonstrated. The diurnal motion itself confirms precisely that the comet had been between the sphere of the Sun and the Moon, if indeed its diurnal course, when it was to be the fastest, was much slower than [that of] the Moon, and faster than [that of] the Sun; for in this way too it is proper that [it] should be in the intervening region of Aether.

It was therefore argued and demonstrated above, that this comet was not nearer to the Earth than the distance of 300 radii, and because of that, it existed between the sphere of the Moon and the Sun. But whether it was higher than so many radii demanded, it is not possible to conclude precisely. For the very small parallaxes at such a distance and their differences in regular motion with respect to the centre of the Universe [Earth] hardly strike the senses,

especially when the transit through the meridian and at 90 degrees from the horizon is unobservable; but at least that point which it describes with the motion of the Prime Mover is granted to us to be perceived.

But let us also take into consideration other distances obtained by the same reasoning with respect to the fixed stars after some hours have elapsed, from which [distances] this, which was already mentioned and demonstrated, will be proven again more copiously [than it has been] so far.

Therefore on the 29th day of November, at the 6th hour and 40 minutes, the comet was seen, by the staff, to be distant from Sheat Pegasi by 35 degrees 45 minutes, and then at the 9th hour 10 minutes, also by the staff, it was away from the same star by 35 degrees 36 minutes. Therefore, with 2½ hours having elapsed, the comet approached more closely towards Sheat Pegasi by 9 minutes. But the daily motion of the comet in its circle, close to which the said fixed star is positioned, is 1 degree 20 minutes, as can be gathered from the things above; thus far, since there corresponds 8½ minutes to the 2½ hours in the motion and approach to Sheat Pegasi, a difference from the earlier [value above, of 9 minutes] by not quite one minute, [a difference] not being perceived by the senses, such that almost no parallax would seem to have been removed from [the comet's] proper motion. Whence the comet was at such a distance from the Earth that a radii of the Earth would not be a proportion of its distance impringing on the senses, and on that account the course of this comet would have been completed far above the Moon in the Aether itself.

By the same reason, on the following day, when around the 6th hour the comet was away from the Mouth of Pegasus [by] 10 degrees 25 minutes and at 9 hours 15 minutes from the same by 10 degrees 14 minutes, with three and quarter hours having lapsed, it approached the star more closely by 11 minutes. But since on the preceding day, around the 6th hour, it was distant from the Mouth of Pegasus by 11 degrees 33 minutes, it appears that the daily motion towards the Mouth of Pegasus should be of 1 degree 8 minutes. Whence after those hours having elapsed, it [the comet] should progress by 9½ minutes, which differs from observation by a clearly insensible one and a half minute. So here too it is clear that the comet, by reason of parallax, detracted almost nothing which falls on the senses from its regular motion with respect to the centre of the Universe, but because of this, it was at such a distance that the Earth, with respect to [its distance] had a hardly perceptible proportion.

Likewise, on the following day at 7⅙ hours it was at a distance from that same star in the Mouth of Pegasus of 9 degrees 17 minutes, and indeed at 9½ [hours at a distance] from the same of 9 degrees 11 minutes; so that in the space of 2⅓ hours it advanced by 6 minutes. And since [its] daily motion towards the same star in the Mouth of Pegasus stands at precisely one degree, as is clearly apparent from the distances observed on this and the preceding day, it is in accordance [*competit*] that in the said interval of time it is moved by nearly six minutes, which agrees precisely with that very observation. It follows that the things we said earlier about the imperceptibility of parallax are further corroborated.

Likewise, on the 13th day of December at 7 hours 40 minutes, when the comet was at a distance of 22 degrees 18 minutes from the *Scheat* of Pegasus, and then at 9½ hours [at] 22 degrees 14 minutes from the same, with one hour fifty minutes having elapsed, it came nearer by 4 minutes. And since [its] daily motion is approximately 42 minutes, 3½ minutes correspond to the interval of time, which agrees with that very observation to within half a minute, which clearly escapes any perception, whence in this case too the variation of parallax introduces no discrepancy in [its] orderly motion. Therefore it is either none or almost imperceptible. So it is quite clearly proved that this comet was far above the Moon.

Again on the last day of December around the sixth hour the comet was at a distance of 12 degrees 0 minutes from the *Scheat* of Pegasus, and then near the ninth hour, with three hours having passed, [it was] at 11 degrees 56 minutes from the same [star], so that in the meantime by its proper motion it had approached by four minutes, just as [its] regular daily path required. For that was of about half a degree, so four minutes correspond to three hours. Thus it is evident in this case too that parallax did not impede the regular motion, whence it is either none or almost imperceptible.

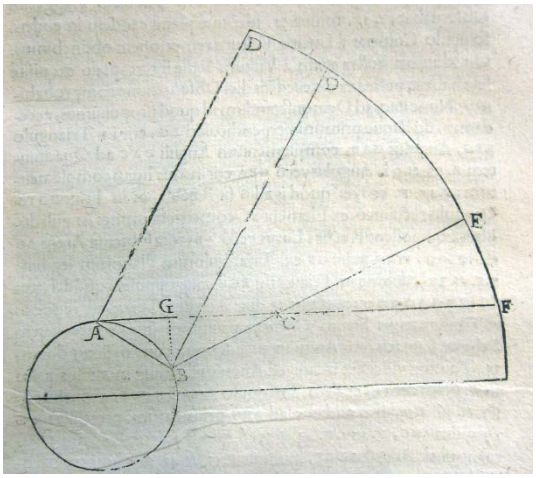
So since it has been proved by so many different observations that in its course towards the fixed stars close to its path this comet was not directed otherwise than its daily motion required, to the extent that through variation in altitude the motion of the Prime Mover left either no or only a tiny vestige of parallax [and] received far less [parallactic] variation than the Moon is observed to show in its orb at a similar site, as we have sufficiently demonstrated by means of the repeated distance from the Mouth of Pegasus—on this account, we conclude that this comet by no means arose below the sphere of the Moon, but completed its journey

far above it in the liquid Aether, at such a distance that the bulk of the earthly globe did not contribute to that interval an amount that struck the senses at all, which we have most certainly proved at length by so many different observations and have evidently demonstrated to those of sound judgment.

Original Text

pp. 123-30

Idem ex distantiis cometae a stellis affixis in diversis orbis Terreni locis habitis, manifestum reddere. Comprobatio tertia.



Quod per antecedentia in uno eodemque situ orbis Terrae, diversis observatis cometae altitudinibus manifestum reddidimus, idem hoc loco per similem quasi cometae positum, sub diversis Terrae horizontibus, demonstrare conabimur. Accipiemus itaque in subsequente figuratione, ubi ABH orbem Terrae repraesentat, C locum cometae, in distantia 50 semidiametrorum Terrestrium proxime infra concavitatem orbis Lunae. Assumatur vero A punctum Terrenae circumferentiae, repraesentans Uraniburgum in Insula Hvaena Regni Daniae, ubi nostras observationes nacti sumus, B vero sit Praga Metropolis Regni Bohemiae, ubi clarissimus vir mathematicus ac medicus excellens Taddaeus Hagecius (quo cum Comitiis Ratisbonensibus, cum modernus Imperator Romanorum coronaretur, pergratam et constantem inivi amicitiam) suas distantias in lucem evulgatas, adeptus est, apparebit (inquam) in utroque loco non posse eandem ab affixa stella, praesertim ad verticem, respectu cometae, tendente, observari remotionem, si proxime infra concavitatem orbis Lunae

collocaretur cometa in loco C, et quantum in his insit discriminis palam faciemus. Cum enim elevatio poli Pragae sit P50 M7, ex veterum observatione cognita, et nostri loci sit P55 M53, ex propriis inventis, erit differentia latitudinis utriusque loci, P5 M46, quam repraesentat arcus Terraeni orbis AB, nam quod paululum longitudine differant assumta loca, nihil fere demonstrationem impedit. Datur itaque subtensa AB 10060, qualium semidiameter Terrae 100000, et talium assumatur BC 5000000, distantia cometae a Terra, proxime infra orbem Lunarem; distantia vero ab aliqua affixa stella in A, sit angulus DAC, distantia vero eadem in B, sit angulus DBC. Dico hos duos angulos minime esse aequales, in eo cometae situ, nam cum stella fixa videatur in A et B, in eodem loco octavae sphaerae, eo quod totus orbis Terrae, nullam habeat sensibus hic incurrentem proportionem, nedum ut tantilla ipsius portio aliquid discriminis induceret, erunt lineae AD et BD parallelae, quasi una linea quo ad visum, et anguli, quos faciunt in AB ad A et B, erunt recti, eo quod eae lineae ad centrum Terrae tendant, quasi esset una linea, et AB lineae a centro ad circumferentiam normaliter incidant, secundum leges subtensarum in circulo rectarum. Quapropter assumemus primam Taddaei Hagecii observationem, factam in B Praga Bohemiae, die XVI Novembris, a Lucida Vulturis stella, ubi distantiam a dicta fixa per radium mensus est, P17 M52. Nos autem eandem hic simili instrumento, eodem die, iuxta sextam vespertinam deprehendimus, P17 M50½. Fuit autem utrobique cometa cum Lucida Vulturis quasi in uno verticali, ita ut Vultur ab hoc versus verticem attolleretur, quod ad demonstrationis certitudinem, quam intendimus, plurimum valet. Observationes autem ambas fuisse satis certas, hinc patet, quod factae sint non longe a prima cometae fulsione, cum lumine et corpore maior esset, et Taddaeus affirmat hanc suam primam observationem factam, cum nitidissima existente coeli facie optime videretur, eratque tempus ab illo annotatum circa Horam sextam post meridiem, circa quam horam nostra etiam distantia eiusmodi fuit, qualis annotata est. Cumque Praga nobis quasi quadrante unius Horae removeatur versus Ortum, et motus diurnus cometae versus Vulturem, circa id tempus, fuerit Partium proxime 2½, ut ex antecedentibus et sequentibus ad Vulturem habitis distantiis patet, competunt quadranti horae, qua per meridianos differimus, Minutum cum semisse, addendum ad nostram observationem, eo quod nos simus hic Praga Occidentaliores. Nam cum illic esset Hora 6, deficiebant hic 15 Scrupula horae, ideoque nostra observatio post facta est quam Taddaei, et ob id, si quadrante Horae ante extitisset, quo tempore respectu utriusque meridiani ipse suam perfecit observationem, fuisset cometa remotior a Vulture sesquialtero Minuto. Quaproper si ad nostram distantiam P17 M50½ tantillum adiecerimus, conflabimus veram distantiam hic, quo momento temporis Taddaeus Hagecius observabat, P17 M52, ideoque plane eandem in eodem Scrupulo cometae a Lucida

Vulturis remotionem obtinebimus. Quod autem nostra etiam a Vulturis stella intercapedo exquisite sese habeat, postea ex antecedentis diei observatione comprobabimus. Nunc itaque ad demonstrandum id quod proposuimus, accedamus, ductaque primum perpendiculari BG, erit in triangulo ABG, angulus GAB, complementum anguli DAC ad quadrantem P72 M9½, angulus vero GBA erit rursus huius complementum, P17 M50½, eo quod is ad G sit rectus, et in trigono rectangulo rectilineo, ex elementis geometricis, omnes anguli duobus aequipollent rectis, latus vero AB, tota subtensa arcus AB est 10060, erit itaque GB ex triangulorum planorum legibus, P5 M29$^{2}/_{3}$, dehinc in triangulo BGC, praesupposito quod latus BC sit 5000000, qualium ea quae a centro Terrae, est 100000, ut constituamus locum cometae paululum infra concavitatem sphaerae Lunaris, erit angulus GCB Minutorum 6, Secundorum 35. Tantum videlicet maior est angulus distantiae in A visus quam in B. Nam cum in eodem triangulo angulus GBC, proveniat P89 M53 S25, si addatur ad ABG prius datum, provenit totus angulus ABC, P107 M43 S55, a quo si auferas rectum ABD, relinquitur angulus DBC quaesitus, P17 M43 S55, qui repraesentat distantiam cometae a Vulture, quae Pragae observaretur in B, quando hic Uraniburgi in A est, P17 M52, idque posito loco cometae proxime infra orbem Lunae, adeo ut illic esset pene septem Scrupulis minor quam hic. At cum observatio facta in B angulum differentiae faciat, prorsus aequalem angulo distantiae hic observatae, necessarium erit cometam tantum fuisse remotum, ut pars circumferentiae Terrae AB, non habuerit ad ipsum sensibilem quantitatem, et lineae AC et BC, non tam prope sese intersecuerint, sed quasi parallelae visae fuerint, quod non infra, sed longe supra sphaeram Lunarem in altissimo Aethere primum fieri posse, manifestum est. Nequaquam igitur extitit hic cometa proxime infra concavitatem orbis Lunae, nec in loco aliquo adhuc propiore, tunc enim longe adhuc factus fuisset maior angulus ad C, qui est differentia utriusque distantiae in diversis locis observatae, quod in hunc modum demonstrandum proposuimus.

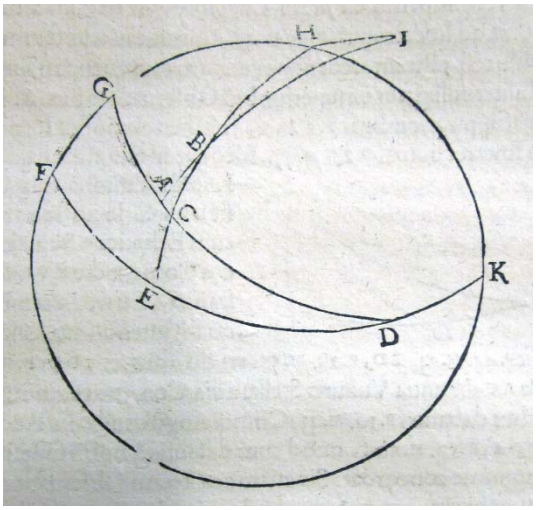
Pari ratione assumentes aliam distantiam ab eodem Taddaeo Hagecio ad eandem fixam factam die XXIIII Novembris, et conferentes cum nostra eodem die habita, idem comprobabimus. Observavit enim Taddaeus eo die distantiam cometae a Vulture, P11 M43, quam nos hic Partium 11 Scrupulorum 45 nacti sumus. Fuisse autem ipsius observationem satis dilgentem, quod eo die diuturna fuerit serenitas, ut ex pluribus factis observationibus colligitur, probabiliter conjectare licet, et nostram etiam exquisitam extitisse, ex distantia praecedentis diei comprobabimus. Movebatur autem tunc cometa quasi in proxima distantia ad Vulturem, ita ut linea a Vulture ad viam Cometae non multum a rectangulo inclinaret. Unde si quae in tempore observationum fuit diversitas, insensibiliter distantias variavit, et

quadrans Horae, qui meridianis interest, nullam sensibus incurrentem efficere potuit distantiarum discrepantiam.

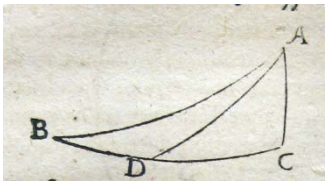
Sit ergo in praescripta figuratione, in triangulo rectangulo AGB, angulus BAG, P78 M15, ex complemento anguli DAC hic observati, P11 M45, et latus AB, ut prius 10060 erit nunc BG, P5 M38 S8. Quare in triangulo GBC, assumto latere BC, 5000000 ut prius, dabitur angulus GCB, M6 S47, qui metitur differentiam utriusque distantiae, quam causare posset intervallum Terrae AB. Nam in trigono ABC, angulus ABC componitur ex angulo GBC, qui evadit P89 M53 S13, et GAB, qui extitit, P11 M45. Ideoque est P101 M38 S13. Ab hoc si abstuleris rectum DBA, residuabitur DBC, P11 M38 S13, ac tanta apparavisset cometae distantia a Vulture ex B Praga Bohemiae, quando in Hvaena Daniae observabatur, P11 M45, differens ab ea quasi septem Scrupulis. At distantia Taddaei illic observata reclamitat, fuit enim ea saltem duobus scrupulis minor vix sensibilibus, cum debuisset 7 Scrupulis defecisse, si cometa hic fuisset in C, proxime infra sphaeram Lunae, et multo plus redderetur minor, si cometa adhuc in propiore distantia ad Terram extitisset. Unde non minus hic, quam in antecedente, cometam hunc longe supra Lunam in ipso Aethere cursum absolvisse, sufficienti demonstratione comprobatum est. Fateor quidem has discrepantias distantiarum in his diversis locis, praesupponere, ac si contingerent in minima altitudine iuxta horizontem, verum cum cometae observationes in Occasum semper inclinarent, non multum differunt eae, quae in aliquantula ipsius altitudine contingunt, ab his quae prope horizontem, et hac praesupposita ratione, qua usi sumus, facilius res ipsa et planius intellectui obviat; cumque utrobique observatae distantiae adeo prope concurrant, et constet, ne in altiori situ potuisse angulum distantiarum in utroque loco adeo sibi similem evadere, si proxime infra Lunam fuisset cometa, id quod proposuimus sufficienter comprobatum est. Quare ad alterum quod promisimus, accedamus, videlicet, distantiam a Vulture a nobis utroque tempore observatam, fuisse exquisitam, et antecedentibus annotationibus correspondentem, manifestare.

Verum ut idipsum probabilius pateat, operaepretium erit prius, stellae Vulturis ad viam cometae positum inquirere, videlicet in quo loco ab intersectione cum ecliptica, eadem linea a polo eclipticae per Lucidam Vulturis ducta, ipsam cometae viam contingat, et in qua remotione hinc existat stella Vulturis. Sit itaque in ascripta figura, FEDK portio eclipticae, cuius polus sit H, sitque arcus viae cometae GCD, cuius polus sit I, utriusque intersectio D, locus vero stellae, quae est lucidior Vulturis, sit B. Quapropter in trigono CDE cum latus DE existat, P34 M57, est enim differentia longitudinis Vulturis a nobis superius annotatae ad

locum intersectionis in D, angulus vero EDC, est inclinationis viae cometae ad eclipticam, quem etiam antea suo loco deprehendimus, P29 M15, cumque angulus ad E sit rectus, dabitur angulus DCE, P66 M23½, et latus CE, P17 M47¼, latus insuper CD, P38 M42, per triangulorum supputationem. Deinde in triangulo ABC, angulus ACB contrapositus, modo invento ECD, etiam erit P66 M23½, cumque BC constet, sublato EC prius invento, a latitudine stellae Vulturis EB superius inquisita, sitque P11 M31¾, idcirco per leges triangulorum dabitur AB, P10 M33. Est autem AB distantia Vulturis, a via cometae, proxima versus Boream, datur insuper latus AC, P4 M40½, quod si adiecerimus ad DC prius datum, prodibit AD, distantia longitudinis stellae Vulturis, in via cometae, ab eius mutua cum ecliptica intersectione, P43 M22½.

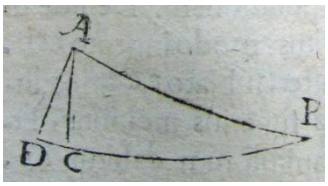


Examinantes itaque distantiam diei XVI Novembris, eam ad priorem die XV iuxta idem horae tempus factam, conferemus. Fuit autem die praecedente, Hora 6, remotio a Vulture, P20 M25. Datur vero superius cometae longitudo in sua via, a loco intersectionis, ad hoc tempus, P25 M48, cumque motus diurnus in suo circulo respectu antecedentium dierum et sequentium, proportionabiliter colligatur ex superioribus observationibus, et hinc inventis



supputationibus, P3 M7, fuit die XVI ipsius longitudo a loco intersectionis, P28 M55. Ideoque in assignata figura, sit A Lucida Vulturis, via cometae sit BC, et locus intersectionis cum ecliptica B. Sit autem D locus cometae die XVI, et DA distantia a Lucida Vulturis eo die quam intendimus. Cum itaque BC, sit P43 M23, BD, P28 M55, uti diximus, erit DC, P14 M28, atque AC distantia Vulturis stellae a via cometae etiam in antecedentibus dabatur, P10 M33. Cumque angulus ad C sit rectus, dabitur DA, P17 M50⅓, quod cum

distantia a nobis superius assignata apprime concordat. Sic etiam ad alteram observationem die XXIIII habitam, repetita proxime antecedenti figuratione, quantum ad situm Vulturis cum

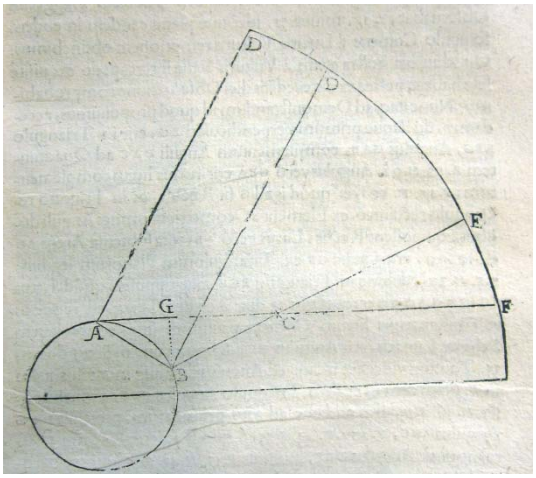


via cometae attinet, quia DC distantia ipsius a longitudine Vulturis in sua via existit, P5 M14½, ut ex superioribus modo antecedenti colligi potest, et AC manet P10 M33, dabitur AD, P11 M46, quod proxime in uno Scrupulo cum annotatione nostra consentit.

Translation

pp. 123-30

The third proof, to render manifest the same [point] from the distances obtained of the comet from the fixed stars in different places of the terrestrial globe.



What in the preceding [proofs] we rendered manifest in one and the same location on the orb of the Earth, with different altitudes observed of the comet, here we will want to demonstrate under different horizons of the Earth as if through the same position of the comet. We should therefore accept in the following composition [*figuratio*], where ABH [**1**] represents the orb of the Earth, C [as] the place of the comet at a distance of 50 terrestrial radii just under the concavity of the orb of the Moon. Let point A on the terrestrial circumference to be taken [as] representing Uraniborg on the island of Hven of the King of the Danes, where we obtained our observations; then B should be Prague, the capital city of the kingdom of Bohemia, where the most distinguished and excellent mathematical and medical man, Thaddaeus Hagecius (with whom I struck up a pleasant and constant friendship at the assembly of Regensburg,

when the most recent Emperor of the Romans [**2**] was crowned) obtained his distances [which were] published. It will appear (I say) that the same distance cannot be observed from the fixed star in each place, especially approaching the zenith, relative to the comet, if the comet were placed very close under the concavity of the orb of the Moon at place C, and we shall make plain how much of the difference there should be between these [two places]. For since the elevation of the pole at Prague should be 50 degrees 7 minutes, known from the observation of the Ancients, and [that] of our place should be 55 degrees 53 minutes from my own findings, there will be a difference of latitude of the two places, of 5 degrees 46 minutes, which the arc of the terrestrial orb AB represents; for because the two given places differ very little in longitude, it hardly impedes the demonstration at all. Therefore the cord AB is given as 10,060 [units], the same [units] of which the radius of the Earth [has] 100,000, and of the same parts BC has 5,000,000, the distance of the comet from the Earth, right under the lunar orb; then the [comet's] distance from a fixed star [D] at A should be angle DAC, and the same at B should be angle DBC. I say that these two angles are not at all equal with the comet in that location, for when the fixed star is seen at A and B, in the same location of the eighth sphere, because the whole orb of the Earth has no proportion impinging here on the senses, much less does so small a portion of it induce any difference, the lines AD and BD will be parallel, just as one line to the sight, and the angles they make with AB at A and B will be right angles, because those lines tend to the centre of the Earth, as if they were one line, and the lines cut AB at right angles from the centre to the circumference, according to the laws of subtended right lines in a circle. Wherefore, we take the first observation of Thaddaeus Hagecius, made at B in Prague of Bohemia, on 16 November, by the bright star of the Vulture, where it was measured from the fixed star by means of a staff at 17 degrees 52 minutes. But we observed the same (comet) here with a similar instrument, on the same day, near the sixth hour of the evening, at 17 degrees 50½ minutes. But on both accounts the comet was with the star of the Vulture as if in one vertical in such a way that, as the Vulture was raised from this towards the vertical, it contributes much to the certainty of the demonstration, for which we strive. But that both observations were sufficiently certain is laid open hence, because they were made not far from the first shining forth of the comet, when it was greatest in light and body, and Thaddaeus affirms that this, his first observation, was made when the comet was seen very clearly with the sky being very pure, and the time was noted by him to be around the sixth hour after the meridian, after which hour also our distance was measured in the same way, as was noted. Because Prague is removed from us towards the east by nearly a fourth of an hour, and the diurnal motion of the comet towards

the Vulture, around that time, was of approximately 2½ degrees, so that it is evident from the preceding and following distances obtained to the Vulture, that the quarter hours coincide, by which we differ by meridians, a minute and a half must be added to our observation because we are more west than Prague. For when at Prague it was 6, it lacked here 15 minutes of an hour, and therefore our observation was made after the observation of Thaddaeus, and on account of that, if it would have been made a quarter of an hour before, when, with respect to the meridian of each place, he made his observation, the comet would have been more remote from the Vulture by 1½ minutes. On account of which, if we add a trifle to our distance of 17 degrees 50½ minutes, we will cobble together the true distance here, at the moment of time Thaddaeus Hagecius observed 17 degrees 52 minutes, and therefore, clearly, we will obtain the same distance to the minute of the comet from the bright star of the Vulture. However, we will also prove that our interval for the star of the Vulture appears spot-on later from the observation of the preceding day. Now, therefore, let us proceed with demonstrating what we proposed: and, first, the perpendicular BG, being drawn, there will be in the triangle ABG the angle GAB, the complement to the angle DAC to the quadrant is 72 degrees 9½ minutes. The angle GBA, however, will again be the complement of this, namely 17 degrees 50½ minutes, seeing as what the perpendicular is at right angles at G, and in a rectilinear right-angled triangle from the elements of geometry, all angles add up to two right angles, the side AB, indeed the whole subtended arc AB, is 10,060, and thus GB will be, according to the laws of plane triangles, 5 degrees 29⅔ minutes. Thus in the triangle BGC, being supposed that BC has 5,000,000 of these units of which that [i.e. radius] from the centre of Earth has 100,000, as we assume that the place of the comet is slightly below the concavity of the lunar sphere, the angle GCB will be 6 minutes 35 seconds. As we can see, the angle of distance seen in A is as much larger than B. For, as in the same triangle, the angle GBC has 89 degrees 53 minutes 25 seconds, if it is added to ABG, which has been given first, the entire angle ABC comes to 107 degrees 43 minutes 55 seconds, from which if you subtract the right angle ABD, the rest will be the angle DBC, which was being sought: 17 degrees 43 minutes 55 seconds; [angle DBC] which represents the distance of the comet from the Vulture which is observed at Prague in B, whereas there at Uraniburg, in A, [the angle DAC] is 17 degrees 52 minutes; and that [is the result obtained], having posited that the place of the comet as slightly under the orb of the Moon, so that [at Prague] the angle would be nearly seven minutes smaller than [at Uraniburg]. But, as the observation made in B makes the angle of distance [**3**] equal to the angle of the distance observed [in Uraniburg], it will be necessary that the comet would be at such a distance that the portion AB of the terrestrial circumference

had comparatively no sensible quantity, and that the lines AC and BC would not intersect so near, but would be seen as if parallel, because it is evident that the [comet] could not [be] at first under the sphere of the Moon, but far away above it in the highest Aether. Thus this comet is by no means close under the concavity of the lunar orb, nor in any nearer place, for then the angle in C would become much larger, which is the difference of the two distances observed in different places, and that is what we wanted to demonstrate in that manner.

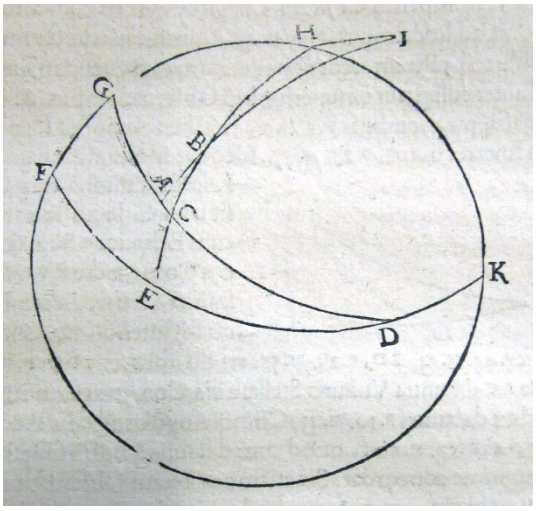
With the same method, we shall confirm the same thing by examining another distance [of the comet] to the same fixed star observed by the same Thaddaeus Hagecius on 24 November, and by comparing it with our distance observed on the same day. For he observed on this day the distance of the comet from Vulture as 11 degrees 43 minutes, which [distance] we here obtained [as] 11 degrees 45 minutes. But we can with probability assume [that] his observation was made with due exactness, because on that day the clarity [of the sky] lasted, as is deduced from the many observations made; that our observations was also precise, we shall confirm from the distance of the preceding day. For then the comet moved as in the nearest distance with respect to the Vulture, in such a manner that the line from the Vulture to the path of the comet deviated not much from a right angle. From this, if there was difference in the time of observations made, it [made the difference in] distance insensible, and the quarter of an hour, which lies between the meridian [of Prague and Uraniburg], could produce no [sensible] [**4**] difference of distances.

So, in the previous figure, let angle BAG in the right-angled triangle AGB be 78 degrees 15 minutes, from the complement of angle DAC observed here, 11 degrees 45 minutes, and of the side AB, as 10,060 as above. BG will now be 5 degrees 38 minutes 8 seconds. For this reason, in triangle GBC, with the side BC taken to be 5,000,000 as above, angle GCB will be 6 minutes 47 seconds, which measures the difference of both distances, which the terrestrial distance AB could bring about. For in the triangle ABC, angle ABC is composed of the angle GBC, which comes to 89 degrees 53 minutes 13 seconds, and angle GAB, which is 11 degrees 45 minutes, and so [angle ABC] is 101 degrees 38 minutes 13 seconds. If you subtract from this the right angle DBA, there will remain DBC, 11 degrees 38 minutes 13 seconds, and the distance of the comet from the Vulture would have appeared such an amount at B in Prague, Bohemia, when at the Danish Hven, it was observed as 11 degrees 45 seconds, different from it by about 7 minutes. But the distance observed there by Thaddaeus shouts out in protest, for it was two scarcely detectable seconds, when it should have fallen

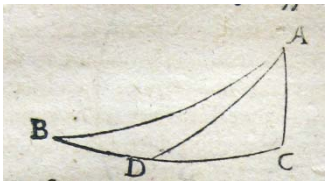
short by seven seconds had the comet been here at C, immediately under the sphere of the Moon, and it would have been much more if the comet had still been at a closer distance to the Earth. Whence it is proven with due demonstration that the comet, no less here than in the preceding case, completed its course far above the Moon in the very Aether. I confess myself indeed to have presupposed the discrepancies in distances in these different places as if they had happened at the lowest height near the horizon; and indeed since the observations of the comet always tend west, they do not differ much from these which are near the horizon. And having presupposed this method, which we have used, the matter itself more readily and clearly strikes the intellect, and since in both cases the observed distances agree quite closely, it is evident that the angle of the distance in each place, even at a higher place [above the horizon], could not have turned out so similar if the comet had been close under the Moon. This, which we have proposed, has been proven sufficiently. So, let us proceed to the other thing which we promised, namely to show that the distance from the Vulture observed by us on the two occasions was precise, corresponding to the early recording.

So that the same thing should be made more probable, it will be necessary first to find the position of the star of the Vulture to the path of the comet, namely in what place from the intersection of the ecliptic [with the path of the comet], the same line that passes from the pole of the ecliptic through the bright star of the Vulture touches the path of the comet itself, and at what distance the star of the Vulture is from these. Therefore in the designated figure let FEDK be a portion of the ecliptic whose pole is H, and let the arc of the path of the comet be GCD, whose pole is I, and let the intersection of the two of them be D, and indeed let the place of the star, which is the brighter one of the Vulture, be B. Wherefore, in triangle CDE since the side DE is 34 degrees 57 minutes, it is also the difference in longitude of the Vulture that is noted by us above from the place of the intersection in D; then angle EDC is that of the inclination of the path of the comet to the ecliptic, which we have also established before in its place to be 29 degrees 15 minutes, and since the angle at E should be a right angle, angle DCE will be given as 66 degrees 23½ minutes and the side CE 17 degrees 47¼ minutes; in addition, side CD [will be given as] 38 degrees 42 minutes through the reckoning of the triangle. Then in triangle ABC, the angle ACB opposite to ECD just found, will also be 66 degrees 23½ minutes; and as it is evident that BC, having subtracted EC found previously from the latitude of the star of the Vulture EB found above, is 11 degrees 31¾ minutes, accordingly, through the laws of triangles, AB will be given [as] 10 degrees 33 minutes. But AB is the distance of Vulture from the path of the comet, nearest towards north; in addition

the side AC is given as 4 degrees 40½ minutes, which, should we add to DC given above, will yield AD, the distance of longitude of the star of Vulture in the path of the comet from their mutual intersection with the ecliptic, as 43 degrees 22½ minutes.

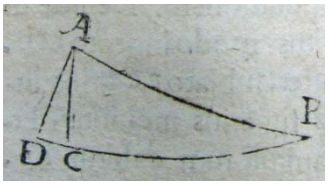


Examining therefore the distance for the 16th day of November, we will compare it to the previous [distance] measured [*factam*] on the 15th day at the same hour. However, the distance [*remotio*] from the Vulture on the preceding day at the sixth hour was 20 degrees 25 minutes. The longitude of the comet on its path, from the place of intersection, is given above however [as] 25 degrees 48 minutes at this time; and since the diurnal motion in its circle in respect of preceding and following days may be proportionately gathered from previous observations and by carrying out reckoning [on them], [as] 3 degrees 7 minutes. On the 16th day its longitude from the place of intersection was 28 degrees 55 minutes. And therefore in the accompanying figure let A be the bright star of the Vulture, let the path of the comet be



BC and the place of intersection with the ecliptic B. Let D be the place of the comet on the 16th day, however, and DA its distance from the bright star of the Vulture on the day in question. Since therefore BC is 43 degrees 23 minutes [and] BD 28 degrees 55 minutes, as we have said, [so] DC will be 14 degrees 28 minutes, and AC, the distance of the star of the Vulture from the path of the comet was also given in the foregoing [as] 10 degrees 33 minutes. And since the angle at C is a right angle, DA will be given [as] 17 degrees 50⅓ minutes, which most closely agrees with the distance assigned by us above. Thus also in the case of the other observation made on the 24th day (the preceding figure being roughly repeated) in as much as pertains to the site of the Vulture with the path of the comet; because

the distance DC of itself on its path from the longitude of the Vulture is 5 degrees 14½ minutes (as can be gathered from the immediately preceding above) and AC remains 10 degrees 33 minutes, AD will be given as 11 degrees 46 minutes, which agrees with our record almost to one minute.



[**1**] H is not represented in the figure

[**2**] Rudolph II was crowned Emperor at Regensburg on 1 November 1575

[**3**] Here we take *angulus differentiae* to be the same as *angulus distantiae*

[**4**] Lit: no difference impinging on the senses

Original Text

pp. 130-4

Examinavimus autem has utrasque distantias ad praecedentes dies, eam praesertim ob causam, quia hisce diebus apud nos non usque adeo erat serenum, atque die XV et XXIII Novembris proxime antecedentibus, cumque in illis duobus Taddaeus nullas obtineat observationes, ob nubium obscuritatem coeli aspectum prohibentem, coacti sumus hisce etiam uti, et illorum ad antecedentes clarioresque dies examinationem instituere. Neque alibi uspiam toto durationis tempore aliquam observationem certam, eodem die et tempore cum Taddaeo factam, ex ipsius et meis observationibus invicem collatis colligere licuit. Nam praeter hoc quod omnes animadversiones, non aeque certae existunt, ubi illic serenum, apud nos obscurum, et contra plerunque evenit, ut ob id meteorologicarum praedictionum ratio, admodum intricata et difficilis, ne dicam impossibilis esse, vel hoc solo documento convincatur; siquidem in tam parva intercapedine horizontum, contraria fere constitutio aeris et nubium pene semper extiterit, ut ex collatione dierum in quibus is et ego observationes habuimus, facile constabit. Vix enim invenies, quin cum hic serenum illic obscurum, et viceversa extiterit. Viderint itaque ii qui diarias prognosticationes mutationum aeris conscribunt, num differentia longitudinis et latitudinis tantilla in orbe Terrae, schemata syzygiarum luminarium et reliquorum planetarum commixtiones, unde suas depromunt praedictiones, tantum alterare possit, ut tam diversam aurae mutationem in Bohemia, et hic producat, quod vix eos etiamsi lynce oculatiores essent, deprehensuros existimo. Quare cum

iudicio moderateque hanc astrologiae partem tractandam censeo, ne vulgo relinquatur calumniandi occasio, sed de his copiosius disserere non est huius loci.

Praeterea conferentes etiam clarissimi mathematici Cornelii Gemmae, illustris parentis Gemmae Frisii non obscuri filii, observationes cum nostris, quantum ad distantias cometae ab affixis stellis attinet, quas Lovanii, per radium astronomicum, instrumentum a patre ipsius excultum, obtinuit, ubi elevatio poli existit Partium 50, et totidem Scrupulorum, iuxta ipsius parentis annotationem in libello, quem inscripsit, *De astrolabio catholico*. Differt itaque a nobis in latitudine Terrae, Gradibus proxime quinis, quae totidem pene Scrupula in differentia distantiarum illic et hic observatarum efficiunt, ut proportionabiliter ex antecedentibus circa Pragam Bohemiae et hunc locum colligi potest. Dicit autem idem Cornelius Gemma, die XVI Novembris cometam distitisse a Clara Aquilae, Partibus circiter 18, ubi videtur summam quidem scrupulositatem non considerasse, attamen id satis inde colligitur, cum maiorem ponat distantiam, quam nos hic invenimus, quae tamen merito minor esse deberet, si in elementari vel suprema Aeris regione extitisset hic cometa, fuisse eum longe supra Lunam in ipso Aethere.

Die XXI annotavit idem Gemma distantiam cometae ab Aquilae Lucida, P10 M34, quam nos sex saltem Scrupulis maiorem invenimus, non tam ratione parallaxeos, quam quod in observatione aliquid desideretur; et quomodcunque sit, nondum caderet infra Lunarem sphaeram ipsius positus.

Die XXVIII, cum Gemma invenisset distantiam ab Ore Pegasi, P12 M40, nos eandem hic deprehendimus, P12 M45, adhuc quinis saltem Scrupulis maiorem, cum tamen Elementaris vel suprema regio Aeris, adhuc maiorem admitteret discrepantiam.

Pari ratione, die XXX Novembris, cum is distantiam a Rictu Pegasi observasset P10 M20, nos eandem P10 M25, quinis adhuc saltem Scrupulis maiorem invenimus, quae differentia etiam contingere poterat ratione diversitatis horarum, in quibus observationes fecimus, nam et ego Hora septima inveni ab Ore Pegasi ad cometam, P10 M20 exquisite ut Gemma, et quadrante post nonam, P10 M14 senis Scrupulis ipsius minorem, cum potius maiorem fore conveniret, si sub sphaera Lunari extitisset hic cometa. Quod vero nos eodem die maiorem habemus distantiam a Manu Antinoi, quam Gemma deprehendebat, Scrupulis 13, non contrariatur iis quae intendimus. Nam si parallaxis sensibilem aliquam induxisset

differentiam, minor fuisset hic distantia observata quam illic, eo quod stella illa Antinoi erat infra cometam versus horizontem, et non maior, prout nos deprehendimus; unde errorem aliquem in hac observatione Gemmae irrepsisse autumo, qui tamen nostrae intentioni non saltem non contrariatur, sed ipsam magis confirmare videatur.

Dehinc Decembris calendis, cum is distantiam ab Ore Pegasi assignet, P9 M14, nos eodem vespere paulo ante sextam invenimus eandem P9 M20, ipsius annotatione senis Scrupulis maiorem, Hora 7⅙, P9 M17, tribus saltem maiorem, Hora vero 9½, P9 M10, ipsius assignatione etiam 4 Scrupulis minorem, ut ob id cum horam observationis non annotaverit Cornelius Gemma, (quod et in ipso, et in Taddaeo Hagecio, praesertim ubi cometa, motu diurno celerior extitit, valde desidero) non certo constare possit, quae nam nostrarum observationum cum ipsius conferenda veniat. Accipiendo itaque medium inter remotissimam et proximam distantiam eo vespere a nobis observatam, comperitur eum medio modo distitisse ab Ore Pegasi, P9 M15. Quod in uno saltem Scrupulo insensibili ab ipsius observatione dissentit. Unde satis evidenter constare poterit, supra Lunam longe extitisse hunc cometam, nam etiamsi maximam differentiam distantiarum, quae erat 5 Scrupulorum assumamus, tamen necdum multum infra Lunam eius situm cadere, parallaxium ratio superius demonstrata admittit.

Ast ultimo Decembris die (intermediae enim distantiae apud Gemmam minus certae sunt, nec sibiipsis correspondentes) cum ipse ponit intercapedinem ab Ore Pegasi, P13 M48, nos eandem invenimus proxime 14 Graduum, quasi quinta Gradus parte maiorem, cum tamen minor hic extitisset, si in Elementari mundo fuisset cometa; siquidem infra cometam versus horizontem, quasi in eodem verticali collocabatur stella in Ore Pegasi. Distantia insuper per eum ab Ala Pegasi accepta, quam nos primam Colli appellamus, nostram quinis saltem Scrupulis excedere deprehenditur, cum tamen merito minor esse debuisset, si Elementaris extitisset cometa, nam stella illa erat superior.

Atque hae sunt praecipuae observationes a Cornelio Gemma habitae, quas cum nostris conferre licuit, nam pleraeque ab ipso observatae, non coincidunt in eos dies, quibus hic serenum extitit, paucae etiam in eos quibus Pragae Bohemiae clarum coelum illuxit, ut ex Taddaei observationibus colligere licebit. Unde id, de quo meteorologicarum praedictionum asseclas superius admonui, manifestius evadit, sobrie et prudenter eam astrologiae partem

esse tractandam, praesertim cum in tam parva differentia horizontum respectu totius Terrae, tanta fuerit diversitas mutationis aurae, tam secundum longitudinem, quam latitudinem ipsius Terrae.

Fuerunt etiam quaedam Cornelianae observationes, meo sane iudicio, non satis exactae, ut et in Nova Stella dissidere ab aliorum certis observationibus visus est. In hoc tamen cometa eiusque distantiis indagandis, maiorem videtur adhibuisse diligentiam; et nos eas observationes ipsius adduximus in medium, quae certiores, collatione caeterorum dierum, et magis veritati convenire videbantur; adeo ut ex his, non minus quam ex iis, quae cum Taddaei Hagecii animadversionibus contulimus, liquido constare possit, cometam hunc non extitisse proxime infra sphaeram Lunarem, nec in loco adhuc propiore, cum multo maior tunc distantiarum causaretur diversitas, sed long supra Lunam, in ipso Aethere cursum suum absolvisse; quod ex distantiis in semotis orbis Terrae partibus a diversis observatoribus deprehensis, demonstrare proposuimus.

Translation

pp. 130-4

We have, however, examined these two distances on the previous days, for this reason especially, namely that where we were on those days it was not continuously altogether clear, as on the 15th and 23rd days of November immediately preceding them, and since on those two days Thaddaeus could obtain no observations because of the darkness of the clouds blocking a view of the heavens, we too have been compelled to use these [observations] and to undertake an examination of them on the earlier and clearer days. Nor was it possible from comparison of his observations with mine to gather any definite observation made on the same day at the same time in any other way over the whole period of time. Besides, all observations are, in fact, not equally certain when as often happens it is clear there but dim where we are and vice versa, and on that account the basis of meteorological prediction is shown to be very complex and difficult, not to say impossible, even by this one example: namely, that in so small an interval between horizons there nearly always exist quite contrary constitutions of air and clouds, as was easily established from the days on which he and I made observations. For you will hardly ever find otherwise and that when it was clear here it was cloudy there. So let those who compose daily prognostications of the change of weather

[*aeris*] see whether the very small differences in longitude and latitude on the globe of the Earth [and] the patterns of syzygies of the luminaries and the other planets and mixtures of the other planets from which they draw their predictions can change so much as to produce such different changes of atmosphere [*aura*] in Bohemia and here, something that I think they would hardly detect even if they were lynx-eyed. For this reason I think that this part of astrology should be handled with moderation, lest an opportunity be provided for popular slander: but this is not the place to discuss these matters further.

Moreover, let us compare with ours the observations of the most distinguished mathematician Cornelius Gemma, the not obscure son of the illustrious parent Gemma Frisius, with respect to the distances of the comet from the fixed stars that he observed with the *radius astronomicus*, an instrument perfected by his father, at Louvain, where the elevation of the pole is 50 degrees and as many minutes, according to a note of his parent in the book that he wrote, *De astrolabio catholico* — so it differs from us in latitude of the Earth by nearly 5 degrees, which brings about almost as many minutes in the differences of distances observed here and there as can be inferred by proportion from what has gone before with respect to Bohemian Prague and this place. The same Cornelius Gemma says that on the 16th day of November the comet was distant from the Clara of Aquila by about 18 degrees, where it seems he did not observe with the utmost accuracy: nevertheless it may readily be inferred from this that [the comet] was far about the Moon in the Aether since he established a distance greater than we find here, which should, however, properly be less if this comet had been in the elemental or highest region of the Air.

On the 21st day the same Gemma recorded the distance of the comet from Lucida of Aquila as 10 degrees 34 minutes, which we have found to be only 6 minutes more, not so much because of parallax as because something is wanting in the observation: and however that may be, its position would not yet fall below the lunar sphere [see Cornelius Gemma, *De prodigiosa specie naturaque Cometae,* Antwerp, 1578, p. 23].

On the 28th day, when Gemma found the distance from the Mouth of Pegasus to be 12 degrees 40 minutes, we found the same here to be 12 degrees 45 minutes, only 5 minutes greater, when, however, an elemental position or one in the highest Air would incur a yet greater discrepancy.

Likewise, on the 30th day of November when he observed a distance from the Mouth of Pegasus of 10 degrees 20 minutes, we [found] the same as 10 degrees 25 minutes, only five minutes more, which difference could have happened because of the different hours at which we made the observations, for I too at the seventh hour found 10 degrees 20 minutes from the Mouth of Pegasus to the comet precisely as Gemma [did], and at quarter past nine 10 degrees 14 minutes, less than his by 6 minutes, when it should be evident that it would rather be greater if this comet had been beneath the sphere of the Moon. And it is not contrary to the things we maintain that on the same day we found a distance greater by 13 minutes from the Hand of Antinous than Gemma detected. For if parallax had produced some discernible difference, the observed difference would have been less than here, seeing that that star of Antinous was below the comet towards the horizon and not greater, as we found, and so I think that some error crept into this observation of Gemma, which nevertheless seems not only not to contradict our view but rather to confirm it.

Next, on the Calends of December [1 December] when he assigned a distance from the Mouth of Pegasus of 9 degrees 14 minutes, we on the same evening a little before six found the same to be 9 degrees 20 minutes, 6 minutes more than his assignment; at 7⅙ hours, 9 degrees 17 minutes, greater by about 3; at 9½ hours, 9 degrees 10 minutes, less than his assignment by some 4 minutes; but it could not be established with certainty which of our observations would present itself for comparison with his, because Cornelius Gemma did not note the time of his observation (something for which I greatly feel the need both with him and with Thaddaeus Hagecius, especially when the comet was going with a faster daily motion). So by taking a mean between the most distant and nearest distances observed by us on that evening, it is found on average distant from the Mouth of Pegasus by 9 degrees 15 minutes, which differs from his by only about one indiscernible minute. From this it can quite evidently be agreed that this comet was far above the Moon, for even if we assume the greatest difference of distances, which was of five minutes, nevertheless the ratio of parallaxes demonstrated above still does not allow its position to fall beneath the Moon.

But on the last day of December (the intervening distances are less certain with Gemma, nor do they match among themselves), when he places the interval from the Mouth of Pegasus at 13 degrees 48 minutes, we found the same at very nearly 14 degrees, about a fifth of a degree greater, when it would have been less here if the comet had been in the elemental region,

seeing that the star in the Mouth of Pegasus was placed below the comet towards the horizon almost in the same vertex. Besides the distance of it observed from the Wing of Pegasus, that we call the First [Star] of the Neck, was found to exceed ours by about 5 minutes, when it ought by rights to have been less if the comet had been elemental, for that star was above it.

And these are the principal observations made by Cornelius Gemma that it was possible to compare with ours, for many of those observed by him did not coincide with those days on which it was clear here, and few [did] with those days on which there shone forth a clear sky at Bohemian Prague, as can be gathered from Thaddaeus' observations. From this there appears more clearly what I warned above about the outcomes of astrological predictions, namely that that part of astrology is to be handled soberly and prudently, especially since there was such a range of changes in the atmosphere within so small a difference of horizons with respect to the entire Earth, both in longitude and in latitude of the Earth.

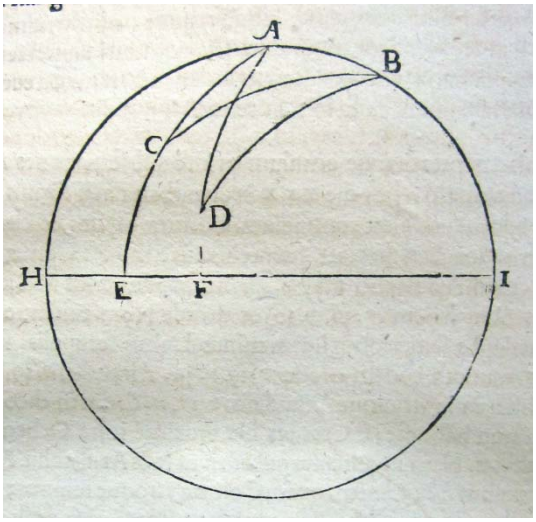
There were besides certain Cornelian observations not, in my view, sufficiently exact, as he is seen in the case of the New Star to be at odds with certain observations of others. In the case of this comet and in seeking its distances he seems to have applied greater diligence; and we have made public those observations of his that seemed more certain through collation with [those] of other days and to agree better with the truth; so that from them, no less than from those that we have compared with the observations of Thaddaeus Hagecius, it can clearly be established that the comet was not placed immediately below the sphere of the Moon, nor in a place yet closer, since that would have caused a much greater diversity of distance, but that it completed its course far above the Moon in the very Aether, which we have set out to demonstrate from the distances detected by various observers in widely separated parts of the orb of the Earth.

Original Text

pp. 134-7

Etiamnum idem ex altitudinibus cometae in diversis azimuthis, interlapso aliquo temporis intervallo, habita ratione interea mutatae declinationis, copiosius concludere.

Quoniam in antecedentibus primum generaliter ex ipso ductu cometae, motuque ordinario, et deinde particularius, ex distantiis a quibusdam fixis sideribus, tam discretis temporibus habitis in eodem Terrae loco, quam iisdem quasi horarum partibus in remotis horizontibus a diversis observatoribus exploratis, manifestum reddidimus, cometam hunc non admittere tantam parallaxin, ut infra orbem Lunae eius situm fuisse, fidem ullam mereatur, sed potius longe supra hunc in ipso Aethere extitisse; idipsum insuper quarta adhuc ratione, ex altitudinibus, azimuthis, et declinationibus diversis, testificari aggrediemur, ut veritas ipsa variis viis inquisita, siquidem ad unum et eundem deveniat scopum, manifestius elucescat.



Assumentes itaque omnium primo observationes altitudinis et azimuthi, quas die XXX Novembris nacti sumus, cum adhuc admodum esset conspicuum cometae caput, et consideratio exactior fieri poterat, deprehensus est eo die cometa, Hora 5 M26 in azimutho P53 M40, ab occasu versus Meridiem, habens altitudinem, P36 M10, et deinde Hora existente 7 M54, interlapsis sesquitribus Horis, minus duobus Scrupulis, fuit eiusdem azimuth eodem modo P15 M50, altitudo, P19 M4, ut sit differentia utriusque altitudinis, P17 M6, quam dico se eo modo non habuisse, si cometa hic proxime infra orbem Lunae extitisset. Nam inquirentes primum ex solis azimuthis et declinationibus altitudinem, quam cometa utroque tempore in eo azimutho obtinere debuisset, conferemus eam cum nostra observatione, et cum iis quas habuisset, si proxime infra concavitatem orbis Lunae extitisset. Descripta itaque sequente figuratione, ubi HABI meridianum repraesentat, HEFI horizontem, cuius polus sit A, Polus vero Mundi B, descendantque per locum utrumque cometae in C et D, quadrantes altitudinum ACE et ADF, manifestum est, quod azimutha utraque sint E et F, declinationum complementa CB et DB, ex quibus innotescent CE et DF altitudines, cum suis differentiis.

Cum enim in triangulo ABC, latus AB sit complementum altitudinis poli, P34 M7, BC sit complementum declinationis cometae (erat autem declinatio ex superioribus suo loco inventa, Hora 5 Min. 26, P7 M8 Borea, unde complementum eius BC, erit P82 M52) cumque in eodem triangulo detur angulus CAB, addendo videlicet azimuth datum ad quadrantem circuli, P143 M40, dabitur per triangulorum rotundorum decreta, resoluto illo triangulo in rectangulum, latus AC, P53 M49, complementum altitudinis, quod isti azimutho in tali Sphaerae situ, et hac praesupposita declinatione, debebatur; ut sit altitudo ipsa, P36 M11, uno saltem Scrupulo nostram observationem exuperans.

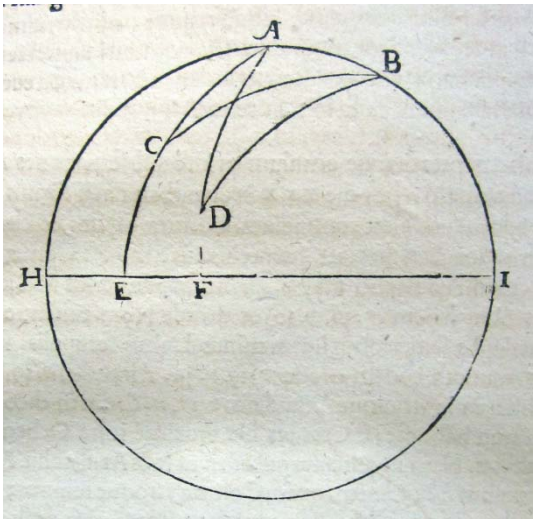
Pari ratione in altero triangulo ABD, quia datur AB ut prius, et BD complementum declinationis nunc est P82 M48 (nam declinatio intervallo Horarum 2½, crescebat in cometa 4 Scrupulis, ut superius capite quarto, ex antecedentium et sequentium dierum deprehensis declinationibus animadvertere licebit) et angulus DAB, ex azimutho et 90 conflatus nunc est P105 M50. Quare eodem modo ut prius, per triangulorum placita, dabitur AD complementum altitudinis secundae, P70 M58, ut sit altitudo correspondens illi azimutho et declinationi, P19 M2, duobus saltem Scrupulis nostra observata altitudine minor. Patet itatque, quod observatio a nobis habita die XXX Novembris, in diversis azimuthis, interlapsis fere sesquitribus Horis, eandem pene altitudinem praebeat, quam exhibuisset, si cometa hic in tanta a nobis remotione extitisset, ut orbis eius ad Terram, immensam haberet magnitudinem, et Terra, respectu ipsius, non admodum esset sensibus obnoxia. Est enim differentia utriusque altitudinis observatae, P17 M6, at utriusque per calculum, respectu centri universi, P17 M9, tribus solummodo Scrupulis observationem excedens, cum tamen longe plus abundasset, si proxime in concavitate orbis Lunae extitisset hic cometa, et adhuc magis, si propius Terrae ipsius situs in suprema Aeris regione concederetur, quod in hunc modum manifestum, et dubitationi minime obnoxium, reddemus.

Translation

pp. 134-7

To reach the same conclusion yet again more fully from the altitudes of the comet at different azimuths, with a certain interval of time having passed, with account being taken of the changed declination in the meanwhile.

Seeing that above we have made it clear—first generally from the very path of the comet and [its] orderly motion, and then more specifically from [its] distances from certain fixed stars, both taken at discrete times from the same place on the Earth and ascertained at approximately the same minutes of the hour by different observers at remote horizons—that this comet does not receive enough parallax for any faith to be warranted that its place was below the orb of the Moon, but that it was rather far above it in that very Aether; accordingly we shall set out with yet another reason, a fourth one, to give evidence from various altitudes, azimuths and declinations, in order that if, indeed, it should reach one and the same target [as the other reasons given], the very truth sought out in diverse ways may shine forth more clearly.



Taking first of all the observations of altitude and azimuth which we obtained on the 30th day of November, when the head of the comet was still quite conspicuous and a more exact examination could be carried out, the comet was found on that day at 5 hours 26 minutes at an azimuth of 53 degrees 40 minutes from the west towards the south, having an altitude of 36 degrees 10 minutes, and then with the time being 7 hours 54 minutes, with 2½ hours less two minutes having elapsed, its azimuth [measured] in the same way was 15 degrees 50 minutes, its altitude 19 degrees 4 minutes, so that the difference of the two altitudes is 17 degrees 6 minutes, which I declare could not have happened in this way if the comet had been here very close below the orb of the Moon. For seeking first, from the azimuths and declinations alone, the altitude that the comet ought to show at the two times at that azimuth, we shall compare it with our observation and with those [altitudes] it would have had, had it been immediately below the concavity of the orb of the Moon. So, having drawn the

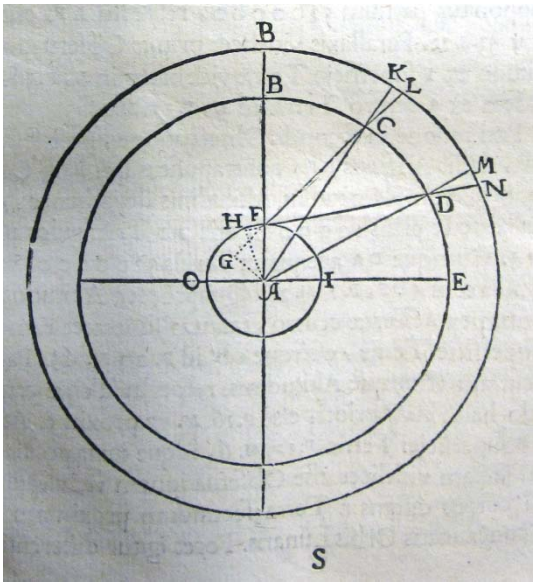
following figure, where HABI represents the meridian, HEFI the horizon, let its pole be A, the pole of the World B, and let there descend through both places of the comet at C and D quarter-circles of altitudes ACE and ADF; it is then clear that the two azimuths should be E and F, the complements of the declinations CB and DB, from which the altitudes CE and DF will be made known, with their differences. For since in the triangle ABC, the side AB is the complement of the altitude of the pole, 34 degrees 7 minutes, BC should be the complement of the declination of the comet (for from the things said above in the relevant passage its declination was found at 5 hours 26 minutes to be 7 degrees 8 minutes north, whence its complement BC will be 82 degrees 52 minutes) and since in the same triangle the angle CAB is given as 143 degrees 40 minutes, namely by adding the given azimuth to the quarter-circle, there will be given by the laws of spherical triangles—having resolved that triangle into a right-angled one—the side AC of 53 degrees 49 minutes, the complement of the altitude, which was determined by that azimuth at such a position in the Sphere and by this assumed declination; whence that altitude is 36 degrees 11 minutes, exceeding our observation by only one minute.

By the same reckoning, in the second triangle ABD, because AB is given as before, and BD the complement of the declination is now 82 degrees 48 minutes (for in the space of 2½ hours the declination of the comet was growing by 4 minutes, as can be gathered in chapter 4 above from the declinations found of the preceding and following days), and the angle DAB, made up of the azimuth and 90 [degrees], is now 105 degrees 50 minutes. Wherefore in the same way as before, by the laws of triangles, there will be given AD the complement of the second altitude as 70 degrees 58 minutes, so that the altitude corresponding to that azimuth and declination is 19 degrees 2 minutes, scarcely two minutes less than our observed altitude. It is clear therefore that our observation on the 30th day of November at diverse azimuths, after the passage of almost 2½ hours, shows almost the same altitude as it would have exhibited if this comet had existed at such a remove from us that its orb would have an immense magnitude [compared to] the Earth, and the Earth, with respect to it, would not be at all evident to the senses. For the difference of each of the observed altitudes is 17 degrees 6 minutes, but of each by calculation with respect to the centre of the Universe 17 degrees 9 minutes, only exceeding observation by 3 minutes – when however it would have exceeded by far more if this comet had existed close to the concavity of the Moon, and by even more if it were accorded a place closer to the Earth in the highest region of Air, which we will make manifest and minimally exposed to doubt in the following way.

Original Text

pp. 137-9

Sit enim orbis Terrae OFI, centro suo A descriptus, infima vero convexitas orbis Lunae, repraesentetur per arcum BCDE, orbis autem aliquis, cuius respectu Terra non habeat sensibilem quantitatem, indicetur per arcum BKLMN. Sitque locus altitudinis cometae observatae, quasi is esset in infima convexitate Lunae in C, quo ad primam observationem, in D vero, quo ad posteriorem, vt sit altitudo oblata visui prima in L, altera in N, altitudo autem vera antecedens in K, sequens in M, respectu centri universi. Dico, quod alia et maior erit tunc differentia utriusque altitudinis apparentis ex F circumferentia Terrae, quam si ex A eius centro eadem animadverti posset.



Nam in prima observatione erat angulus BFC, P53 M50, cui aequalis est ipsi contrapositus in triangulo per constructionem rectangulo, GFA, latus vero FA, cum assumatur 100000 erit GA 80730. Deinde in triangulo GAC, siquidem latus AC praesupponitur Partium 5200000, respectu AF, erit angulus GCA, M53 S22, parallaxis videlicet primae observationis. Unde si altitudo ex F superficie Terrae videbatur in L, P36 M10, erat eadem ex A centro Terrae in K, P37 M3⅓.

Pari ratione in secunda observatione, post sesquitertiam Horam, datur angulus HFA contrapositus ipsi BFD observato, P70 M56, complementum altitudinis deprehensae, et latere AF existente ut prius 100000, erit per Triangulos planos AH 94514. Cumque DA accipiatur

rursus 5200000, erit angulus parallaxeos ADF, P1 M2½. Quapropter altitudo posterior observata ex A Terrae centro, tantum superaret eam, quae est ex F superficie Terrae, essetque ob id P20 M6½. Patet itaque differentiam utriusque altitudinis, respectu Terrae centri, conferendo hanc cum priori, esse P16 M57 proxime. At respectu ipsius F superficiei Terrae, P17 M6, idque iuxta positionem nostram, factam videlicet esse observationem utriusque altitudinis ad corpus distans a Terra secundum proximam remotionem concavitatis orbis Lunaris. Foret igitur differentia, 9 Scrupulorum, quibus parallaxis altitudinis variaretur, cum tamen revera per observationem non alterata sit ab ea differentia quae fieri poterat respectu centri universi, plusquam tribus Scrupulis, quibus observatio minorem praebuit altitudinum differentiam, quam supputatio respectu centri mundi exigebat, cum potius maior esse deberet, si FA aliquam habuisset sensibilem proportionem ad AC vel AD. Quod autem trinis Scrupulis in diversum sentiat, excusationem facile meretur, siquidem in prima observatione uno Scrupulo, in altera duobus sensus falli proclive erat; vel potius occasione refractionis, quae maior sit in decliviori altitudine, quam altiori. Sed cum trium saltem Scrupulorum sit haec variatio pro nihilo reputatur, imo illa quod in contrarium abeant, rem quam intendimus, evidentius comprobant.

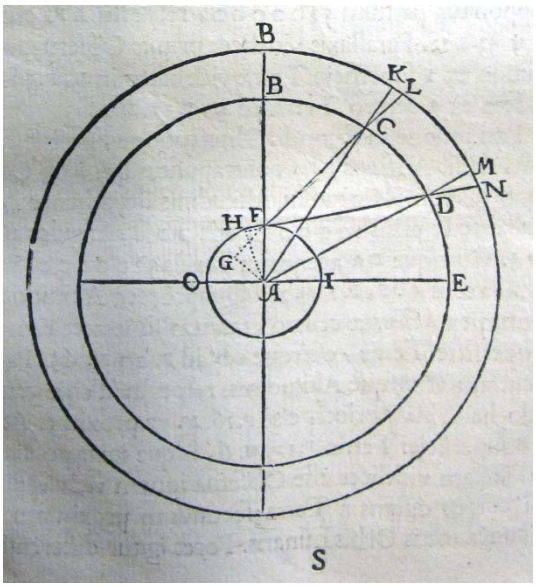
Quapropter liquet et hic, cometam non extitisse in orbe BCDE, proxima videlicet distantia concavitatis Lunae a Terra, nec in loco propiore, tunc enim adhuc maior facta fuisset differentia inter altitudinem visam et veram. Quare longe supra Lunam in ipso Aethere locum obtinebat; quod demonstrare hac quarta ratione intendebamus.

Translation

pp. 137-9

For let the orb of the Earth OFI be drawn with its centre A. Let the lowest convexity of the orb of the Moon be represented by the arc BCDE; moreover, let an orb, with respect to which the Earth should not have a perceptible size, be indicated by the arc BKLMN. And let the place of the observed altitude of the comet, as if it were in the lowest convexity of the Moon, be in C as to the first observation, in D however as to the second, so that the altitude offered to sight is first in L, secondly in N; however, [let] the true altitude of the former with respect to the centre of the Universe be in K, the latter in M. I say that the difference between the

two altitudes will be greater as it appears from F, the circumference of the Earth, than if it had been possible to observe the same from A, its centre.



Now, in the first observation the angle BFC was 53 degrees 50 minutes, to which is equal its contrary in the triangle GFA, right by construction; and when side FA is assumed [to be] 100,000, GA will be 80,730. Then in triangle GAC, since side AC is assumed [to be] of 5,200,000 parts with respect to AF, angle GCA will be 53 minutes 22 seconds, namely the parallax of the first observation. Whence, if the altitude from F, the surface of the Earth, was seen at L [to be] 36 degrees 10 minutes, from A, the centre of the Earth to K, [the altitude] was 37 degrees 3⅓ minutes.

By comparable reasoning, in the second observation, after 2½ hours, angle HFA, contrary to the observed BFD, is given as 70 degrees 56 minutes, the complement of the altitude observed, and with the side AF being as before 100,000, through planar triangles AH will be 94,514. And since DA is taken again to be 5,200,000, the angle of parallax ADF will be 1 degree 2½ minutes. Wherefore the latter altitude observed from A, the centre of the Earth, much exceeds that observed from F, the surface of the Earth, and should be, therefore, 20 degrees 6½ minutes. Thus, comparing this with the previous one, it is clear that the difference of the two altitudes with respect to the centre of the Earth is very nearly 16 degrees 57 minutes. But with respect to the surface of the Earth F itself, it is 17 degrees 6 minutes, and this given our position, is the observation made of the two altitudes to a body distant from the Earth in accordance with the nearest distance of the concavity of the lunar orb. So

the difference will come to 9 minutes by which the altitudinal parallax differs, when in truth according to observation it does not differ from that difference which could arise with respect to the centre of the Universe by more than the three minutes by which observation showed [there to be] less difference in altitude than calculation with respect to the centre of the World required, since it ought to be somewhat greater if FA had had some detectable proportion to AC or AD. But it is readily to be excused that it [observation] perceives it [parallax] differently by three minutes, given that sense was liable to error in the first observation by one minute, in the other by two; or rather, on account of refraction, which is greater at a lower altitude than at a higher one. But since this variation was of only three minutes, it may be counted as nothing. Indeed, those things, in so far as they run contrary to it, quite clearly confirm the matter that we proposed.

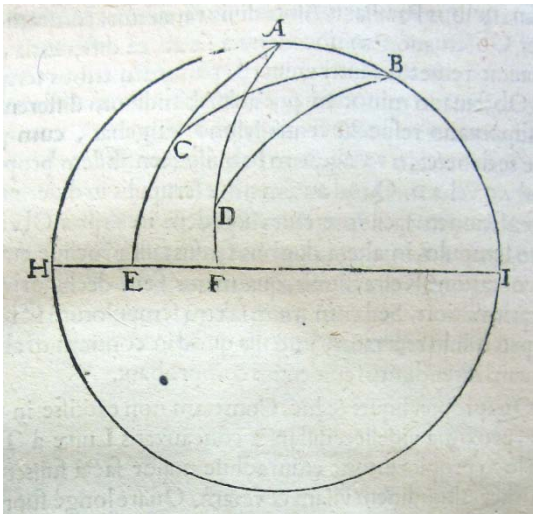
According to which this also is clear, that the comet did not exist in the orb BCDE, namely the closest distance to the concavity of the Moon from the Earth, nor in a closer place, for then, the difference of the apparent and true altitude would have been made greater [than] hitherto. Whence it had its place in the very Aether, as we set out to demonstrate by this fourth reasoning.

Original Text

pp. 139-40

Sed assumatur ulterioris etiam certitudinis gratia, observatio facta die XIII Decembris, primum Hora 7 M1, ubi azimuth deprehendimus ab Occasu versus Meridiem, P19 M45, altitudinem, P28 M56. Secundo vero Hora 9 M3, interlapsis paulo plus duabus Horis, quando azimuth erat P6 M20, versus Septentrionem, altitudo, P12 M14. Fuit autem ex iis quae superius suo loco diximus, et inde colligi poterunt, prima declinatio, P13 M34. Posterior vero, P13 M36. Unde considerata figura mox ante proximam annotata, cum sua demonstratione, ubi in numeros redacta fuerit, dabitur in primo triangulo CAB, latus AC, P61 M4¾. In posteriori DAB, latus DA, P77 M47½, ut sit altitudo prima, P28 M55¼, posterior, P12 M12½, respectu centri universi, ex datis his azimuthis et declinationibus. Estque differentia utriusque altitudinis P16 M42¾, cum tamen discrepantia altitudinum a nobis observatarum, et prius annotatarum, sit P16 Minut. 42. Quae, si scrupulose velimus rem considerare, non integro Minuto, sed saltem tribus quartis unius Minuti ab ea, quae ex centro Terrae

conspiceretur, discrepat minorque existit, id quod plane est sensibus incomprehensibile. At si cometa hic proxime infra orbem Lunarem extitisset, longe maiorem potius induxisset differentiam utriusque altitudinis, in eo intervallo temporis azimuthorumque.

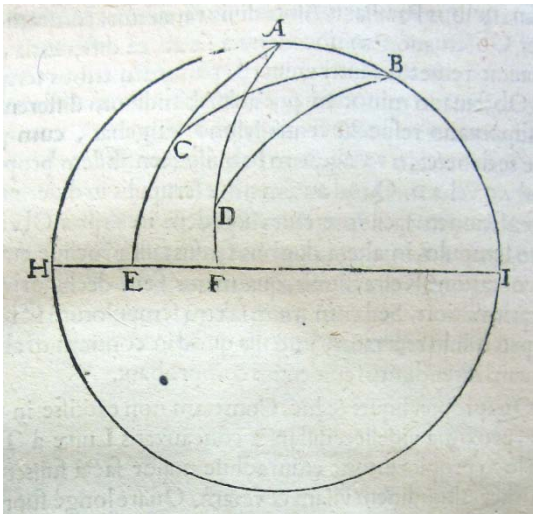


Translation

pp. 139-40

However, for the sake of further certainty, let us take the observing that was done on the 13th day of December, first at the 7th hour 1 minute, where we discerned the azimuth from the west towards the south as 19 degrees 45 minutes, the altitude as 28 degrees 56 minutes; and secondly at the 9th hour 3 minutes, with a little more than two hours having elapsed, when the azimuth was 6 degrees 20 minutes towards north, the altitude 12 degrees 14 minutes. However, from the things that I have discussed above in the relevant place and which could be gathered from there, the first declination was 13 degrees 34 minutes, the latter 13 degrees 36 minutes. Whence, having considered the figure given just before with its demonstration, where it was reduced to numbers, side AC in the first triangle CAB will be given as 61 degrees 4¾ minutes. In the latter [triangle] DAB, side DA [will be given] as 77 degrees 47½ minutes, so that the first altitude is 28 degrees 55¼ minutes, the latter [altitude] 12 degrees 12½ minutes, with respect to the centre of the Universe, from these given azimuths and declinations. And the difference between the two altitudes is 16 degrees 42¾ minutes, since the discrepancy between the altitudes observed by us and remarked on before is 16 degrees 42 minutes. This, if we would want to consider the matter scrupulously, differs from, and is

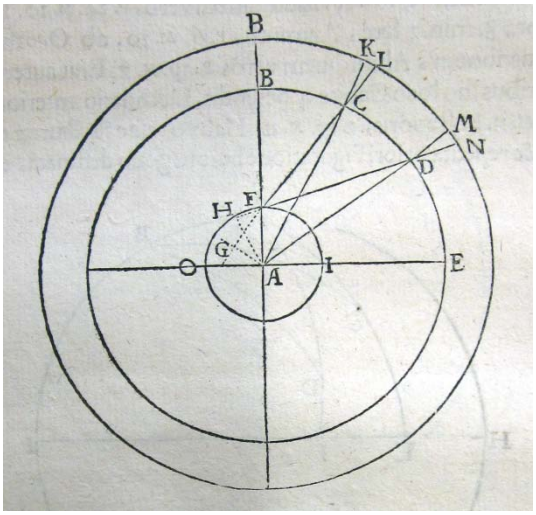
less than, that which should be discerned from the centre of Earth by not a whole minute, but by only three quarters of a minute, which is clearly ungraspable by the senses. But if this comet had been close below the lunar orb, it would have induced a rather greater difference between the two altitudes, in that interval of time and between azimuths.



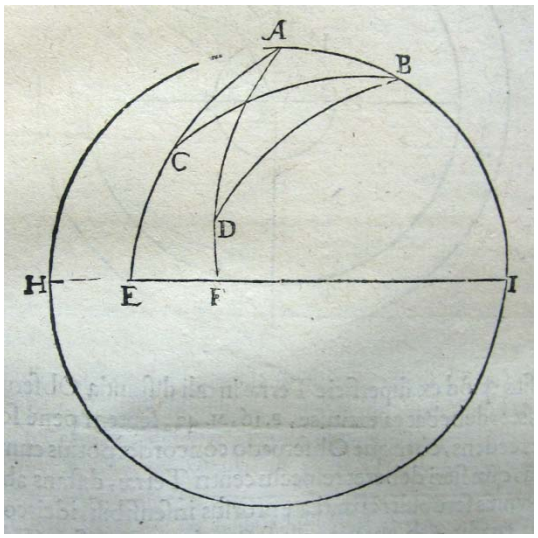
Original Text

pp. 140-4

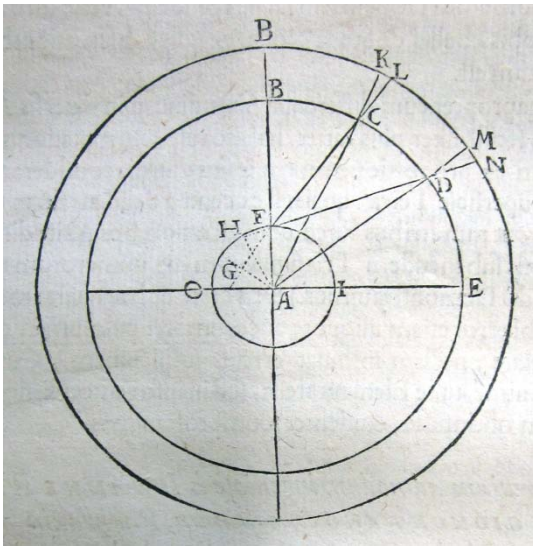
Assumentes enim figurationem, qua prius usi sumus, per quam parallaxes indagabantur, invenimus diversitatem aspectus altitudinis prioris temporis, videlicet angulum GCA, P0 M58 fere, et posterioris, utpote angulum ADF, P1 M47½, ut sit ob id altitudo vera prior respectu centri A, P29 M54, posterior ratione eiusdem, P13 M18½, cuius differentia est P16 M35½, quam causaretur in iis azimuthis, si cometa ex centro Terrae videretur. At quoniam superius, posito quod ex superficie Terrae in tali distantia observatio facta fuisset, debebat ea extitisse, P16 M42, septem pene Scrupulis hanc excedens, cumque observatio concordet potius cum ea differentia, quae fieri deberet respectu centri Terrae, distans ab ea saltem ¾ unius Scrupuli, quantitate prorsus insensibili, idcirco manifestum evadit, observationem factam in F, superficie Terrae, insensibiliter differre ab ea, quae fieri posset a centro Terrae A; ideoque cometam multo longius remotum fuisse, quam quod FA semidiameter Terrae, ad ipsius situm habuerit sensibus admodum incurrentem magnitudinem, id quod longe supra Lunam primum fieri, astronomiae peritis nullatenus dubitatione dignum censetur.



Experiamur vero adhuc tertio idipsum per observationem altitudinis et azimuthorum factam die II Januarii, quando Hora 6 Min. 10, deprehendimus azimuth cometae ab Occasu versus Meridiem P17 M23, altitudinem vero, P34 M20. Et deinde Hora 8 Min. 2 fere, azimuth, P6 M20, ab Occasu versus Septentrionem, altitudinem vero, P19 M7. Erat autem ex superioribus suo loco capite 4 petendis, declinatio anterioris loci, P19 M11, posterioris, P19 M12. Habito respectu diurnae mutationis, et repetita priori figuratione huic negotio destinata, est post supputationem in triangulo priori ABC, complementum altitudinis primae AC, P55 M40, posterioris ABD, evadit AD, P70 M54, unde altitudo prior existit P34 M20, posterior, P19 M6, ut sit differentia utriusque, P15 M14, distans a discrimine utriusque altitudinis a nobis observatae, et modo annotatae, tantum unico Scrupulo insensibili, quo excedere videtur; cum tamen multo minor foret, si cometa in proxima concavitate orbis Lunae, vel adhuc propius versaretur. Nam in sequenti figuratione, per quam parallaxes eruimus, manifestatur, hanc respectu centri Terrae ad primam observationem extitisse per angulum GCA, M54½, et in posteriori per angulum HAD, P1 M2½. Quapropter fuisset altitudo vera respectu centri



Terrae A, prior P35 M14½, posterior P20 M9½, ut sit differentia utriusque P15 M5; cum tamen conferendo superficiem Terrae debuisset, ex priori positione, fuisse, P15 M14, discrimine existente utriusque 9 Scrupulorum, quibus distantia observata a supremitate Terrae superaret eam, quae ex centro. At cum variatio distantiarum a nobis observata in superficie Terrae F, eadem sit pene cum ea, quae fieri posset ex centro A, nec differat nisi uno Scrupulo insensibili, nedum ut noventis dissentiat, manifestum hac tertia vice evadit, tantum fuisse quantitatem lineae FC et FD, quae est distantiae a Terra ad cometam, ut linea FA, semidiameter Terrae, non habuerit, respectu illius, sensibus incurrentem proportionem, et ob id idem sequi, sive observatio haec facta esset in F sive in A, respectu distantiae ipsius C et D loci utriusque cometae. Idipsum vero fieri non posse in proxima concavitate sphaerae Lunaris, nedum in loco adhuc propriore, geometrica ratiocinatio facile convincit, velut tum ab aliis, tum a nobis libello de Stella Nova, ex ipsis observationibus demonstratum est.

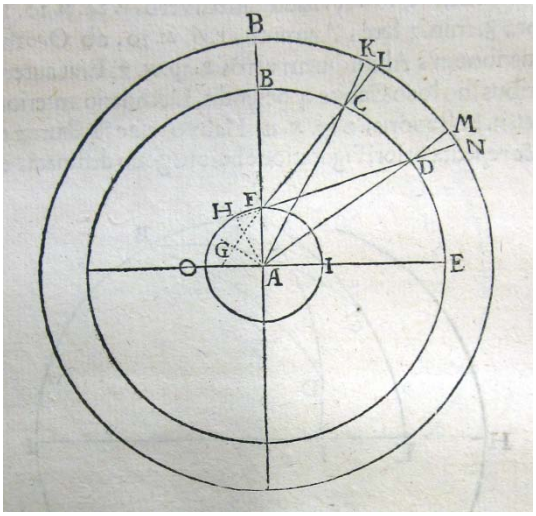


Quapropter cum differentia altitudinum in diversis azimuthis, non sensibiliter plus variet, habito respectu mutationis declinationum ex proportione motus ipsius diurni, consideranti eandem ex superficie Terrae, quam si ex centro eiusdem fieret observatio (prout nunc tribus hisce considerationibus altitudinum et azimuthi, sub incudem triangulorum, et numerorum revocatis, liquido demonstravimus). Satis certo et hac quarta ratiocinatione (ubi error etiam aliquot paucorum Scrupulorum in temporis varietate, nullam insinuat erroris suspicionem) cometam hunc minime fuisse Elementarem, sed in ipso remotissimo Aethere locum obtinuisse, evidenter comprobavimus.

Translation

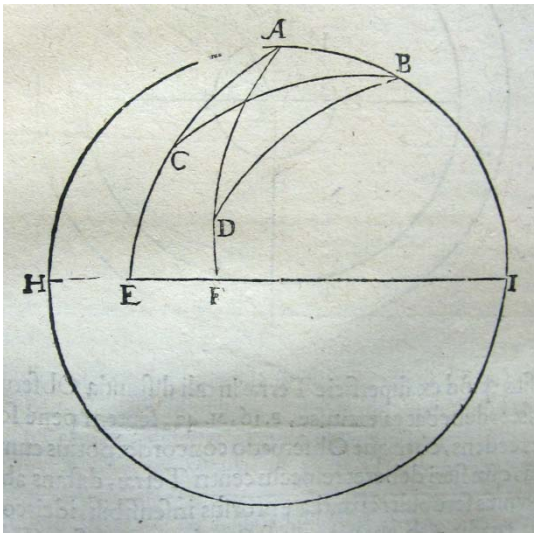
pp. 140-4

For taking the figure that we used previously, with which parallaxes were investigated, we find the difference in aspect of the altitude at the first time, namely, the angle GCA, about 0 degrees 58 minutes, and at the later time, as the angle ADF, 1 degree 47½ minutes, so that, on that account, the earlier true altitude with respect to the centre A is 29 degrees 54 minutes, by reasoning the later of the same, 13 degrees 18½ minutes, whose difference is 16 degrees 35½ minutes, which would be caused in those azimuths were the comet seen from the centre of the Earth. And given that it should have been greater, namely 16 degrees 42 minutes (exceeding this by about 7 degrees), given that the observation was made at such a distance from the surface of the Earth, and since the observation agrees rather with that difference that ought to occur with respect to the centre of the Earth, being distant from it by only ¾ of one minute, an almost undetectable amount, it clearly turns out on that account that the observation made at F, on the surface of the Earth, differs imperceptibly from that which would occur from the centre of the Earth A: and accordingly that the comet was at a much greater distance than for FA, the radius of the Earth, to have had in relation to its position a magnitude impinging on the senses, on account of which it is thought to be in no way worthy of doubt by those skilled in astronomy that it appeared at first above the Moon.



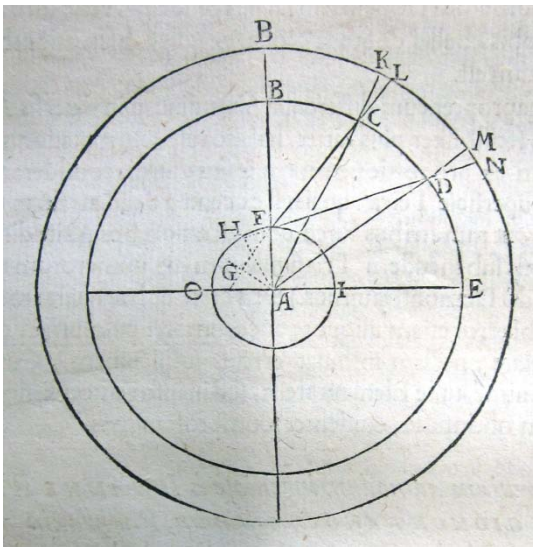
Besides, we proved the same a third time through observation of the altitude and azimuths made on the 2nd day of January, when at 6 hours 10 minutes we found the azimuth of the comet from the west towards the south to be 17 degrees 23 minutes and the altitude 34

degrees 20 minutes, and then at about 8 hours 2 minutes the azimuth 6 degrees 20 minutes from the west towards the north and its altitude was 19 degrees 7 minutes. But the declination, to be sought above in its place in chapter 4, of the former location 19 degrees 11 minutes, of the latter 19 degrees 12 minutes. Taking account of the daily change and returning to the previous figure assigned to this business, after calculation in the first triangle ABC, the complement of the first altitude AC is 55 degrees 40 minutes [and] in the second [triangle] ABD, AD comes to 70 degrees 54 minutes, whence the first altitude is 34 degrees 20 minutes, the second 19 degrees 6 minutes, so that the difference of the two is 15 degrees 14 minutes, differing from the difference of the two altitudes observed by us and immediately recorded, by only one imperceptible minute, by which it appears to be greater, when, however, it would be much less if the comet was situated in the nearest concavity of the orb of the Moon, or yet closer. Now in the following figure, through which we elicit the parallaxes, it is manifest, with respect to the centre of the Earth at [the time of] this first observation, that this [comet] was at the angle GCA of 54½ minutes and in the latter case at the angle HAD of 1 degree 2½ minutes. Whence it follows that the true altitude with respect



to the centre of the Earth was in the first case 35 degrees 14½ minutes, in the latter 20 degrees 9½ minutes, so that the difference of the two is 15 degrees 5 minutes; when, however, referring to the surface of the Earth, in the first situation, it should have been 15 degrees 14 minutes, the difference of the two being 9 minutes, by which the difference observed from the surface of the Earth exceeds that which [would be observed] from the centre. But since the variation of the distance observed by us on the surface of the Earth is almost the same as that which it would be from the centre A, nor does it differ except by a single imperceptible minute, let alone differing by nine times as much, hence it turns out

from this third [attempt] that the extent of the line FC and FD, which is the distance of the Earth to the comet, is so great that the line FA, the radius of the Earth, would not have with respect to it an amount evident to the senses, and on that account that the same follows, whether the observation were to have been made at F or at A, with respect to both distances of the position of the comet, C and D. Geometrical reasoning readily proves that it truly cannot be in the nearest concavity of the sphere of the Moon, let alone yet nearer, as has been demonstrated both by others and by us from these very observations in the book, *De stella nova*.



So since the difference of altitudes at diverse azimuths does not vary detectably more – taking account of the change of declination in proportion to its diurnal motion, considering the same from the surface of the Earth – than if the observation were made from its centre (as we have now clearly demonstrated from these three considerations of altitudes and azimuths applied to the anvil of triangles and numbers), we have evidently demonstrated by this fourth reasoning also (where likewise the error of some few minutes in the difference of times introduces no suspicion of error) that this comet was not in the least elemental, but had its place in the most remote Aether.

Original Text

pp. 144-6

Per viam admodum ingeniose a Johanne Regiomontano excogitatam, parallaxin huius cometae adhuc alia quadam ratione perscrutari.

Sufficienter quidem in antecedentibus demonstratum esse arbitror, cometam hunc nullatenus sublunarem extitisse, sed in ipso coelo inter orbes perpetuos et Aethereos, sublimiorem sedem sibi vendicasse; veruntamen, ne vel ignorasse, vel data opera praeteriisse neglexisseque ea, quae ab antecessoribus nostris de hoc negotio literis prodita sunt, insimulari possimus, adducam etiam ulterioris comprobationis causa, eam viam indagandae parallaxeos cometarum, quam clarus ille Germanorum mathematicus Johannes de Monteregio, scriptis posteritati reliquit. Is enim cum prae aliis suis coaetaneis in astrorum totaque mathematum scientia antecelleret, suaque aetate aliquot cometas, brevi interjecto tempore, conspexisset, eorum dimensionem sublimi ingenio agressus est. Licet vero cum Aristotele de cometarum Elementari situ prorsus consentiret; ipsius enim authoritas omnia pulpita, omnes scientiarum aditus, eo aevo (utinam non de nostro idem conqueri liceret) adeo occupaverat, ut nefas iudicarent, ab eius placitis latum unguem discedere; adeo semper praeclusa est servilibus hominum ingeniis libera veritatis via: nihilominus cum is, ut erat ingenio arduo et iudicio gravi praeditus, motum cometarum conformem et regularem, adeo ut circulum in Sphaera maximum fere semper describerent, animadvertisset, caepit nonnihil haesitare, et rem altiori indagine opus habere, secum constituere. Ideoque eruditum simul atque utilem libellum de cometarum observationibus posteris reliquit, quo eorum situm, distantiam, motum, magnitudinemque solerter indagare docuit. Cumque quattuor rationibus ibidem proposuerit, diversitatem aspectus cometae in circulo altitudinis investigare, imitabimur hoc loco eam, quae sola huius cometae (de quo agimus) phaenomenis congruere invenitur, quam Problemate eiusdem libelli Secundo tradidit; ubi per duas altitudines, ante vel post meridianum, in diversis azimuthis acceptas, et cognito etiam tempore inter easdem binas observationes elapso, utramque parallaxin in circulo altitudinis notam efficit, subtili quidem et ingeniosa satis speculatione, sed quae in parallaxibus illis minoribus, quales in Aethere fiunt, nullatenus locum mereatur. Struit enim ex minimis maxima, adeo ut unius aut alterius Scrupuli error in tempore, qui facile obrepere potest, in nimiam excrescat deviationem; tum etiam azimutha atque altitudines, nisi adeo scrupulose, ut nihil desideretur, obtineantur, oleum et operam (ut dici solet) perdideris. Paucorum namque Scrupulorum vix sensibilium lapsus, in tempore atque caeteris datis, aliquot Graduum a veritatis scopo digressionem facile inducit. Verum cum Regiomontanus, Peripateticorum argumentis et authoritatibus inductus, potius crederet cometas esse sublunares, et in superiori Aeris regione generari, ubi multorum Graduum parallaxin inducerent, non dubitavit hanc rationem, utut in subtiliori negotio minus praxi idoneam, et his saltem maioribus parallaxibus utilem, in medium proponere.

Translation

pp. 144-6

To investigate the parallax of this comet by yet another method, one most ingeniously devised by Johannes Regiomontanus.

Indeed, I judge to be sufficient the earlier demonstration that this comet was by no means in the sublunar realm, but that it claimed [*vendicasse*] a higher seat for itself in the heavens itself between the perpetual and aethereal orbs. Nevertheless, in order that we should not be able to be charged with either ignorance or neglect of the things that have been published on this topic by our predecessors, I shall add by way of a final proof the method of investigating the parallax of comets which that famous mathematician of Germany, Johannes Regiomontanus, left to posterity in his writings. For he, since he excelled his contemporaries in the whole science of stars and mathematics and in his lifetime observed some comets, occurring at short intervals, with his exalted genius, he embarked on their measurement. Although indeed he was in complete agreement with Aristotle on the elemental position of the comets, for at that time (would that the same could not be said of ours) his authority controlled every pulpit, every access to the sciences, to such an extent that they judged it a crime to deviate from his opinions by a hair's breadth [literally, 'by the breadth of a fingernail']. Truly the free path of truth is always closed to the servile wits of men. Nonetheless, as he was gifted with lofty wit and serious mind, he noticed that the motion of the comets was well-formed and regular to such a degree that they nearly described a great circle in the Sphere, he began in some measure to be undecided and to hold the matter as a work for profounder study, to be undertaken by himself. For that reason, he left to his successors a small book, learned and at the same time useful, on observations of comets, in which he showed cleverly how to investigate their place, distance, motion, and size. And since he proposed in that place to investigate with four methods the difference in aspect of the comet in the circle of altitude, we will follow in this place the one that, alone of his, is found to be adapted to the phenomena of the comet with which we are dealing, which he related in the Second Problem of the same book; where through two altitudes taken before or after the meridian, at different azimuths, and also with the time elapsed between the two observations known, he makes known each parallax in the circle of the altitude in a subtle and most ingenious method of examination [*speculatione*], but one which by no means deserves a place

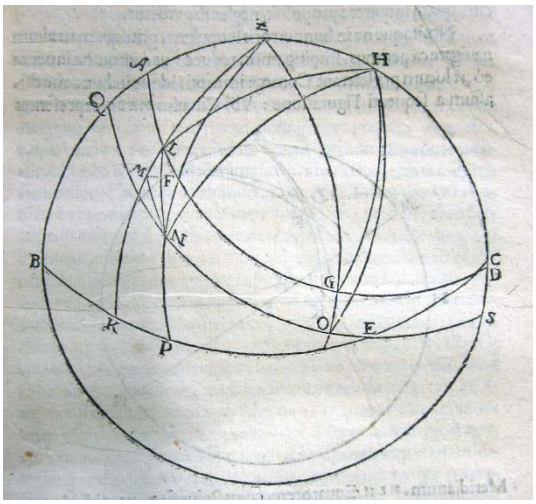
with those lesser parallaxes that occur in the Aether. For he constructs maximums from minimums, in such a way that the error in time of one or two minutes, which can easily creep in, grows to an excessive deviation. Then, moreover, unless the azimuths and altitudes are obtained so precisely that nothing is lacking, you will have wasted the effort and work [*oleum et operam*] (as the saying goes). For an error of a few hardly detectable minutes in time, and the other given things, produces a departure of some degrees from the goal of truth. Indeed, since Regiomontanus, led by the arguments and authorities of the Peripatetics, believed rather that the comets were sublunar and were produced in the upper region of the Air, where they produced parallax of many degrees, he did not hesitate to publish this method of reasoning, though less suitable in a more subtle enterprise, but useful at least for these greater parallaxes.

Original Text

pp. 146-7

Ut itaque idipsum, quod de cometa hoc prius demonstravimus, manifestius evadat, per ipsius semitam ingressi, assumamus primum binas diligenter habitas observationes altitudinum et azimuthorum, certoque tempore repertas, die XIII Decembris, qui nobis ante annos XXXI natalis illuxit; quarum prior fuit Hora 7 M7¼, visusque est cometa in azimutho, P19 M45, ab Occasu aequinoctiali versus meridiem, altitudine, P28 M56 existente, altera Hora 9 M8, in azimutho, P6 M20 ab Occasu versus Septentrionem, et in altitudine, G12 M12. Lubet hinc Regiomontani imitatione, parallaxin in circulo altitudinis utrobique indagare. Describatur idcirco sequens figuratio, in qua circulus ABCHZ meridianum repraesentet, BEC sit medietas horizontis Occidentalis, L sit locus verus cometae in prima observatione, M visus, G locus verus in posteriori, O visus. Ducantur a polo horizontis Z, quadrantes per haec puncta (notum enim est verum et visum locum existere semper in eodem verticali) videlicet quadrans ZLMK per locum verum et visum priorem, et ZGO per posteriorem, arcus semidiurnus cometae verus sit ALGD, in quo utraque loca vera, tanquam manente cometa quo ad proprium cursum immoto, assumantur L et G. Arcus vero semidiurnus loci visi in secunda observatione, in puncto O, sit QOS. Rursus a polo aequatoris H, ducantur duo arcus HG et HO, ad locum verum et visum secundae observationis in G et O; trahatur insuper ab eodem ad situm verum primae observationis, HL, qui erit aequalis ipsi GH; Praeterea constituatur angulus LHN, aequalis angulo GHO, et insuper arcus HN aequalis ipsi HO. Quoniam itaque in medio tempore interlapso, punctum L ad G motu primo defertur, ita etiam N ad O traduci

necessarium erit, siquidem duo anguli GHL et OHN, invicem sunt aequales, eo quod per constructionem fecimus LHN, aequalem angulo GHO, et intermedius NHG est communis utrique. Connectantur dehinc L et N, arcu circuli maximi, et eodem modo M et N. Manifestum est, quod LM sit parallaxis in circulo altitudinis primae observationis, et GO parallaxis secundae, quae duo inquirere intendimus.



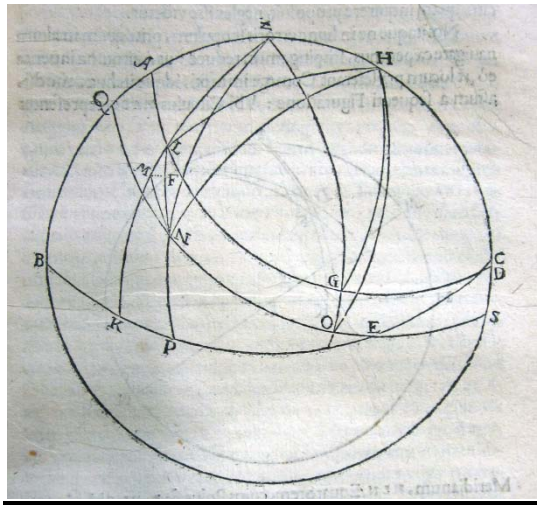
Translation

pp. 146-7

So that what we have already demonstrated about this comet may be made clearer from the path at its beginning, let us consider first two observations of altitudes and azimuths diligently performed on the 13th day of December, which 31 years ago dawned as our birthday.[1] The first of these was at 7 hours 7¼ minutes, and the comet was seen at an azimuth at 19 degrees 45 minutes from the equinoctial west towards the south, [its] altitude being 28 degrees 56 minutes; the other at 9 hours 8 minutes, [the comet being] at an azimuth at 6 degrees 20 minutes from the west towards the north, and at an altitude of 12 degrees 12 minutes. Hence, in imitation of [the method of] Regiomontanus, the parallax can be investigated on both sides of the circle of altitude. So let the following figure be drawn, in which the circle ABCHZ represents the meridian; and let BEC be the middle of the western horizon, let L be the true place of the comet, M the apparent one, in the first observation, and G the true position, O the apparent one, in the second [observation]. Let there be drawn quadrants from the pole of the horizon Z, through these points (it is to be noted that the true

[1] Tycho is conventionally said to have been born on the 14 December 1546

and apparent places are always on the same vertical), namely the quadrant ZLMK through the first true and apparent places and ZGO through the second ones; and let the half-daily true arc of the comet be ALGD, in which the two true places are taken to be L and G, as if with the comet remaining unmoved with respect to its true path. Let the half-daily arc of the apparent place in the second observation at point O be QOS. Again, let there be drawn from the pole of the equator two arcs, HG and HO, to the true and apparent places of the second observation at G and O; in addition let there be drawn from the same [point] to the true place of the first observation HL, which will be equal to GH itself. Besides, the angle LHN is made equal to the angle GHO and likewise the arc HN equal to HO itself. So, given that in the course of the time elapsed the point L is moved to G by the prime motion, accordingly it will also be necessary that N be conveyed to O, since indeed the two angles GHL and OHN are equal to each other, since through construction we have made LHN equal to the angle GHO and the [angle] NHG is common to both. Next, let L and N be connected by the arc of the great circle, and in the same way M and N. It is clear that LM should be the parallax in the circle of altitude of the first observation and GO the parallax of the second, both of which we intend to seek out.



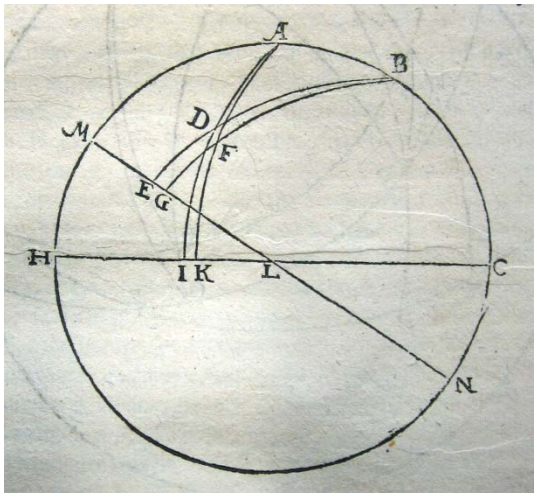
Original Text

pp. 147-51

Verum, quia Regiomontanus, in hac pragmatia, praesupposuit, cometam non moveri nisi motu primi mobilis, hic vero (de quo nunc tractamus) et omnes fere alii, sensibilem cursum proprium, etiam vel tantillo interjecto temporis spatio, obtineant, res haec maiori ante omnia indigebit limitatione, quam Regiomontanus, sive de industria, sive quod eam in magnis

parallaxibus, quas cometis, inesse praesupposuit, minus movere dubii iudicarit, non sine dispendio veritatis, quam inquirere proposuit, neglexisse videtur.

Nos itaque ne in hunc erroris scopulum, priusquam in altum navigare caeperimus, impingamus, reducemus azimutha inventa eo, ut locum praeseferant cometae immoti, idque in hunc modum, assumta sequenti figuratione: ubi circulus HABC repraesentet meridianum, MLN aequatorem, cuius polus sit B, HLC horizontem, cuius polus sit A, locus cometae ratione primae observationis sit in D, posterioris in F, per quae duo loco ducantur tam a polo horizontis, quam a polo aequatoris quadrantes ad suos circulos, ut in figura patet. Cupio nunc



scire quantum varient azimutha I et K, quae sunt differentia eorum, quae fierent cometa quiescente et promoto. Nam altitudines ID et FK, insensibiliter interea alterantur. Quapropter primum in triangulo ABD, quia latus AB est complementum elevationis poli, P34 M7, et latus AD, complementum altitudinis observatae posterioris, P77 M48, latus vero BD est complementum declinationis, superius suo loco capite 4 inter declinationes et ascensiones rectas proportionaliter inquirendae; ubi colligitur, declinationem cometae extitisse ad tempus primae observationis, P13 M34, cuius complementum est, P76 M26, repraesentans latus BD. Igitur ex tribus cognitis lateribus, datur, per triangulorum leges, angulus BAD, P83 M45 S21, et angulus ABD, P88 M12. Angulus vero EBG est Scrupulorum trium, videlicet quantum mutatur ascensio recta cometae intervallo isto, veluti etiam ex superioribus suo capite et loco liquet. Deinde in triangulo ABF, latus AB ut prius, P34 M7, latus FB, P76 M24 evadit, nam declinatio augetur a prima ad secundam observationem, ex motu cometae, duobus Minutis, quare complementum hoc existit nunc binis Scrupulis minus, quam fuit in priori BD, angulus vero ABF constat, si addideris angulum EBG, differentiam ascensionis rectae interea causatam, trium (ut dixi) Scrupulorum, ad angulum ABD prius inventum, ut sit ABF nunc

P88 M15, datur itaque AF, P77 M48, nihil differens a complemento altitudinis secundo observatae. Angulus insuper BAF evadit, P83 M41 S48, qui si subductus fuerit ab angulo BAD, prioris trianguli, relinquit angulum IAK, M3½ cognitum. Metitur autem hic angulus quantitatem arcus IK, qui ostendit differentiam azimuthorum, inter locum cometae motum et quiescentem, quae quaerebatur. Sunt ergo sesquiquattuor Scrupula addenda azimutho posterioris observationis. Nam si cometa plane immobilis quievisset, ita ut solummodo primi motus revolutioni obtemperasset, tunc tempore sequentis observationis, tantilla portione in ulterioribus versus Septentrionem azimuthorum Scrupulis visus extitisset. Cumque altitudinem interea non variet sensibiliter, eam quam dedit observatio, retinebimus, Solis azimuthis tantundem immutatis, ut omnia data, limitata et correcta, habeant se in hunc qui sequitur modum:

	H	M	Azimuth	Altitudo
Prior observatio	7	7¼	P19 M45	P28 M56
Posterior obser.	9	8	P6 M23½	P12 M12

Ex his nunc tandem, Regiomontani methodo, parallaxium inquisitionem pertexemus.

Repetita superius assignata figuratione prima, iuxta Monteregii mentem delineata, examinatoque ante omnia in ea triangulo ZOH, cuius duo latera cognita dantur, ZH complementum altitudinis poli, P34 M7, ZO complementum altitudinis inventae in secunda observatione, P77 M48, angulusque comprehensus OZH, tanquam complementum azimuthi ad quadrantem, P83 M36½, reperitur per triangulorum placita, latus HO, P76 M21, et ex tribus cognitis lateribus, etiam uterque reliquorum angulorum, ZOH, P35 M0 S4, et ZHO, P88 M19 S23. Deinde ex cognitione temporis binis observationibus interlapsi, constabit angulus NHO. Si enim intercapedinem utriusque observationis, quae est Horarum 2 et M1, minus una quarta, resolverimus in tempora aequatoris, habito respectu diurni cursus Solis, revolutionem proprio motu retardantis, proveniunt G30 M16 S17, tantusque existit angulus NHO; quem si subduxerimus ab angulo ZHO, prius dato, relinquetur angulus ZHN cognitus, P58 M3 S6. Quare in altero triangulo HNZ, siquidem angulus ad H modo innotuit, et latus HZ, sit P34 M7, HN vero aequale ipsi HO per constructionem, P76 M21, dabitur latus ZN, P61 M4, cuius complementum est, P28 M56, aequale altitudini prius observatae. Itaque latus ZN efficitur eiusdem quantitatis cum complemento altitudinis primae, quod fieri non potest,

nisi ZN aequetur ipsi ZL. Erat autem ZL complementum altitudinis loci veri cometae, ideoque cum ei ZN aequalis existat, insensibiliter differet locus verus a viso, et per consequens, ipsa parallaxis, aut nulla erit, aut tam exigua, ut omnem sensum effugiat, quod demonstrandum proposuimus.

Quapropter cum insensibilis, imo potius nulla reperiatur hac ratione cometae parallaxis, adeo ut Regiomontani speculatio ulterius produci, per hanc pragmatiam nequeat, sistentibus se rotis, ubi id quod praesupponebatur inaequale, per experientiam factae observationi, aequabatur: idcirco satis liquido constat, etiam per hanc Regiomontani viam, cometam hunc omni sensibili caruisse aspectus diversitate; ideoque non infra Lunam, sed longe supra eam, in ipso Aethere, locum suum obtinuisse. Patet insuper et hoc, quod prius diximus, hanc Regiomontani speculationem, potius locum mereri, quo ad praxin, in distantiis corporum a Terra minus remotis, idque in Aere, longe infra Lunam, ubi aliquot Graduum parallaxis induci poterit. Nam licet observatio a nobis omni possibili diligentia facta sit, tamen non ad finem succedit operatio: siquidem parallaxi quasi in nihilum abeunte, sistebatur processus, ipsis etiam sinuum tabulis tam subtilem numerationem respuentibus.

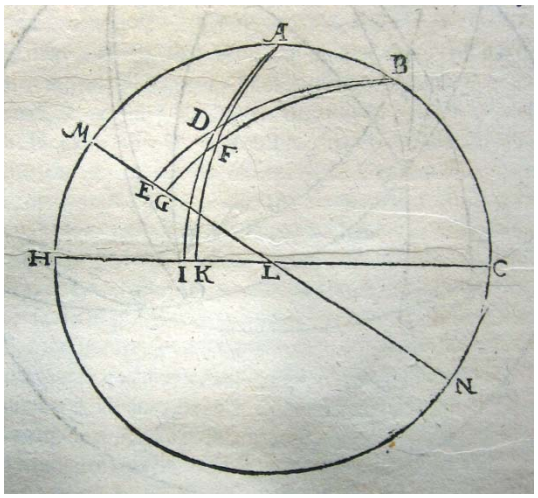
Translation

pp. 147-51

Indeed, because in this business Regiomontanus assumed that the comet was not moved except by the motion of the Prime Mover, but in truth this comet (with which we are now dealing) and almost all others have their own detectable motion in even so small an interval of time, this matter will require above all more accuracy in measurement [*limitatio*]; this Regiomontanus seems to have neglected, either deliberately or because he judged the measurement to provoke less doubt in the case of large parallaxes which he presupposed comets to possess, not without loss of the truth that he sought to establish.

Therefore, so that we should not run into this danger of error before we begin to scale the heights, we shall treat the azimuths found in such a way that the unmoved comets show their place, and [we shall do so] in this way, using the following figure. Where circle HABC represents the meridian, MLN the equator, whose pole is B, HLC the horizon whose pole is A, let the place of the comet at the first observation be by calculation in D and at the latter

observation in F, through which two places quadrants with respect to their circles are drawn from the pole of the horizon as well as from the pole of the equator, as shown in the figure.



I wish now to know by how much the azimuths at I and K differ, which is the difference of those [quantities] that would come about with the comet resting and [with it] moving forward. For altitudes ID and FK would be changed undetectably inbetween. According to which, first, in triangle ABD, because side AB is the complement of the elevation of the pole, 34 degrees 7 minutes, and side AD the complement of the altitude observed at the latter time, 77 degrees 48 minutes, and side BD is the complement of the declination, to be found by comparison between the declinations and right ascensions in the relevant place in chapter four, where it is infered that the declination of the comet with respect to the time of the first observation was 13 degrees 34 minutes, whose complement is 76 degrees 26 minutes, representing side BD. Therefore, from the three known sides, by the laws of triangles, angle BAD is given as 83 degrees 45 minutes 21 seconds, angle ABD as 88 degrees 12 minutes. Then angle EBG is of three minutes, namely as much as the right ascension of the comet is changed in that interval, as is indeed clear from the things said above in the relevant chapter and passage. Then, in triangle ABF, side AB as before comes out as 34 degrees 7 minutes, side FB as 76 degrees 24 minutes, for the declination is increased from the first to the second observation by the motion of the comet by two minutes, for which reason its complement is now smaller by two minutes than it was in the first [complement] BD. Angle ABF is composed [thus]; if you add angle EBG, the difference in the right ascension brought about in that interval, namely (as I said) three minutes, to angle ABD, found earlier, so that then ABF will now be 88 degrees 15 minutes. Therefore AF is given as 77 degrees 48 minutes, differing not at all from the complement of the altitude observed at the second time.

Moreover, angle BAF comes to 83 degrees 41 minutes 48 seconds, which if subtracted from angle BAD of the first triangle, leaves angle IAK known as 3½ minutes. But this angle measures the quantity of arc IK, which shows the difference of azimuths between the position of the comet in motion and at rest, which is what was sought. Therefore four and a half minutes should be added to the azimuth of the later observation. For if the comet had stayed quite immobile, so that it followed the motion of the first revolution alone, then at the time of the following observation it would have been visible for only a very small time in the later minutes towards the north of azimuths. And since the altitude meanwhile would not differ detectably, we shall retain that which observation gave, with the azimuth of the Sun unchanged, so that all the data, fixed and corrected, present themselves in the following way:

	Hour	Minute	Azimuth	Altitudo
First observation	7	7¼	19 degrees 45 minutes	28 degrees 56 minutes
Second observation	9	8	6 degrees 23½ minutes	12 degrees 12 minutes

From these, we shall now, at last, by Regiomontanus' method, complete the inquiry into parallaxes.

By repeating the first figure assigned above, drawn up after the manner of Regiomontanus, consider before anything else triangle ZOH, whose two sides are given as known: ZH the complement of the altitude of the pole, 34 degrees 7 minutes, ZO the complement of the altitude found in the second observation, 77 degrees 48 minutes, and the angle included OZH, being the complement of the azimuth to the quadrant, 83 degrees 36½ minutes. Through the laws of triangles side HO is found to be 76 degrees 21 minutes and from the three known sides each of the remaining angles [is known]: ZOH, 35 degrees 0 minutes 4 seconds, and ZHO, 88 degrees 19 minutes 23 seconds. Then from the knowledge of the time lapsed between the two observations angle NHO will be established. For if we had reduced the interval between the observations, 2 hours and 1 minute less a quarter, to the times of the equator, by taking into consideration the daily path of the Sun, holding back the revolution by its proper motion, they come to 30 degrees 16 minutes 17 seconds, and such would be angle NHO; and should we subtract this from angle ZHO, previously given, angle ZHN is left as 58 degrees 3 minutes 6 seconds. Wherefore in the other triangle HNZ, since the angle with respect to H has now become known, and side HZ is 34 degrees 7 minutes, and HN is equal

to HO itself through construction as 76 degrees 21 minutes; then side ZN will be given as 61 degrees 4 minutes, whose complement is 28 degrees 56 minutes, equal to the altitude observed first. Thus side ZN is found to be of the same amount as the complement of the first altitude, which cannot happen unless ZN is equal to ZL itself. But ZL was the complement of the altitude of the true place of the comet, and therefore ZN would be equal to it; the true place would differ undetectably from the apparent place, and consequently the parallax itself is either none or so small that it escapes every sense, which is what we had proposed to demonstrate.

So, since by this method the parallax of the comet is found to be undetectable, or rather none, in that the speculation of Regiomontanus cannot proceed further, with the wheels grinding to a halt when what was presupposed to be equal is made equal through the experience of observation carried out – on this account it is quite clearly established that by Regiomontanus' method as well this comet lacked any detectable parallax and that therefore it held its place not under the Moon but far above it in the Aether itself. Moreover this, which we have discussed before, is also clear; that this speculation by Regiomontanus merits a place in practice rather for bodies than in less remote distances from Earth, in the region of the Air well below the Moon where some degrees of parallax could be derived. For although the observation was made by us with all possible diligence, the work did not achieve its goal; for, indeed, with the parallax shrinking to almost nothing, the procedure came to a halt, with its own table of sines spurning such subtle calculations.

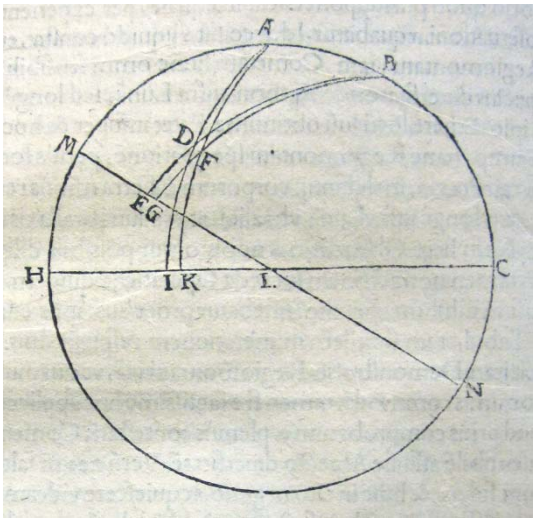
Original Text

pp. 151-5

Sufficit itaque demonstrasse, Regiomontani viam, ut quamvis huic negotio minus commodam, tamen si exactissime huc applicetur, idipsum quod prius comprobavimus, plenius contestari, cometae huic pene insensibilem affuisse aspectus diversitatem. Verum ne uni saltem observationi fidere, et huic in tanto negotio acquiescere videamur, ad aliam etiam in fine Decembris factam, rei certitudinem expendemus.

Ultima die Decembris Hora pomeridiana 6 M26½ , fuit cometa observatus in azimutho ab Occasu versus Meridiem, G16 M9, et altitudine, G33 M7. Deinde H8 M5¾, fuit eiusdem

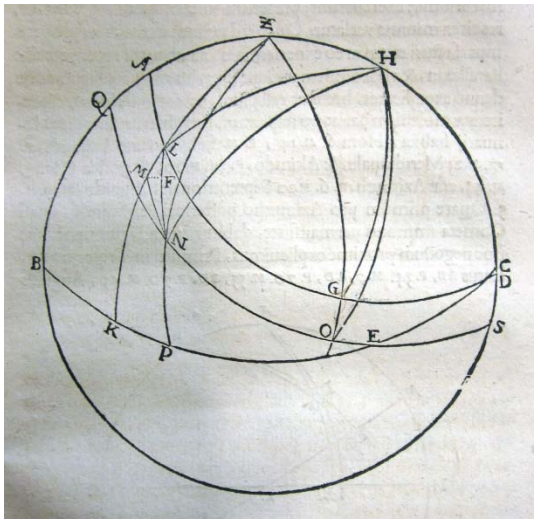
azimuthum, P5 M13, versus Septentrionem, altitudo vero, P19 M19. Hinc rursus libet parallaxeos quantitatem, si qua forte fuerit, pervestigare. Quare repetendo posteriorem figurationem, pro corrigendis azimuthis, ut error qui eveniret ob



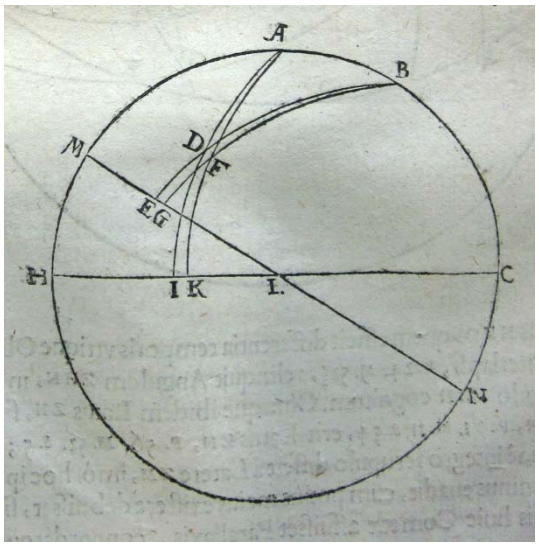
cometae motum proprium, evitari possit, inveniemus, retentis supra annotatis delineationum appellationibus, et eodem demonstrationis servato processu, primum in trigono ABD, esse AB, P34 M7, AD, P70 M41, BD, P71 M14, angulum BAD, P84 M48 S48, angulum ABD, P83 M2, cui addito angulo DBF, quantum videlicet ascensio recta, interea temporis promota est (quod patet ex superioribus suo capite fuisse Scrup. 1½) efficitur angulus ABF, in altero triangulo, P83 M3$^{2}/_{3}$, ibique latere AB existente, P34 M7, et BF, P71 M13, erit FA, P70 M41 S4, angulus vero BAF, P84 M47, qui subtractus ab angulo BAD, relinquit angulum IAK, Scrupulorum fere duorum, pro mutatione azimuthi, et ob id addendum azimutho posterioris observationis, ut habeatur emendatum, ac si quievisset cometa. Proveniunt itaque omnia, quibus uti oportebit, in hunc modum exacte correcta.

I. Hora 6 M26½, azimuth P16 M9, altitudo P33 M7.
II. Hora 8 M5¾, azimuth P5 M15, altitudo P19 M19.

Quare habita ratione prioris figurationis, quam hic repetemus, ut planior fiat intellectus, parallaxin si qua fuerit, demetiri conabimur. Primumque in triangulo HOZ, cum ZH sit P34 M7, latus ZO, P70 M41, ex complemento posterioris altitudinis, (nam omnia eadem



processus et operationis cohaerentia fiunt, prout in primo exemplo dilucidius explicuimus, ne opus sit rem totam iisdem verbis saepius taediose repetere) sitque angulus HZO, P84 M45, provenit latus HO, P71 M11 S54, angulus HOZ, P36 M9 S28, angulus ZHO, P83 M4 S51, a quo si auferatur angulus NHO, quem efficit differentia temporis utrique observationi interlapsi, P24 M52½, relinquit angulum ZHN, in altero triangulo ZHN cognitum. Cumque ibidem latus ZH, sit P34 M7, HN, P71 M11 S54, erit latus ZN, P56 M52 S5; quod non plene integro Scrupulo differt a latere ZM, imo, hoc ipso tantillum minus evadit, cum potius maius existere debuisset, si aliqua sensibilis huic cometae affuisset parallaxis, concordatque cum complemento altitudinis primo observatae. Quod vero unius fere Scrupuli insinuatur differentia, quae potius in contrarium abundat, suam meretur excusationem apud eos, qui praxin mechanicam astronomiae exercuerunt; praesertim in tam subtili negotio, ubi res circa minima versatur. Quare ad tertium exemplum properemus, facturi etiam in eo experientiam, an aliquam reperire liceat parallaxin, et rem omnem utraque superius assignata figuratione



denuo expedientes, breviter calculum, ne copia declarationis reiteratae molestiam pariat, persequemur. Ex observatione die II Januarii habita, Hora 6 M14½, P.M. fuit cometae azimuth, P17 M23 Meridionale, et altitudo, P34 M20; et postea Hora 8 M4⅓, erat azimuth, P6 M20 Septentrionale, altitudo, P19 M5. Quare primum pro azimutho posteriori verificando, quasi cometa immotus permansisset, dabitur in ea figuratione, qua hoc negotium proxime explicuimus, primum in trigono ABD, latus AB, P34 M7, AD, P70 M55, BD, P70 M49, angulus BAD, P83 M43 S37, angulus ABD, P84 M3, cui additus angulus DBF, interea mutatae ascensionis rectae ex motu proprio cometae, qui est ex superioribus suo loco petitus, duorum Scrupulorum, relinquit angulum ABF, P84 M5 cognitum. Quare in illo triangulo, ex hoc angulo dato, et AB cognito, atque BD existente, P70 M49, latus FA, erit P70 M55 S16, et angulus BAF, P83 M41 S46, qui sublatus ab angulo BAD prius invento, relinquit angulum IAK, duorum ferme Scrupulorum, addendum azimutho posterioris observationis, ut sint omnia emendata, ac si cometa per se quievisset, hoc pacto:

I. H6 M14½, azimuth P17 M23, Mer. altitud. P34 M20.
II. H8 M4⅓, azimuth P6 M22, Sep. altitud. P19 M5.

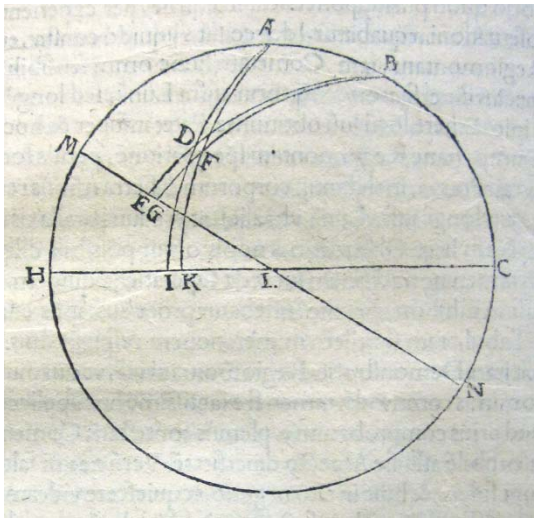
Quare repetita ea figuratione, qua secundum Regiomontani mentem parallaxes indagare conamur, et breviter singulis, iuxta primo usurpatam explicationem, in operationem deductis, erit in trigono HZO, latus ZH, P34 M7, latus ZO, P70 M55, angulus HZO, P83 M38, latus HO, P70 M45 S52, angulus HOZ, P36 M11 S3, angulus ZHO, P84 M7 S36, a quo subductus angulus NHO, P27 M31½, relinquit angulum ZHN, in altero triangulo, P56 M36 S6 cognitum, et latere ZH existente, P34 M7, HN, P70 M45 S52, uti diximus, erit latus ZN, P55 M39. Quod saltem uno Scrupulo minus est latere ZM. Cum tamen maius necessario evaderet, si sensibilis aliqua affuisset huic cometae parallaxis, adeo ut ob id haec Regiomontani speculatio, ulteriorem processum non admittat. Nam quod unicum illud Scrupulum ultra debitam metam excreverit, facile (velut prius etiam diximus) excusabile est. Sensum enim omnem etiam accuratissime rem peragentis, in tam subtili negotio, subterfugit, et refractio in posteriori, quam in priori observatione, aliquantulum maior, huic augmento non dubiam praebet occasionem.

Translation

pp. 151-5

So it is sufficient to have shown that the method of Regiomontanus, although less convenient for this business, nevertheless if it is most precisely applied in this case fully bears witness to what we have already proved, that the difference in aspect of the comet was in this case almost imperceptible. But lest we should seem to put our trust in just one observation and to acquiesce in this in so great a business, we shall judge the certainty of the matter with respect to another [observation] made at the end of December.

On the last day of December at 6 hours 26½ minutes p.m. the comet was observed at azimuth at 16 degrees 9 minutes from the west towards the south and with an altitude of 33 degrees 7 minutes. Then at 8 hours 5¾ minutes its azimuth was 5 degrees 13 minutes towards the north with an altitude of 19 degrees 19 minutes. Hence, again, the amount of parallax, if perchance there were any, could be detected. So, returning to the previous figure in order to correct the azimuths so that the error that would have arisen from the proper motion of the comet could be avoided, we shall find, retaining the lettering of the delineation above and using the same procedure of demonstration, firstly that in the triangle ABD, AB is 34 degrees 7 minutes, AD 70 degrees 41 minutes, BD 71 degrees 14 minutes, the angle BAD 84 degrees 48 minutes 48 seconds, and the angle ABD 83 degrees 2 minutes; and after adding to this the angle DBF –

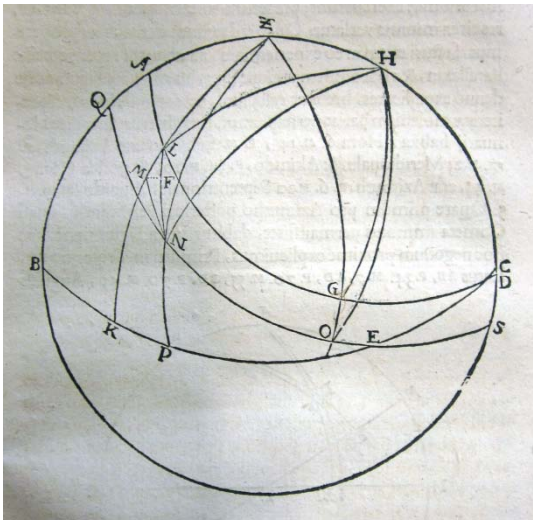


namely the amount by which the right ascension increased in the interval of time (which was, from the things said above in the relevant chapter, 1½ minutes) – the angle ABF in the other triangle comes to 83 degrees 3⅔ minutes, and with the side AB there being 34 degrees 7

minutes and BF 71 degrees 13 minutes, FA will be 70 degrees 41 minutes 4 seconds and the angle BAF 84 degrees 47 minutes, which when subtracted from the angle BAD leaves the angle IAK of about 2 minutes, representing the change of azimuth, and so to be added to the azimuth to the previous observation in order for it to be corrected, as if the comet had been at rest. So everything that ought to have been done in this matter came out precisely correct.

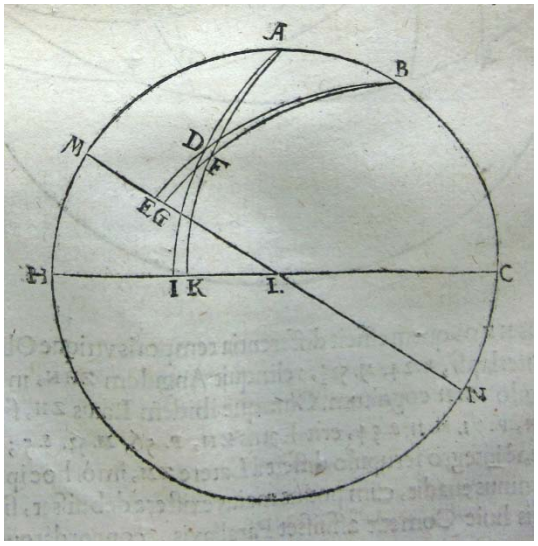
I. 6 hours 26½ minutes, azimuth 16 degrees 9 minutes, altitude 33 degrees 7 minutes.
II. 8 hours 5¾ minutes, azimuth 5 degrees 15 minutes, altitude 19 degrees 19 minutes.

So on the basis of the first figure (which we shall repeat here, so that the mind may be made clearer) we shall attempt to measure the parallax, if there was any. And first, in triangle



HOZ, since ZH is 34 degrees 7 minutes, the side ZO 70 degrees 41 minutes from the complement of the previous altitudes (for all are carried out with the same coherence of procedure and operation as we explained quite clearly in the first example, lest it should be necessary to repeat tediously the whole matter largely in the same words), and the angle HZO is 84 degrees 45 minutes, accordingly the side HO comes out at 71 degrees 11 minutes 54 seconds, the angle HOZ 36 degrees 9 minutes 28 seconds, the angle ZHO 83 degrees 4 minutes 51 seconds; and if there is subtracted from it the angle NHO of 24 degrees 52½ minutes, which the difference elapsed between the two observations brings about, the angle ZHN is left, to be seen in the other triangle ZHN. And since the side ZH is 34 degrees 7 minutes and HN 71 degrees 11 minutes 54 seconds, the side ZN will be 56 degrees 52 minutes 5 seconds, which does not differ from the side ZM by a whole minute, and indeed it turned out a little less than this when it should rather have been greater if this comet had had

any detectable parallax, and it agrees with the complement of the altitude first observed. But that a difference of about 1 minute had crept in, which should rather be substantially in the opposite [direction], deserves to be forgiven among those who exercise the mechanical practice of astronomy, especially in such a subtle business where the matter turns on very small things. So we shall hurry on to the third example, being about to test in it too whether any parallax can be found, and carrying out the whole matter with the two lettered figures above, we shall perform a brief calculation, lest the copiousness of reiterated declaration should cause distress. From the observation made on the second day of January at 6 hours



14½ minutes p.m. the azimuth of the comet was 17 degrees 23 minutes south and its altitude 34 degrees 20 minutes; and afterwards at 8 hours 4⅓ minutes the azimuth was 6 degrees 20 minutes north and the altitude 19 degrees 5 minutes. So, firstly, for verifying the later azimuth as if the comet had remained unmoved, there will be given in that figure in which we have just explained this business, first in the triangle ABD the side AB as 34 degrees 7 minutes, AD 70 degrees 55 minutes, BD 70 degrees 49 minutes, the angle BAD 83 degrees 43 minutes 37 seconds, the angle ABD 84 degrees 3 minutes; and when there is added to it the angle DBF – that of the change of the right ascension rising from the proper motion of the comet, which is to be sought where it is mentioned above – of two minutes, the angle ABF is known to be 84 degrees 5 minutes. So in that triangle from this given angle and AB known and BD being 70 degrees 49 minutes, the side FA will be 70 degrees 55 minutes 16 seconds and the angle BAF 83 degrees 41 minutes 46 seconds, which when subtracted from the angle BAD found before, leaves the angle IAK of precisely 2 minutes, in addition to the azimuth of the last observation, so that everything when corrected is as if the comet had stayed still, as follows:

I. 6 hours 4½ minutes, azimuth 17 degrees 23 minutes, altitude 34 degrees 20 minutes south.
II. 8 hours 4⅓ minutes, azimuth 6 degrees 22 minutes, altitude 19 degrees 5 minutes north.

So, returning to that figure by which in accordance with the view of Regiomontanus we attempt to seek parallaxes, and briefly putting into operation particular things, according to the account first used, there will be in the triangle HZO, side ZH 34 degrees 7 minutes, side ZO 70 degrees 55 minutes, angle HZO 83 degrees 38 minutes, side HO 70 degrees 45 minutes 52 seconds, angle HOZ 36 degrees 11 minutes 3 seconds, angle ZHO 84 degrees 7 minutes 36 seconds; and having subtracted from this the angle NHO 27 degrees 31½ minutes there is left the angle ZHN in the other triangle known to be 56 degrees 36 minutes 6 seconds, with the side ZH being 34 degrees 7 minutes and HN 70 degrees 45 minutes 52 seconds, and as we have said, the side ZN will be 55 degrees 39 minutes. And this is only 1 minute less than the side ZM, when, however, it would necessarily have turned out greater if this comet had detectable parallax, to the extent that this method of Regiomontanus does not allow further calculation. Now that this single minute should have exceeded the due measure is (as we have also already said) readily excusable. For in so subtle a business it escapes all sense, even of one most accurately prosecuting the matter, and a slightly greater refraction in the latter observation than in the former doubtless provides the occasion for this increase.

Original Text

pp. 155-8

Quapropter, cum in omnibus tribus propositis observationibus, quibus ex azimuthis et altitudinibus, adhibito temporis intervallo, iuxta Regiomontani imaginationem, parallaxin indagare conati sumus, ubique quasi in absurdum deveniamus, adeo ut operatio ad finem deduci non potuerit; nam omnibus in locis, latus ZN reddebatur aequale quasi ipsi ZM, quod tamen maius esse debebat, si cometae huic aliqua notabilis affuisset aspectus diversitas; ut propterea parallelus aequatoris (quem motu universi describit) fuerit aequidistans utrobique a polo, non dissimilis ipsi LO: manifestum itaque evadit, hunc cometam, velut et aliis pluribus experimentis, eadem hac methodo satis laboriose examinatis (quae hic non ulterius duxi recitanda, ne nimium copiosa fieret de his commemoratio) experti sumus, etiam ex hac Regiomontani speculatione in praxin deducta, aut nullam, aut plane insensibilem obtinuisse

parallaxin, ideoque minime in Elementari regione, sed longe supra Lunam in ipso altissimo Aethere motum suum exercuisse; contra quam Peripatetici veteres, et plurimi modernorum credidere; usque adeo ipsi veritati praevaluit Aristotelica authoritas.

Patet insuper id etiam, quod semel atque iterum testati sumus, hanc Regiomontani viam non habere locum, ubi res circa minima versatur, sed saltem quando magna et sensibilis parallaxium existit diversitas. Nam aliquot Secundorum saltem in tempore, vel unius Scrupuli in altitudine aut azimuthis mutatio, admodum sensibilem magnaque quantitate excrescentem inducit variationem; adde quod ipsae tabulae sinuum, cum ad ultimum triangulum LMN fuerit deducta operatio, non praebeant in tam minutulis parallaxium differentiis, numerorum ratam certitudinem, eo quod circa finem quadrantis, non sit satis exactus canonis usus. Quapropter haec Regiomontani speculatio non ob id a nobis in medium producta est, quod per hanc aliquid certius, quam in antecedentibus, quantum ad parallaxium investigationem, enucleare speraverimus, sed solummodo, quia a tanto artifice solerter excogitata erat, et a modernis astronomis ipsius vestigia sequentibus (qua vero observationum certitudine, et quam diligenti praxeos processu, videant ipsi) etiam in hoc cometa, per parallaxes examinando, usurpata sit; utque simul ostenderemus, etiamsi hac demonstrationis via procederetur, ex nostris observationibus, nullam sensibilem huius cometae parallaxin inveniri, et negotium omne, superioribus demonstrationibus pulchre consentire: idcirco volui etiam hanc parallaxes indagandi rationem non intactam relinquere. Quod autem operationes ad finem deducere nusquam licuerit, rei subtilitas, quae circa minima et pene insensibilia sistitur, occasionem praebuit; ut non tam usui facile accommoda, quam subtiliter et ingeniose excogitata fuerit, haec Regiomontani ratiocinatio. Multa enim sunt, quae in speculationem ducta, recte quidem consistere possunt, si vero praxeos usum adhibeas, etiam exquisitissimis instrumentis et lynceis oculis usus (praesertim ubi scopus dirigitur circa tenuia, ut ex illis maxima superstruantur) inextricabiles absurditates devenies: adeo ut opus ipsum ad finem constitutum non commode perducas. Idque sine dubio animadvertens industrius vir, ipse Regiomontanus, in cometa anni 1476, cuius observationem nobis descriptam reliquit, non confisus est huic propriae investigandae parallaxeos viae, sed potius ad fixam stellam, quae est in Virginis Spica, eam examinavit, quod utinam maiori certitudine nobis testatum reliquisset, nec praeoccupato ex Peripateticorum recepta sententia iudicio, nimium indulsisset, ut alibi plenius discutiemus.

Quare iam satis superque, non solum propriis rationibus, quae in praxin commodius et rectius deduci poterant, sed etiam Regiomontani methodo, utquamvis minus negotio huic competenti, evidenter confirmavimus, cometam hunc plane Aethereum extitisse, et omnem sensibilem parallaxeos quantitatem respuisse. Ideoque relictis his, ad caetera, quae ab initio pervestiganda proposuimus procedamus. Fuimus autem in hoc capite circa parallaxes eruendas, paulo prolixiores, eo quod cardo totius rei, et praecipuus scopus eorum, quae in considerationem cometarum veniunt, circa hoc vertatur; siquidem inde constet, utrum in Elementari regione, nec ne, observentur. Qua in re quamplurimos hallucinatos videmus, partim quod aliorum authoritate seducti sint, partim, quia cum res versetur circa exquisitam quandam subtilitatem, grossiori, qua utebantur, indagine, ad veritatis scopum perveniendi via omnis praeclusa fuerit.

Haec itaque de iis, quae hoc capite tractanda erant, et luculenter in medium protulisse, et satis evidenter, tot adhibitis diversis ratiocinationibus, geometriae arithmeticaeque invicta certitudine demonstrasse, sufficiat.

Translation

pp. 155-8

So, when with all the three reported observations by which, in accordance with the device [*imaginationem*] of Regiomontanus, we have sought from the azimuths and altitudes adopted in a given interval of time to investigate the parallax, we arrive in all cases at what is, so to speak, so absurd that the operation could not be brought to completion, for at every position the side ZN is rendered as if equal to ZM itself, which ought, on the contrary, to have been greater if any notable difference in aspect had been present in the case of this comet, so that on that account the [line] parallel to the equator (which it describes with the motion of the Universe) was equidistant on either hand from the pole, not unlike LO itself; accordingly, it becomes clear, as we have found from many other observations [*experimentis*] most meticulously examined by this same method (which I have decided not to be worth spelling out here lest the record of these matters should become too wordy), and also from this exercise of Regiomontanus applied in practice, the comet showed no, or quite indiscernible parallax, and so carried out its motion not at all in the elemental region, but far above the

Moon in the highest Aether itself, contrary to what the ancient Peripatetics and many of the moderns have believed, insofar as the authority of Aristotle trumped truth itself.

This too is evident, as we have declared again and again, that this method of Regiomontanus is not appropriate when it is a matter of very small things, but only when there is large and discernible difference in parallaxes. For a change of only a few seconds in time or of one minute in altitude or azimuth induces a variation that is quite detectable and increasing to a large amount. Besides, since the operation was applied to the final triangle LMN, those tables of angles do not provide settled certainty about numbers in the case of such minute differences of parallaxes, in that towards the end of the quadrant the use of the table [*canon*] is not sufficiently precise. So on this account this speculation of Regiomontanus has been presented by us not because we hope by means of it to find out anything more certain than in what has gone before, but only because it was ingeniously thought up by so great a master of the art [*artifex*] and has also been used by recent astronomers following in his footsteps (and in the certainty of [his] observations they see as accurate a process of practice) in studying this comet too by means of parallaxes; and [we have done so] so that at the same time we may show that even if one proceeds in this way no detectable parallax of this comet is found and the whole business agrees beautifully with the demonstrations above. That is why I have not wanted to leave this method of examining parallaxes unmentioned. But the subtlety of the business, which deals with very small and almost imperceptible things, provided the explanation why the operations could on no occasion be brought to a conclusion, as this way of reasoning of Regiomontanus was not as readily put to use as it was subtly and ingeniously thought up. For there are many matters which considered speculatively can stand firm as correct, but if you apply them in practice, even with the most exquisite instruments and using lynx eyes, you will arrive at inextricable absurdities, especially when the aim is directed at small things in order that great things be built on them, so that you will not readily bring the work itself to the appointed end. And it was doubtless noticing this that that illustrious man Regiomontanus in the case of the comet of the year 1476 [should be 1472], the observation of which he left described for us, did not trust in this method as appropriate for the investigation of parallax, but rather examined it with respect to the fixed star Spica Virginis, and if only had left this proved to us with greater certainty and had not conceded too much with judgment prejudiced by the received opinion of the Peripatetics, as we shall discuss elsewhere more fully.

So we have now more than sufficiently confirmed, not only with appropriate reasons that could conveniently and correctly be applied in practice, but also by the method of Regiomontanus (though it was less appropriate for this business) that this comet was clearly aethereal and spurned any detectable amount of parallax. And so, leaving these matters behind, let us proceed to the remaining things that we proposed for investigation at the outset. But in this chapter about the revealing of parallaxes we have been rather prolix, in that the hinge of the business and the principal aim in the matters that arise in the consideration of comets turns on this: if it is then agreed whether or not they are observed in the elemental region. In this matter we see many to be hallucinated, in part because they have been led astray by the authority of others, in part because, since the matter turns on a certain exquisite subtlety, every way of reaching the goal of truth has been precluded by the cruder method that they have been employing.

So this suffices both to have made public the things that were to be treated in this chapter and to have demonstrated [them] quite clearly with invincible certainty with the employment of so many different reasonings of arithmetic and geometry.

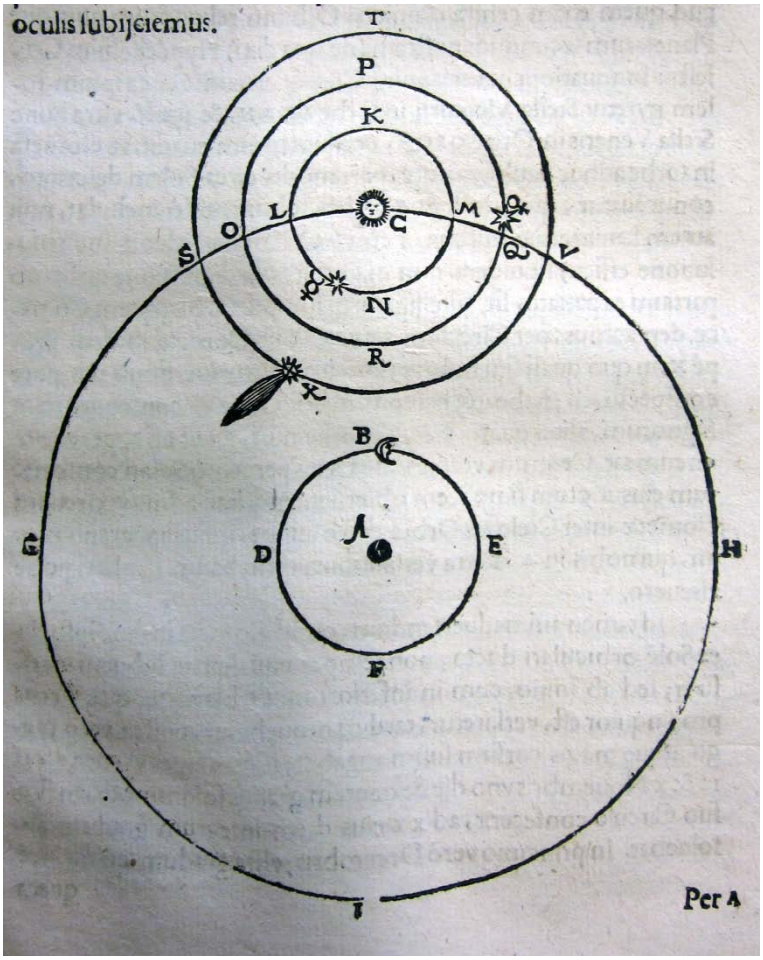
Original Text

pp. 190-4

Nunc autem ex hac ipsa neoterica Aetherearum revolutionum conformatione, saltem eam partem mutuabimur, quae ad praesens negotium in deputando loco huic cometae, et hypothesi qua eius apparentiis succurratur ordinanda, satisfaciet.

Iactis enim his revolutionum coelestium fundamentis, dico motui apparenti huius cometae omnia aptissime congruere, si intelligamus, ipsum etiam, tanquam erraticam aliquam ascititiam et extraordinariam, apud Solem, non minus quam caeteros planetas, centrum sui circuitus invenisse, et circa hunc portionem quandam orbis proprii designasse, quo non solum Mercurii, sed etiam Veneris sphaeram excederet; ita ut a Sole digredi ad coeli sextantem potuerit, cum Venus non multum ultra octavam euisdem partem ab eo elongetur. In hoc vero orbe cometa sic incedebat, ut si quando Solis medio motui conjunctus fuisset, in infima orbis sui parte et Terris proxima constitutus assumatur, atque hinc per consequentiam Signorum, aliter quam in Venere et Mercurio usuvenit, versus euisdem orbis apogaeum perrexisse,

centro huius revolutionis Solis simplici motui perpetuo concurrente, admittatur. Quae omnia ut rectius percipiantur, nunc orbium huc aliquid facientium oportunam dispositionem oculis subiiciemus.



Per A intelligatur globus Terrae in centro universi existens, circa quem proxime volvatur Luna in orbe BEFD, quo tota Elementaris regio comprehendatur. Quod autem cometa intra hos limites Lunaris orbis nullatenus reperiebatur, capite sexto a nobis affatim est demonstratum. Orbis insuper annuus Solis circa Terram revoluti sit CHIG, in quo Sol repraesentatur iuxta C, apud quem etiam centra omnium orbium reliquorum quinque planetarum secundum nostram (de qua dixi) hypothesium coelestium innovationem versantur. Cumque proxime circa ipsum Solem gyretur stella Mercurii in orbe LKMN, et paulo ultra hunc stella Veneris in orbe OPQR, consentaneum evadit, ut cometa in orbe adhuc paulo maiore, pari modo circa Solem descripto, convolvatur, quo hos [Mercurius] et [Venus] orbes solummodo includat, non autem Lunarem simul cum Terra (ut Martium sidus in sua revolutione efficit) siquidem non maiori a Sole digressione quam 60 Partium expatiatus sit.

Intelligaturque hic ipse orbis, quem cometae deputamus, per circulum STVX, ut sit cometa ibidem prope X, in quo quasi situ nobis primo suae animadversionis tempore conspectus est; habeatque motum in hoc orbe in consequentiam Signorum, aliter quam [Venus] et [Mercurius] revolvuntur, ita ut ab X per S in T circumeat. Centrum vero eiusdem orbis perpetuo Solari consociatum euis motum simplicem observet. Atque hac admissa circuitus cometae inter coelestes orbes dispositione, ipsius apparenti motui, qui nobis in A Terra versantibus, cernebatur, satisfieri posse assevero.

Id tamen animadvertendum, quod cometa in hoc ipso circa Solem orbiculari ductu, non semper aequalem exhibuerit incessum; sed ab initio, cum in inferiori sui orbis parte, quae Terris propinquior est, versaretur, tardius movebatur, postea vero magis atque magis cursum suum augebat; idque ea lege, ut cum circa IX et X Novembris uno die dextantem Gradus solummodo in hoc suo circulo confecerit, ad XX eius diem integrum Gradum absolvebat. In principio vero Decembris, ultra Gradum quincuncem quem motum paululum adhuc sensimque augmentabat, usque dum proximis diebus post XX Decembris, eundem ad sesquialterum Gradum perduxisset, ultra quem terminum concitationem suam non intendebat, sed paulatim remissior reddebatur; adeo tamen lenta variatione, ut usque in XXVI diem Januarii, quo ultimo a nobis conspectus est, saltem quina Scrupula sesquialtero Gradui in motu eius proprio, decesserint. Fuit enim circa finem Januarii eius promotio intra diem naturalem denuo unius Gradus cum quincunce, adeo ut per totum Decembrem et Januarium, non alteraverit progressum in suo orbe diurnum, nisi ad summum 5 Scrupulis; tam parum tanto tempore abfuit ipsius circa Solem convolutio ab aequalitate perfecta. In Novembri vero paulo celeriori variatione eundem indies fere maiorem reddidit; velut haec omnia multo plenius e quarta serie eius tabulae, quam fini sequentis capitis subjungemus, discernuntur.

Fateor quidem, quod convenientius foret, si cometa in hoc ipso orbe per totam suam durationem aequali temporis intervallo aequales arcus confecisset. Sic enim revolutionis simplex uniformitas rectius conservaretur, eadem videlicet regularitate, qua ipsi planetae perpetuam in suis circuitibus aequalitatem constanter observant. Et licet haec ipsa, quae cometae accidit in sua propria circumgyratione inaequalitas, limitari emendarique possit, sive per centrum orbis ipsius circa Solem in contrarias partes circulariter et requisita ratione contortum, sive per orbiculare in circumferentia eiusdem additamentum, cuius beneficio motus nunc inhibeatur, nunc vero relaxetur; tamen quia per talem motionis innodationem negotium hoc, plus obscuritatis et involucri, quam lucis et promptitudinis acquireret, nolui

perplexiorem variorum motuum compositionem ad tuendam aequalitatem congerere; praesertim cum minime consentaneum sit, cometarum tam cito evanida corpora adeo artificiose compositis et multiformiter involutis motionum anfractibus obnoxia esse. Malui itaque eosdem cometae in suo orbe circa Solem quotidianos gressus retinere, quales ipsa experientia nobis suppeditabat, nihil obstante, quod illi ab initio paululum tardiores erant, postmodum vero celeriores successivo ductu reddebantur; praesertim, cum per maximum et diutissimum suae apparitionis tempus aequalitati propemodum constanti conformarentur. Nam in Decembri et Januario, duobus integris mensibus, motus aequalitas non variebatur plus 5 Scrupulis (ut antea quoque indicavi) quod sane est perexiguum et nullius fere momenti; in solo Novembri, et saltem per dimidium quasi mensem, alterationem sensibilem admisit; adeo ut tantummodo quinta circiter pars totius durationis inaequalitati obnoxia fuerit, reliquae vero quattuor ab eadem fere exemtae.

Nec est quod quispiam ob hanc per se non admodum diutinam aut magnam inaequalitatem, hypotheseos nostrae certitudinem labefactari existimet. Verosimile enim, cometas, quemadmodum non habent adeo perfecta et ad perpetuam durationem consummata corpora, sicut reliquae stellae inde ab initio mundo coaevae: sic etiam non tam absolutum et constantem in suis circuitibus observare aequalitas tenorem; sed saltem velut mimi quidam planetarum regularitatem uniformem quodammodo aemulantur, non autem omnimode assequuntur; quod etiam subsequentium aliquot annorum cometae, qui non minus in Aetherea mundi regione versabantur, nos haud obscure docuerunt. Sive igitur cometa hic noster non undequaque et exquisite rotundum ad Solem circuitum, sed aliquantulum oblongiorem, in modum figurae quam ovadam vulgo vocant, confecerit, sive perfecte quidem circulari tramite, sed motu per se ab initio tardiori, posteaque paulatim adaucto incesserit, circa Solem nihilominus revera convolvebatur, utut aliqualem inaequalitatem, non tamen confusam et inordinatam, admiserit.

His itaque sufficienter indicatis, nunc ad ipsam cometae theoriam cum suis dimensionibus et motibus exponendam, nos conferemus.

Translation

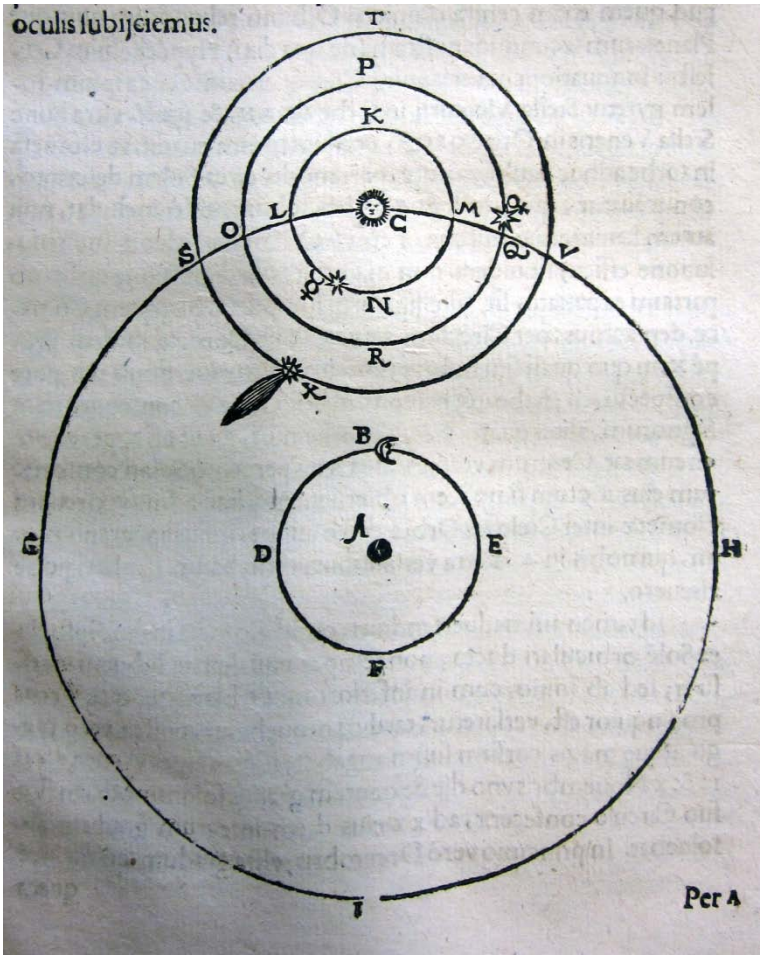
pp. 190-4

Now, however, we shall borrow from this same new disposition of the aethereal revolutions at least that part which suffices for the present task of allotting a place to this comet and providing a hypothesis by which it is saved with respect to its appearances.

For having laid down these bases of the celestial revolutions, I declare that everything most aptly agrees with the apparent motion of this comet, if we understand that it too, like some adventitious and extraordinary planet, has, no less than the other planets, the centre of its revolution in the Sun, and that it has described about it a certain portion of its own orb by which it goes beyond the sphere not only of Mercury, but also that of Venus; so that it could digress from the Sun by a sixth part of the heaven, while Venus is distanced from it by not much more than an eighth part. Indeed, the comet proceeded in this orb in such a way that, when it was joined to the mean motion of the Sun, it may be taken to have been at the lowest part of its orb and nearest to the Earth; and it may be allowed to have proceeded thence in the order of the Signs toward the apogee of its orb, otherwise than occurs with Venus and Mercury, with the centre of this revolution constantly coinciding with the simple motion of the Sun. To perceive all these things more correctly, we shall now place before the eyes a suitable arrangement of the orbs contributing something to this end.

By A is to be understood the globe of the Earth located at the centre of the World, around which the Moon is turned most closely in the orb BEFD, in which the whole elemental region is contained. That the comet was in no way to be found within these bounds of the lunar orb was, however, amply demonstrated by us in the sixth chapter. Above this let CHIG be the annual orb of the Sun revolved about the Earth, in which the Sun is represented at C, at which are turned the centres of all the orbs of the rest of the five planets, according to our innovation of the celestial hypotheses. And since the star of Mercury is revolved closest to the Sun in the orb LKMN and a little above this the star of Venus in the orb OPQR, it happens fitly that the comet revolves in a somewhat greater orb described around the Sun, in which it includes the orbs of Mercury and Venus only; it does not include the lunar orb together with the Earth (as the star of Mars in its revolution does), since indeed it cannot diverge from the Sun by more than sixty degrees. And this same orb that we impute to the comet is to be taken as the circle STVX, with the comet itself being near X, in approximately

which situation it was seen at the time of our first observation; and it has a motion in this orb in the order of the Signs, otherwise than Venus and Mercury are revolved, so that it goes round from X through S to T. Indeed, the centre of that same orb follows its simple motion constantly coincident with the solar [motion]. And this disposition of the revolution of the comet between the celestial orbs being accepted, I declare that it is possible for its apparent motion as it is perceived by us dwelling on A, the Earth, to be demonstrated.



This, however, is to be noted: that in this same circular path about the Sun the comet did not always show the same speed; but at the beginning, when located in the lower part of its orb, which is nearer the Earth, it was moved more slowly; but thereafter, it increased its motion more and more and this in such a manner that, whereas around the 9th and 10th of November it completed in one day barely five sixths of a degree in its circle, by the 20th it completed in each day a whole degree. Moreover, at the beginning of December it increased its motion little by little from one degree and five twelfths, until in the days immediately after the 20th of December it was brought up to a degree and a half, beyond which limit it did not increase

its haste, but gradually slowed down again; but its variation was so slight that up to the 26th day of January, when it was last seen by us, no more than five minutes had been lost from the one and a half degrees of its motion. For there was around the end of January once again a motion of one degree and five twelfths during the natural day, so that through the whole of December and January it altered its daily progress only at the most by five minutes; so little in so long a time did its revolution about the Sun deviate from perfect equality. Indeed, in November, with a slightly more rapid variation, it returned to a rather greater daily progress; and all these things may be seen more fully from the fourth row of its table, which we shall append to the following chapter.

I do, indeed, I admit that it would be more appropriate if the comet through the whole of its duration had completed in its own orb equal arcs in each equal interval of time. For thus a simple uniformity of revolution would be more correctly preserved, namely with that same regularity by which the planets themselves constantly observe a perpetual equality in their circuits. And although this inequality of the comet that occurred in its own circumgyration could be limited and corrected, either by turning the centre of its orb about the Sun circularly and in a due proportion in the opposite direction, or by adding a little orb to the circumference of the same, with whose help the motion would be now inhibited, now released, nevertheless, because through such knotting of motions this business would acquire more obscurity and complexity than light and clarity, I have not wanted to put together a more intricate composition of diverse motions in order to save equality, especially since it would not be in the least appropriate for the so quickly vanishing bodies of comets to be subjected to such artificially compounded and multiply entangled windings of motions. So I choose to retain those daily progressions of the comet in its orb about the Sun of the kind that experience itself so abundantly supplied, notwithstanding that at the beginning they were a very little slower, and soon after this were made to appear more quickly in each successive passage; [I do so] especially because through the greatest and longest time of their visibility [those daily progressions] were made in conformity with a nearly constant equality. For in December and January, for two whole months, the motion did not vary from equality by more than five minutes (as I have indicated above), which is truly very little and almost of no significance; only in November, and then for at most half the month, did it admit a significant alteration; so that only about one fifth part of the whole duration was subject to inequality, with the four remaining ones being almost exempt from it.

Nor is it the case that anyone should think that because of this in itself not very long lasting or great inequality the certainty of our hypothesis is shaken. For it is probable that comets, just as they do not have bodies as perfect and made for perpetual duration as do the other stars, which are as old as the beginning of the World, so also they do not maintain so perfect and constant equality in their revolutions; but rather, it is as though as mimics they emulate to a certain extent the uniform regularity of the planets, but do not follow it altogether; and the comets of several subsequent years, which were no less in the aethereal region, have also taught us this quite clearly. Therefore either this comet of ours may have completed a circuit not everywhere precisely circular with respect to the Sun, but somewhat oblong in the manner of the figure commonly called ovoid, or it may have proceeded in a perfectly circular path, but with a motion slower at the beginning and then gradually augmented; however this may be, it in fact revolved about the Sun, in such a way that it allowed some inequality, but not confused or irregular.