Giovanni Battista Riccioli

ALMAGESTUM NOVUM

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SECTION TWO — On the Movers and Motions of the Heavens

CHAPTER I

Whether the Heavens or Stars are Moved by Intelligences, or rather from within, by their own Form or Nature

(printed p. 247:)

[Margin: 1. Opinion — on the proper form moving the heavens.]

[I.] The **first opinion** was that the heavens are moved by their own form, that is, from within—lest that form be idle and inferior to the forms of the elements, since each thing exists for the sake of its own operation, as the Philosopher says (*On the Heavens* bk. 2, ch. 3, text 17); and lest that perpetual motion in a circle be violent, since (from the *Ethics* bk. 3, ch. 1) the violent is that whose principle is outside [the thing]. And certainly it does not seem repugnant that some body could be made by God to which there is a natural appetite for perpetual circular motion, and so a power of moving itself perpetually in a circle—just as an impetus once impressed on a stone for circular motion, if it were not gradually corrupted by a contrary impetus produced by gravity, would perhaps last forever, as some say. Since, therefore, in the heaven there is no gravity or levity, what wonder if that impetus—acting on the celestial body from the beginning, once [impressed], in a circle by the force of its own form—should perpetually whirl it around?

[Margin: Major, [William of] Paris, Albert of Saxony, Gabriel, Trallianus, Strato.]

Therefore of this opinion were John Major (bk. 1 *On the Heavens*), [William of] Paris (part 2 *On the Universe*, ch. 152), thinking the opposite vain and frivolous; and Albert of Saxony (*Physics* bk. 8, last question); and others, in [the report of] St. Bonaventure and Bassolis (on [*Sentences*] 2, dist. 14, art. 3, q. 2); and Gabriel [Biel] thinks it probable (ibid., q. 1, art. 3, dub. 2). And of old too Trallianus and Strato of Lampsacus, as the Conimbricenses relate (2 *On the Heavens*, ch. 5, q. 1); and Pererius (*On Genesis* bk. 2, q. 5) said that the motion from right to left—that is, from East to West—is from an Intelligence, but [the motion] from left to right is from [the heaven's] own form.

[Margin: Longomontanus. Vallesius. Camerarius.]

Among the more recent [writers], Longomontanus (*Theorics* bk. 1, in the proem) says [the heaven is] moved from within; but Vallesius (Controversies 11 and 26, *Physics*) teaches that it is moved partly by its own form, partly from without—for an Intelligence moderates the velocity; and Camerarius (disp. 25), whom that [text] of Psalm 18 [19] moved—"He hath rejoiced as a giant to run his course"—to think that the Sun is moved from within, although it is said metaphorically; and that [phrase] in the Preface of the Mass, "the heavens and the powers of the heavens," where the powers of the heavens are numbered [as] distinct from the Angels—as if, forsooth, there by the name "powers" could not be understood forces for influencing, or even some order of Angels, since [the Preface] goes on to say, "And the blessed Seraphim."

[Margin: Eusebius Nieremberg. — St. Francis Xavier stops the Sun.]

Toward the same opinion strongly inclines Eusebius Nieremberg (in his *Philosophy*, bk. 6, *On the Life of the Stars*), who, however, concedes that some Intelligence was appointed—of old, or [for the moment]—for stirring up extraordinary motions, or for stopping their motions; as when, at the death of Christ, the full Moon was brought back to conjunction with the Sun; and [as when] the Sun's course was held back—not only at Joshua's command, but also at the prayer of St. Francis Xavier (that the ship, which was being tossed by a violent storm, might reach harbor before sunset)—as Velasquez, Sherlock, and Oviedo (the single controversy *On the Heavens*, point 1, num. 7) relate of St. Xavier.

[Margin: Téllez.]

But that the Stars are moved absolutely [unqualifiedly] by their own form, Baltasar Téllez affirms (disp. 44, sect. 3), who also had taught (disp. 40, sect. 3) that, if the stars are considered in themselves and without respect to inferior [things], circular motion is not connatural to them, but [comes] from without; but if they are considered as they are the chief part of the Universe, having

(printed p. 247, right column — the column opens mid-sentence, completing the claim that, in virtue of their natural powers for influencing, circular motion is natural to the heavenly bodies, as held by the author of the Philolaic Astronomy *(bk. 4, ch. 2).)*

[Margin: Bullialdus.]

Ismaël Bullialdus [Boulliau] too (*Philolaic Astronomy*, ch. 12, and in the *Philolaus*, bk. 4, ch. 2) concludes that both the Sun—about its own axis, in the center of the World—and the rest of the Planets (among which he had placed the Earth) are moved by their own form.

[Margin: Kepler.]

But Kepler (in the introduction to [the commentary on] *Mars*, and ch. 33; and bk. 4 of the *Epitome of Copernican Astronomy*, parts 2 and 3, that is, from p. 499 to 530) teaches that the Sun is in the center of the World, and has a moving soul with a certain corporeal life, by which it is perpetually moved about its own axis: "For although by another means," he says (p. 514), "that motion could be continued, yet by the aid of a soul the long-lastingness and perpetuity of this motion—in which the life of the whole World consists—is more rightly obtained." He says, then, that the Sun emits from itself a certain species [emanation] similar to that which a magnet emits, and by it, as if with a hand, grasps the other Planets; and that, while it is itself turned by [its] rotation about its own axis, it leads the other Planets around—yet in such a way that, when that magnetic power falls upon the friendly part of the Planets (according to the disposition of [their] magnetic fibers), it attracts them to itself, and they become perihelial; but since the Planets have a power of holding themselves in the parallel position which they once obtained from the beginning, with respect to [their] position in the Universe, it comes about that gradually the hostile and contrary part and face is turned toward the Sun, and therefore they are repelled by the magnetic species or quality of the Sun, and become aphelial—just as a magnet allures to itself the friendly part of the magnetic needle [and] repels the unfriendly. Finally, he says that in the other Planets there is a certain **inertia** toward motion, and a greater resistance the farther they are distant from the Sun. And so he teaches that the Sun is moved from within, but the rest of the Planets from without—namely, set in motion by the Sun—but by no means by an Intelligence (p. 508); whose ingenious figments Bullialdus refutes at length in the place cited above. Yet the same Kepler, in the *Hyperaspistes* (p. 6), admits that "Christian scruples transfer these motions of the heaven to Angels"; and (p. 7) [admits] that the Star of the Magi and Comets are moved either by a Genius [spirit], or by an inborn knowledge, according to Tycho.

[Margin: What of Tycho?]

Hither likewise seems to be referred Tycho, who (vol. 1 of the *Progymnasmata*, p. 268) says: "It is proved, therefore, even from the observations of two ethereal Comets alone—namely of the year 1577 and 1585—by reason of their motion peculiar [different] from the rest of the Planets, that no orbs really exist in the ether,

and that the heaven itself does not consist of hard and impervious matter; but that the stars themselves possess a certain natural and congenital—or rather divinely implanted from the beginning, and perpetually preserved—knowledge of regular motion, by which, impelled or supported by no orbs, they perform their courses most perfectly and most constantly." But from these very [words], and from what was said in the preceding section (ch. 8, num. 4), it is sufficiently established that he [Tycho] is to be referred to the second class, which teaches that the stars are moved by a soul not only sensitive but also intellective—to which [class] Kepler too in part belongs.

[Margin: What of Suárez and Raynaudus?]

But now Suárez said (*Metaphysics* disp. 29, sect. 1, num. 16; and earlier disp. 18, sect. [—], num. 36)—yet, in disputing, he concedes that motion can be attributed to an incorruptible proper form; and Theophilus Raynaudus (in the *Natural Theology*, dist. 2, q. 1, art. 1) says that the opinion of those affirming that the heaven or stars are moved by an intrinsic and proper form is to be condemned for rashness.

[Margin: 2. Opinion — on a moving soul.]

The **second Opinion** was that of those who said the heavens and Stars are indeed moved by their own form, but [a form] which would be an Intellective soul, or even a sensitive and vegetative one—[the views] which I reviewed distinctly in Section 1, ch. 8, from num. 1 to [4]; which therefore we do not repeat.

[Margin: 3. Opinion — on God as mover.]

The **third Opinion**, then, [is] that the heavens are moved by God himself immediately. So judged Albertus Magnus (on [*Sentences*] 2, dist. 14, art. 6), Alpetragius [al-Bitr■j■] (*On the Physical Cause of the Celestial Motions*), and—if you believe the Conimbricenses—Ptolemy himself, [and] Leonard Lessius (the book *On Providence*, from num. 20). Which [view] also Ga—

[…continues on p. 248 (PDF 283): "…Gabriel [Biel] (on [Sentences] 2, dist. 14, q. unica) and Gregory of Rimini (on 2, dist. 8, q. 3) thought probable. For although the Abulensis denies that local motion can be made immediately by God, yet it is an error to deny this, as St. Thomas teaches…" — then Riccioli's digression giving his own (Cartesian-style) argument for God's existence, against the Atheists; then the 4th and most common opinion: the heavens are moved by the Angels/Intelligences as assisting movers.]

(printed p. 248 — continuing the third opinion (God moves the heavens immediately): further authorities are cited for its probability, Gabriel Biel and Gregory of Rimini, while Tostatus's denial that God can immediately cause local motion is rejected as an error, with St. Thomas. The page then argues that denying God's immediate particular causation of the supreme heaven's motion neither entails an infinite regress of movers nor undermines the demonstration of God's existence from creatures.)

[Margin: God's existence is demonstrated by a new argument.]

And besides, there are other modes of demonstrating the Divine existence, among which this one occurs to me as the most evident of all: namely, that we evidently judge it possible that there be a being supremely perfect, and having all the pure perfections [*perfectiones simpliciter simplices*] which are compossible—(for if any perfection is mixed with imperfection, or repugnant to another more necessary and more to be chosen, of this we do not speak)—but among the other pure perfections, and repugnant to no such perfection, is necessary existence; that is, so to exist that it can never, and could never, not exist, as any intellect not badly disposed judges. Therefore, if such a being is possible, it also exists in reality, since that perfection does not include a mere possibility of existing, but an actuality, and indeed a necessary one. And in this one case alone does the argument from the possible to [actual] being hold—that is, from being-able-to-be to being-in-fact. Which argument, many years afterward, I found later indicated—but in another form of words—by René Descartes (in the *Principles of Philosophy*, part 1, num. 14).

[Margin: Some said the heaven is moved by chance.]

Let these things be said against the Atheists. But to those who wish to demonstrate God from the motion of the heaven, [there] are diametrically opposed those who said the heaven is moved by chance—namely Democritus and Epicurus.

[Margin: 4. Opinion — moved by the Angels.]

[III.] The **fourth Opinion**, and the most common, is: that the heaven and stars are moved by Intelligences, that is, by Angels—as assisting, and immediate, efficient causes; but not as by souls informing the heaven; and so [that they are] moved by an extrinsic principle, but a created one. In which opinion are all [those] already enumerated in Section 1, ch. 8, from number 5; and [those] expressly treating this controversy—namely St. Thomas (*Prima Pars*, q. 70, art. 3; and q. 6 *On Power*, art. 3; and Opusculum 10, art. 3; and Opusculum 11, art. 2; and 2 *Against the Gentiles*, ch. 92, and there Ferrariensis); likewise the Scholastics almost universally (on [*Sentences*] 2, dist. 14)—

[Margin: Authors of the 4th opinion.]

especially St. Bonaventure (art. 3, q. 2), Scotus (q. 1), Durandus (q. 2), the Argentine [Gregory of Rimini] (q. 1 and 2); [Gregory] of Rimini (on 2, dist. 1, q. 1), Capreolus (dist. 9, q. 1, art. 3), Albert [the Great] (*On the Four Coevals*, part 1, q. 4, art. 26), Nicolaus Cusanus (*Exercitations* bk. 7), Soncinas (*Metaphysics* bk. 12, q. 36), Jandun (*On the Substance of the Orb*, q. 2, 13, and 14; and 2 *On the Heavens*, q. 92). Among the more recent: the Conimbricenses (2 *On the Heavens*, ch. 5, q. 5), Rubius (ibid., and 1 *On the Heavens*, ch. 2, q. 8), Toletus (2 *On the Heavens*, ch. 5), Suárez (in the *Metaphysics*, disp. 18, sect. 7, num. 36; and disp. 35, sect. 1, num. 20), Pererius (bk. 2 *On Genesis*, q. 5; and bk. 7 *Physics*, ch. 7, q. 2), who says it is, as it were, handed down by the Philosophers and received by the Theologians; and Bubalus (*On the Angels*, q. 1, diff. 2, art. 15), who thinks the opposite dangerous; Arriaga (the single disputation *On the Heavens*, sect. 5, num. 64), Hurtado (disp. 2 *On the Heavens*, sect. 4), Oviedo (the single controversy *On the Heavens*, point 1, num. 7), Mastrius and Bellutus (disp. 2 *On the Heavens*, q. 4, art. 3), George Polaccus (in the *Anti-Copernicus*, assertion 111), Aversa (q. 34, *Physics*, sect. 7), John Anthony Delphinus the Franciscan (the opusculum *On the Celestial Orbs*, from p. 80), John Punch (disp. 22, *Physics*, q. 9), Amicus (tract 5, *On the Heavens*, q. 6, dub. 2), [and] Claramontius [Chiaramonti] (bk. 2 *On the Universe*, ch. 17).

[Margin: St. Thomas's notable sayings.]

But it pleases [me] to note St. Thomas's opinion, who (q. 6 *On Power*, art. 3) says: "But it is a matter of Faith that the Angels move the celestial bodies locally by their command—and also other bodies, God ordaining and permitting [it]"; for he had reported the opinions of the Philosophers conceding to the Angels the motion of the heavens, but denying [it] of other bodies. And in Opusculum 10, art. 3: "But that the celestial bodies are moved by a spiritual creature, I do not remember to have read denied by any of the Saints or Philosophers." Finally, in Opusculum 11, art. 2: "But it seems to me that it can be demonstratively proved that the celestial bodies are moved by some intellect—either by God immediately, or by means of the Angels. But that he moves them by means of the Angels agrees with the order of things, which Dionysius asserts to be infallible: that inferior [things] are administered by God through intermediaries, according to the common course." And that this is the opinion of the ancients, Trithemius taught (the book *On the 7 Intelligences moving the orb*), whose words I have already reported in bk. 7, sect. 1, ch. 1, where I reviewed many things—not unworthy of a learned reader—about the 7 spirits moving the 7 Planets.

The Single Conclusion

Although it can be demonstrated neither Metaphysically nor Mathematically—but at most Physically or morally—that the heaven or stars are moved by Intelligences; nevertheless, the Authority both sacred and profane being regarded, it must be said that they **are moved by Intelligences.**

[IV.] The **first part** of the Conclusion is clear, because from neither the principles of Metaphysics nor those of Mathematics can a necessary connection be deduced between the motion of the heaven or stars and the

Intelligences—whether their motion be regarded according to [its] substance, or [its] essentials, or as regards accidental perfections, but especially the most perfect order and harmony (that is, the *uniformly non-uniform* anomaly), and the infallible rules which they keep in their periods and revolutions, and the perpetuity and constancy through so many ages. For it is repugnant neither to the principles of being-as-being, nor to bounded quantity as such (whether it be continuous or discrete), that bodies could be made by God which are moved from within in this way—by a power and qualities connatural to them and implanted by God from the beginning of the World (as we were saying, under number 1, in reporting the first opinion); and [that] by such a motion they are so moved toward the good of inferior [things], that this very thing is their good—to exercise their power and communicate their influences to others—just as it is the perfection of a Master to teach others, and of a Physician to heal others, though it be an extrinsic perfection, which nevertheless betrays an intrinsic [one]. For the things which some have attempted against [this] are too slight to need a response: as when they say that circular motion is reflexive upon itself, and that reflection is from a soul; and that every mover supposes an immovable part on which it rests, as when an animal rests on [pushes off with] its foot—for what will they say about the fins of fishes and the wings of birds? Or when they say that the same [thing] cannot be at once in potency and in act, and that therefore every movable must be moved from without. But neither is a moving Angel **necessary**, such that the existence of [the Angel] could be demonstrated from this; for either it is known from elsewhere—and so is not necessary on that account—or it is unknown, and so is not shown from things more known [than] that very [thing] about which, as [if] less known, the question is here [raised].

[Margin: Whether the existence of the Angels is demonstrated from the motion of the Heavens.]

Moreover, we have already shown at length in the treatise *On the Angels* (when we were publicly professing Theology) that there is no natural means by which the existence of the Angels may be demonstrated; for all effects either include a determination to a moral fault or to falsity, and [so] can be attributed to separated souls; or they do not include [it], and [so] can be attributed either to the same [souls], or to God. And so [it goes], reasoning through the rest.

[Margin: 2. Part of the Conclusion.]

The **second part**—about the Physical or Moral demonstration, conceded rather than asserted—is proved because, on the one hand, we have no indication in the stars, or from the stars, of an animal [vital] operation, since neither organs nor other similar [things] appear in them; but, on the other hand, the admirable harmony of the celestial motions, and the reason and order constant through so many ages—far greater than in the humors of the human body, nay, than in any machines whatever devised by human artifice—is an argument of a soul or a mind continually preserving and directing such motions. Therefore it is physically, or at least morally, evident that the heaven or stars are moved by some mind, which nevertheless is not properly their soul—especially since so great is the variety and subtlety in the motions of the Planets, that not even the most skilled of Astronomers have hitherto fully comprehended it. There is added that, by sufficient induction, we have [the principle that] whatever is moved locally is moved so that it may be better off in a different place; and to be moved [toward] its proper place is proper to living beings: but neither [of these] belongs to the heaven or the stars.

The **third part** is confirmed, first, from the multitude of Authors—

[…continues on p. 249 (PDF 284): "…of both classes [philosophers and theologians], then from the Sacred writings: for that [text] of Job 9, 'Under whom they are bowed who bear the world'; and Job 26, 'The pillars of heaven tremble'; and ch. 38, 'When the morning stars praised me, and all the sons of God shouted for joy'; and that of Matthew 24, 'The powers of the heavens shall be moved' — many Fathers expound of the Angels. Finally, St. Dionysius (On the Celestial Hierarchy, ch. 5), St. Augustine (On the Trinity bk. 3, ch. 4), and St. Gregory (Dialogues bk. 4) teach…"]

(printed p. 249 — completing the third part of the Conclusion, that the heavens are moved by Angels: the thesis is confirmed from the multitude of authors, from Scripture (Job 9, 26, 38; Matthew 24), and from Dionysius, Augustine, and Gregory, who teach that divine providence governs corporeal things through spirits. Nor is it absurd, against Lessius's scruple, that some Angels be perpetually occupied in this ministry, since God can easily substitute others.)

[Margin: Kepler's objections resolved.]

[V.] But now the objections of John Kepler are to be dissolved, by which (in the *Epitome of Copernican Astronomy*, from p. 508) he contends that created Intelligences do not move the Planets, but that they are moved by the Sun by a certain material necessity and natural [one]. For solid orbs, he says, cannot be admitted, since it has been shown that the heaven of the Planets is fluid; but without solid orbs a created Intelligence cannot move the Planets—both because a mind destitute of an animal and locomotive power cannot, by a mere nod, or by the desire or command of [its] will, effect motion in another body; and because, if a Mind were to move [them], it would surely move the Planets in a perfect circle, of which there is a mental beauty and perfection. But from Astronomical observations legitimately handled, we are convinced that the path of a Planet is not a perfect circle, but either an ellipse or a similar figure, which savors rather of the nature of a balance [steelyard] and of material necessity than of the conception of a mind. Again, although the tempering of the extreme motions—that is, of the slowest and the swiftest in each Planet—is most exquisitely harmonic, and the work of the supreme and adorable creative mind, yet the lengths of the periodic times do not have a mental beauty, because they do not have effable [expressible] or rational proportions (such as double, triple, etc.), but ineffable or irrational ones, and so tending to infinity; nor are the times of one period gathered from equal [motions], but from unequal motions in different parts of the circle, according to the ratios of a balance. Finally, no place can be assigned in which the Intelligence resides, and from which it might know the path along which it could direct the Planet—not in the center of the circle, nor in the centers (that is, foci) of the Ellipse; for in the ethereal breeze those places do not differ from other points, nor could the mind perceive thence whether a Planet so far distant went along the path by which it ought, unless you give it eyes, or a cord by which the Planet, tied [to it], is led around. For to have a mental idea of the planetary orbit does not suffice, but there is need of some instrument by which the real path of the Planet—having a definite magnitude—is carried into execution. But neither can it be placed on the circumference of the orbit; for either it will rest in one point (and the argument just made recurs, when the Planet will be at very distant points), or it will be moved from place to place, like a soul with a body; but since this mind lacks a body, and is not of itself movable or place-able, it will have no means by which to measure its distance from the center of the world (since this center is outside the center of the planetary orbit), or to keep its position with respect to it. Yet Kepler concedes that the figure of the planetary orbit, and the periodic motions, are the work of the creative Mind—that is, of God.

This is plainly Kepler's reasoning, the more obtuse to me, the more acute it seemed to him—both because he assumes as conceded certain things which cannot be conceded without injury and disgrace redounding upon the Intelligences, and because he entangles reasons mutually repugnant. But I shall have done [something] worth the effort, if I reduce these arguments to form and blow them away.

[Margin: 1. Argument, from Kepler.]

[VI.] The **first Argument** is of this kind: "If a Mind or created Intelligence moved the Planets, it would move them in a perfect circle, and in such a way that the periodic time of the Planet would have a rational proportion, gatherable from equal motions." *Its proof:* For such a figure and motion have a beauty and perfection worthy of a mind, and befitting an Intelligence. But the Planet's motion is not made in a perfect circle, nor does its periodic time have a rational proportion, nor [one] gathered from equal motions. [Therefore it is not moved by a Mind.]

[Margin: 1. Response.]

I answer, first, by denying the Major [premise]; for there is no necessity of such a proposition. For not the circle alone is a perfect figure—especially with respect to the end to which the motion is ordained—but the Ellipse too, and many other figures; nor are [only] those proportions effable to us beautiful, but also [those] ineffable to us, [yet] to God, who ordained them, rational and effable, at least by his divine Word, to whom he tells all things finite and infinite. Nor is it necessary that [God] distinctly communicated to the Angels an idea or knowledge of them; but it suffices, if he willed them to move the Planets along such and a determinate path of the ethereal breeze, with such velocity, and within such a time to revolve them to the same or nearly the same point—whatever proportion, after all, may arise between the parts of that motion, or of the whole period with the period of another Planet.

[Margin: 2. Response (ad hominem).]

I answer, secondly, by retorting the argument thus: "The imperfection of figure and motion which is unbecoming to an Intellectual nature, and not worthy of a created mind on account of the perfection of such a nature, is much more unbecoming to the Divine nature, and unworthy of that supreme Mind; but the figure and periodic motion of the Planets are of this kind, according to you, O Kepler; therefore they are not the work of the divine mind"—which it is impious to say, nor indeed do you [Kepler] say it; nay, you have expressly professed the opposite. Nor will you escape if you say that that figure and motion are not immediately from God, but from the Sun moving the other Planets; for since the Sun does not determine it freely, but by natural necessity, all this determination [comes] at last from God, and is not to be attributed to him, if it contains an imperfection unworthy of God [as its] author.

[Margin: 2. Argument, from Kepler.]

[VII.] The **second Argument** is of this kind: "The motion of the Planets is made in an Ellipse according to the ratios of a balance and steelyard—that is, according to a material necessity arising from the nature of a balance—rather than according to an intellectual reason, or a voluntary appointment. But if [the Planets] were moved by an Intelligence, they would not be so moved; therefore, etc." It could be answered, [first,] by denying the Major—if the discourse be about a reason primarily intended *per se* by the motive faculty of the Planets; granted that some likeness or analogy of such motions with motions made by a balance and lever be not conceded, yet it is worthy of God that he willed to represent this analogy primarily *per se*; nor is that [saying] of Wisdom 11 to be restricted to these mechanical narrows: "He disposed all things in weight, number, and measure"—but [it extends] to higher ends, and to determinate proportions of the means with their ends. I answer, secondly, the Major being granted, by denying the Minor; for the knowledge of such ratios could be infused into the moving Angels, so that they might move the Planets, and so move them that the analogy [with a balance] be preserved—as it were more accommodated to us, who are of a grosser intellect—yet not repugnant to the end of these motions.

[Margin: 3. Argument, from Kepler.]

[VIII.] The **third Argument** is such: "If an Intelligence moved the Planets, it would need some body by which it might perceive along what path they were to be directed, and the distance of them from the center of the world to be preserved in such motion. But the Intelligences have no such body—because neither are there solid Planetary orbs, by whose motion that path and distance would be kept; nor do they have cords or similar supports by which they might lead the Planets around; nor are they forms informing or animating the Planets; or if they were, yet there are not in the Planets organs of senses through which the aforesaid path and distance could be perceived. Therefore [they cannot move them]." I answer, [first,] by denying the Major—as [a thing] unworthily brought against the most perfect mode of understanding with which the Angels are endowed; for they understand, without sensations, all sensible things, and all corporeal motions, and the figure describable by them, by impressed species alone and ideas divinely infused—indeed far more perfectly than Kepler [understood] those Ellipses and librations of his; unless he is so dull as to think that the Angels, without eyes or hands, etc., do not understand the figures and ratios of the motions, and the intervals

between the Planets and the center of the world—which Kepler himself thinks are understood by himself (although not immediately through the senses, but deduced by reasoning from observations); or [so dull as to think] that they do indeed understand, but cannot, without corporeal organs, impress on the Planets a motion such as shines forth in the intelligible Ideas of them.

> *[…continues on p. 250 (PDF 285): "Than which saying or thought, what can be more stupid? Could a painter, then, be found who would draw a perfectly straight line and a most perfectly round circle without ruler and compass — and an Angel will not be able, without any corporeal instrument, to impel a Planet, or lead it around through that orbit through which the Keplerian Sun and its soul (which is neither intellective nor sensitive) drive the Planets around by a certain blind direction? But I am ashamed, in Kepler's name, to linger longer on these trifles…"]*

(printed p. 250 — concluding the rebuttal of Kepler: it is ridiculed as stupid to grant that a painter might draw perfect lines freehand yet deny that an Angel can impel a Planet without corporeal instrument, when Kepler's own solar soul drives the Planets by blind direction. Riccioli declares himself weary of refuting such trifles and turns to three further Questions of the chapter.)

On the Mode by which the Intelligences move the Heaven or the Stars

[IX.] It is wont to be asked whether the Intelligences move the heavens—or generally whether the Angels move bodies—by intellect and will alone, or rather by a power distinct from both of these. For [that] the Intellect and the mere desire or command of the will suffices, [this] thought Averroes, Durandus, Bassolis, the Argentine [Gregory of Rimini], Capreolus, Soncinas, [William of] Paris, Hervaeus, Aquarius, Victoria, and certain other Thomists (whom the Conimbricenses cite, 2 *On the Heavens*, ch. 5, q. 7); and Amicus (tract 5, *On the Heavens*, q. 6, dub. 6); and among ours [Jesuits] there follow Vasquez (disp. 102, ch. 5), Delrio (2 of the *Magical Disquisitions*, q. 6), and Molina (*Prima Pars*, q. 54, art. 5). And St. Thomas strongly favors them (ibid.; and Quodlibet 2, art. 2; and Opusculum 11, art. 3 and 13; and q. 16 *On Evil*, art. 1, ad 14); and Aristotle (*On the Soul* bk. 3, text 49), where he said: "Both of these, therefore, are motive with respect to place—the intellect and the appetite." For another power seems to be multiplied in vain, especially in a merely intellectual nature, in which it is fitting that those [powers] which in inferior [beings] are dispersed be united, and [that] all its powers be merely intellectual.

[Margin: An Angel's locally-motive power is distinguished from intellect and will.]

But, on the contrary, [that] a power locally-motive of itself and of bodies is distinguished from the intellect and will of the Angels—[this] more rightly taught Scotus (on [*Sentences*] 4, dist. 10, q. 7; and on 1, dist. 45), Henry of Ghent, Mayronis, Aureolus, Cajetan, Godfrey [of Fontaines], and others (whom the Conimbricenses and Amicus adduce and follow above); Suárez (disp. 35, *Metaphysics*, sect. 2, num. 21; and *On the Angels* bk. 4, ch. 29), Raynaudus (in the *Natural Theology*, dist. 4, q. 3, art. 4), Rubius (2 *On the Heavens*, ch. 5, q. 11), Tanner (*Prima Pars*, disp. 5, q. 5, dist. 1), Meratius (disp. 21 *On the Angels*), and Alarcon (disp. 6, ch. 8). For both the objective concept of these powers, and the proper object, are different; nor can the intellect elicit any operation other than intellection, nor the will [any] but volition, as it is such a power; but neither of these is local motion, or the production of the impetus effecting it—otherwise [the Angel] could move [a body] in an instant, and to any distance, and [a body] however large, because the Angel can understand and love these [things]. Therefore the intellect, by directing and proposing, and the will, by commanding, can be only the **moral** cause of this motion; but there is need of an **executive power**, to which the command is given—as St. Thomas also taught (q. 6 *On Power*, art. 7; and Quodlibet 9, art. 10); nay, in the *Prima Pars* (q. 25, art. 1) he teaches that the divine power implies the character of a principle executing what the will commands, and to which knowledge directs. When, therefore, he teaches that God and the Angels move by intellect and will alone, he is to be understood as excluding a motive power really distinct [from them], or adequately including corporeal organs, such as is in animate beings. But I suppose,

from what we said elsewhere in the treatise *On the Angels*, that they impress a certain quality—translative of the movable from place to place—which is called **impetus**, and from which motion immediately follows (as Molina also teaches, *Prima Pars*, q. 110, art. 3; Vasquez, disp. 128 and 218; and Tanner, above, dub. 2), at least when the movable body is separated from the Angel. Granted that Suárez teaches that only motion is produced by them (disp. 35, sect. 6, num. 24; and *On the Angels* bk. 4, ch. 31), and Amicus above—at least when [the Angel] is immediately present—whether that impetus be spiritual (inasmuch as [it is] from a spiritual principle), or rather corporeal (inasmuch as [it is] ordained for moving a body, and received in a corporeal subject).

Whether, and where, the Moving Intelligences are at rest

[X.] It is asked, moreover, whether the Intelligences, while they move the heaven or the Planets, are at rest—and in what part of the heaven—or whether they fly around together with them. That an Intelligence resides in one determinate place of the heaven, and thence impresses motion on the heaven (to which it is immediately present), which is afterward diffused into the other parts of the heaven, [this] taught Aristotle (*Physics* bk. 8, last chapter, text 84; and *On the Heavens* bk. 2, ch. 2), St. Thomas (*Prima Pars*, q. 52, art. 2), St. Bonaventure and Scotus (on [*Sentences*] 2, dist. 2, q. 5), the Conimbricenses (2 *On the Heavens*, ch. 5, q. 8), Tanner (vol. 1 of the *Theology*, disp. 5, q. 5, dub. 2), [and] Amicus (tract 5, *On the Heavens*, q. 6, dub. 6). And that that part [where the Intelligence resides] is at the Equator (where the motion is swiftest) and in the East (whence the motion begins), the Peripatetics teach. But others distinguish, and say that the Intelligence which moves the total heaven (that is, one whole heaven—say, the prime mobile) rests in one determinate part of it; but those [Intelligences] which move the Planets, they say are moved according to the motion of the Epicycle, so that they may impress a different motion on it and on the Planet—so Bartholomew Mastrius and Bonaventure Bellutus (disp. 2 *On the Heavens*, q. 4, num. 148)—granted that they say it seems to Scotus inconvenient that the Angels run around, and are moved according to the motion of the heaven.

[Margin: The Angels that move the Planets are moved with them.]

But I think it must be answered otherwise. For, speaking of the Planets—since they are moved in the fluid ether (from what was said in sect. 1, ch. 7, num. 21)—it is consonant that the Planets are led around by the Intelligences; for [the Intelligences] are not everywhere, nor can they produce an impetus or motion in a body enormously distant (as I suppose, from Sts. Damascene, *On the Faith* bk. 2, ch. 3; Ambrose, *On the Holy Spirit* bk. 1, ch. 10; Chrysostom, homily 3 on [the Letter] to the Hebrews; and Gregory, *Morals* bk. 2, ch. 2); for their place is circumscribed and limited, and [their] power finite. And this is conformable to Sacred Scripture, if that [text] of Ecclesiastes 1—"The Sun rises and sets, and returns to its place; and there, rising again, it wheels through the South and is bent toward the North: the spirit, surveying all things, goes on in its circuit, and returns into its circles"—be understood of the Spirit, that is, of the Intelligence moving the Sun (with St. Thomas, Opusculum 10, art. 6)—Pineda and Lorinus not refusing [this] on that passage of Ecclesiastes (although they bring other interpretations too); nay, nor [refusing it] St. Jerome, who, since he concedes that it can be understood of a spirit or mind setting the Sun in motion, and elsewhere disapproves of Origen's granting a soul to the stars, seems able to take [it] of an Intelligence not informing, but extrinsically moving, the Sun. This being posited—if Sacred Scripture be taken to the letter, as it can be—it can sufficiently be confirmed from this that the Angel which moves the Sun also itself goes around, and accompanies the Sun which it moves. The same opinion—about Angels carrying the Planets around—I afterward saw defended by John Anthony Delphinus (in a truly learned opusculum, *On the Celestial Globes*, p. 80), and in Arriaga (the single disputation *On the Heavens*, num. 54). But if the discourse be about the heaven of the Fixed [stars]—whether it be moved by one, or by several, Intelligences—it can be conceded that they reside in a single place of the heaven; but if it be one [Intelligence], and any point of the heaven at the Equator be rising with respect to some horizon, it will be necessary to determine some particular region—say Palestine—in whose eastern horizon that Angel is; or, to avoid this singular position, and the

difficulty in moving so vast a machine, it could be done by several Intelligences disposed in a circle. But to divine about these [things] is not for our weakness; and so we ought to remember those divine rebukes of Job 38: "Dost thou know the order of heaven, or wilt thou set down the reason thereof on the Earth?"

How many are the Moving Intelligences of the Heavens, and [whether] God [is] among them?

[XI.] There were not lacking certain unnamed [persons]—[noted] by Fracastorius (in the *Homocentrica*, sect. 1, ch. 7)—who would say that all the celestial orbs are moved by a single Intelligence (among whom [holding this] Alpetragius [al-Bitr■j■] is numbered): just as by one soul all the vital operations of one body are carried out; especially since no heaven resists a motion once impressed, nor is there need that the contact of the Angelic power be immediately—

[…continues on p. 251 (PDF 286): "…applied to all the parts of the body to be moved, but [it suffices] to be present to one part, whence the motion is diffused into the others. But, as the Conimbricenses note (On the Heavens bk. 2, ch. 5, q. 8), and Mastrius and Bellutus (disp. 2, q. 4, num. 147), it is the common opinion of the Theologians that the sphere of Angelic activity is defined by certain spaces, and their power limited…" — then the question of the number of Intelligences (4? 12? 24? seven?).]

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*(printed p. 251 — completing **[XI.]**, the refutation of the single-Intelligence view: angelic power need touch only one part of the movable body, yet the common opinion of the Theologians holds that angelic power is limited to definite spaces, so one Intelligence could not impart such various motions to so many vast heavens. Since the planetary heaven is fluid, at least seven Intelligences besides that of the Fixed stars are required, in conformity with the order of offices and with Aristotle, who posits an Intelligence for each partial orb.)*

[Margin: Whether God [is] among the moving Intelligences?]

But, moreover, it is disputed whether Aristotle numbered God among these Intelligences, as the immediate mover of the supreme heaven—as the Conimbricenses think (2 *On the Heavens*, ch. 5, q. 6), Piccolomineus, Pendasius, Rubius, Aversa, and Amicus with Gregory (on 2, dist. 1, q. 1, art. 1); or whether [God] is rather outside and above this number, inasmuch as he does not move that heaven except by means of some created Intelligence—as St. Thomas thinks (1 *Against the Gentiles*, ch. 13) and with him the Thomists, likewise Jandun (12 *Metaphysics*, q. 17), the Abulensis [Tostatus] (on ch. 27 of Exodus, q. 3), Scotus (on 1, dist. 2, q. 1; and dist. 8, q. 5; and Quodlibet 7), Contarenus (*On the Heavens*, in the question on this matter), Suárez (disp. 35 *Metaphysics*, sect. 1), [and] Mastrius and Bellutus (disp. 2 *On the Heavens*, q. 4, art. 4). And indeed, since Aristotle thought that God necessarily acts toward the outside [*ad extra*], as St. Thomas teaches (q. 16 *On Evil*, art. 10; and 12 *Metaphysics*), and so exerts his whole effort; and that besides he is of infinite power—it would follow, from Aristotle's discourse (8 *Physics*, text 78 and 79), that God moves with infinite velocity and in no time; or, if anything resisted him, that finite power could prevail over, or be equivalent to, infinite [power]—both of which are absurd. Moreover (12 *Metaphysics*, text 36) he taught that the first mover moves as [something] lovable and desirable, inasmuch as the created Intelligences, contemplating his supreme goodness in communicating being to themselves and to other things, strive to assimilate themselves to him by moving the heavens, and through their motions and influxes to communicate very many goods to inferior natures: whence it comes about that God moves the heavens by way of the good and the end, or even of an Idea—yet not excluding the effective concourse by which, as a universal cause, he concurs immediately with all effects. And thus he is to be understood in the same place, text 38, where he says that the prime mobile is moved by the first Intelligence; and text 45, where he numbers as many Intelligences—the first not excluded—as there are orbs.

[Margin: The Aristotelian number of Intelligences.]

Therefore, since [Aristotle] had learned from Eudoxus that the whole inequality of the Planets in motion could be demonstrated by 25 *anastric* [reverting] orbs, and by Callippus [by] 33, Aristotle himself, believing the heaven to consist of solid orbs, added 22 other orbs, ■νελ■τοντας [*anelittontas*]—that is, "Revolving" [counter-rolling] ones—namely, so that any lower orb might be freed from the carrying-along [*raptus*] which, on account of the contiguity of the surfaces, it was going to suffer from the higher one, by means of an interposed Revolving [orb] striving in the contrary [direction] with an equal time, and by that reluctancy exhibiting the appearance of a [body] at rest; so that the lower or inner orb, resting upon that orb as upon an immovable one, might accomplish its own proper period: as Kepler expounds (on Mars, ch. 2; and in the *Epitome of Copernican Astronomy*, bk. 4, p. 505)—but in those passages he wrongly says that the Movers set down by Aristotle [are] 49, or according to Callippus 53 or 55. For below (sect. 3, ch. 5, num. 5) we shall show that, according to Aristotle's mind, they are 55, and with the prime Mobile 56; but under another hypothesis 47, and with the sphere of the Fixed [stars] 48; and we shall uncover the errors of many in this Aristotelian number. Again, [in] sect. 3, ch. 7, there will be treated the 70 solid orbs which Fracastorius devised in the *Homocentrics*, compacted of Circitors, Anti-circitors, Circumducents, [and] Contravects, etc.

[Margin: A conjecture about the number of Intelligences.]

[XII.] If, moreover, it were permitted me to determine anything by some conjectures about this number, I would say that—besides the Intelligences (whether 4, or 12, or 24) moving the supreme orb of the Fixed [stars]—there are seven principal Intelligences, destined for revolving the seven Planets; and that these are those seven Spirits about whom, with Trithemius and Cornelius a Lapide, I said many things worth knowing in bk. 7, sect. 1, ch. 1—which it will be helpful to reread in this place. I would add, however, less principal Angels, either for the less principal motions in altitude and latitude, or at least for Companions [satellites]—two to be turned about for Saturn singly, and four for Jupiter; for to the spots of the Sun, which are generated and perish from time to time, I would by no means assign individual Angels. But I fear lest God and the Angels themselves, if it be lawful to say [so], deride these efforts of ours, as [those] of men who would wish to investigate the things which are above us.

CHAPTER II

On the Instruments of the Celestial Motions: whether they are solid Orbs, or mere Circles describable in the fluid ether; and [whether] these [are] Eccentrics with Epicycles, or mere Concentrics

[Margin: Who [is] the Eccentrist and [who] the Concentrist?]

[I.] Although the admirable variety of motions in the Planets has been detected by observation, and indeed [is] as manifold as we indicated in bk. 7, sect. 1, ch. 7; nevertheless [this variety], according to the threefold dimension of bodies, was more manifest to the ancient Physicists and Astronomers—namely, according to longitude, latitude, and depth or altitude. But because, out of these very [dimensions], the diversity as to altitude was not patent to all, or was not seen [to be] real but apparent (arisen from some deception of our sight, or from the diversity of the interposed medium), hence two most ancient sects took their origin. One [was that] of the Eccentrists, who, namely, said that the motions of the Planets are accomplished by orbs having their center diverse from and distant from the center of the World, together with smaller orbs—which, fixed in the larger, they called Epicycles—by whose aid they explained the inequality in motion both of longitude and latitude, and of altitude. The other [was that] of the Homocentrists or Concentrists, who, namely, affirmed that these motions are accomplished by orbs concentric with the center of the World, in such a way that the Planets really always preserve the same distance from the center of the World which each once had; but [they held] that, since their orbs were moved upon diverse poles, some orbs hastening, others

retarding, it came about that the motion of the Planet, which in itself was equal [uniform], appeared unequal. But what Eccentrics are, what Epicycles, what Concentrics, "Trepicycles," etc., and by what reasoning they are imagined to be interwoven with one another, we have declared abundantly—by an appended diagram—for the Sun indeed in bk. 3, ch. 19 and 21, for the Moon in bk. 4, from ch. 25, and for the rest of the Planets in bk. 7, sect. 2, ch. 1; and therefore we refer the Reader thither.

[II.] The Authors of each sect, however, are further subdivided into two classes. For some thought that all these motions are accomplished by solid orbs; others without solid orbs—namely, in the liquid ether—whether by an intrinsic faculty and principle implanted in the Planet, or by an informing soul, or by an Intelligence merely presiding over [them] and leading the Planets around through circles [that are] designable and describable only by imagination or intellect. But this part of the controversy—about the solidity and fluidity of the heavens, abstracting from the concentricity and eccentricity of the orbs—we have already sufficiently weighed in Section 1, ch. 7, where, among the asserters of solid orbs, we placed not only Alfraganus with many of the Arabs, Sacrobosco, and Peurbach with [their] followers, but also, of the Ancients, Eudoxus, Callippus, and Aristotle—inasmuch as they attributed the inequality of the motions to diverse orbs revolved about diverse poles—

[…continues on p. 252 (PDF 287): "…and to an orb in which the Planet was fixed, [these orbs] pushing forward or rolling back; nay even [the view] of Anaximander, of whom Plutarch (bk. 2, On the Opinions of the Philosophers, ch. 16) says: 'Anaximander carries [the stars] around by circles and orbs, in which each star is placed.' For neither Peurbach nor the Arabs first introduced that solidity of the orbs…"]

(printed p. 252 — continuing ***[II.]****, on who first asserted solid orbs: the doctrine of stars carried in circles and orbs is traced back as far as Anaximander, on Plutarch's testimony. Neither Peurbach nor the Arabs first introduced the solidity of the orbs; Peurbach merely stuffed Ptolemy's eccentrics and epicycles into solid material, so that he and Alfraganus were authors of solid Eccentrics and Epicycles, not of solid orbs as such.)*

[Margin: Ptolemy does not support the solidity of the orbs, but rather [their] fluidity.]

[III.] For Ptolemy and Hipparchus—nay even the Pythagoreans, who introduced the Eccentrics and Epicycles, or [who] more perfectly delineated [them once] introduced into Astronomy—by no means consigned them to the solidity of orbs, but, either abstracting from solidity, or rather supposing fluidity, set forth the motions of the Planets by mere circular lines, and explained their hypotheses by bare circles, or by the peripheries of circles. And so concerning them—or at least concerning Ptolemy—judged St. Thomas (lect. 10 on 12 *Metaphysics*), Piccolomineus (in the *Theorics of the Planets*), Vielmius (lect. 21 on Genesis), Martinengus (in the Gloss, p. 1023), Kepler (on Mars, ch. 2; and in the *Epitome of Copernican Astronomy*, bk. 4, part 2), Cabeus (on 1 *Meteorology*, text 38, q. 2), [and] Blancanus (in the *Sphere*). But what need is there of a gloss, since Ptolemy's own meaning is sufficiently plain and clear? For thus Ptolemy (bk. 13 of the *Great Work*, or *Great Construction* [the *Almagest*], ch. 2), speaking of the manifold motion of the Planets, especially in latitude, says:

"But let no one think hypotheses of this kind too laborious, when he considers the manifold artifice which is required in carrying them out; for it is not fair to equate human [things] with divine, or to seek assurance about sublime things from the examples of things most dissimilar. For what is more dissimilar than the things which always behave in the same way [compared] to the things which never are constant with themselves, and [than] the things which can be hindered by any cause whatever [compared] to the things which cannot be hindered even by themselves? Rather, one ought to strive that the hypotheses be made as simple as possible and adapted to the celestial motions; and, if this does not succeed, that they be at least such as are possible for us. For if, by such hypotheses, it follows that all the things which appear in the heaven are accounted for, what wonder is it if this variety can befall the celestial motions? Especially since there [in the heaven] there is no nature which would hinder the motions, but [a nature] which is apt by birth to yield to the natural motions of each globe, even if they seem to be contrary; so that all things can permeate through those simple bodies—widely and liquidly

diffused—and be transparent or seen through, equally [in every direction]. Nor only in circles can this rightly proceed, but also in the very spheres and axes of the revolutions, whose variety and alternating diversity of motions it is so laborious and difficult for us to represent in constructed figures and in the examples of [planetary] Theorics, that the motions seem to hinder one another. In the heaven, however, that variety of motions least hinders itself. One ought not, therefore, to judge the simplicity of celestial things from those things which can appear simple to us, since there is nothing with us which would appear equally simple to all men. For if anyone should wish so to estimate, he will think nothing in the heaven [to be] simple—not even the stable and simple nature of the prime mobile itself; because something similar [to it] among men is not only difficult to find, but even altogether impossible. Not, therefore, from these [things], but from the very nature and immutability of the celestial motions, must judgment be made. For thus it will come about that all those motions appear simple, and indeed far simpler than the things which seem to us most simple, since we can devise nothing of difficulty, and nothing of labor, in their periods."

Since, therefore, Ptolemy names spheres and axes, while nevertheless he acknowledges the very greatest simplicity of the motions—and that too through a single continuous line—and posits the Planets as going through the substance of the ether [which] yields and in no way hinders [them], who does not see that he favors the fluidity of the heavens rather than [their] solidity? And so St. Thomas understood him (1 p., q. 70, art. 1, ad 3), the Carthusian (art. 12 on Genesis), [and] Kepler (in the *Epitome*, p. 504)—granted that [Kepler] in that [place] reprehends [Ptolemy's] motion [as] from an intrinsic and natural [principle in] the Planets, and the divinity attributed to them, and the exclusion of every figure or image or example of our [terrestrial] things; for Kepler thinks that, by means of the Ellipse, and by examples of the balance and the Magnet and things like these, the motions of the Planets can best be represented. But below there will again be discourse for us about this simplicity of the motions, according to Ptolemy's mind. Now we must come to the other part of the proposed question: namely, whether—whether in a solid or in a liquid ether—the Motions of the Planets can be accomplished in the heaven and explained on earth by concentric orbs or circles alone; or whether Eccentrics, or [things] equivalent to Eccentrics, are required.

[Margin: 1. Opinion — asserting Concentrics.]

[IV.] The **first opinion** was that of the Homocentrists, some of whom thought the motions of the Planets equal [uniform], others indeed unequal, but [thought] their intervals from the center of the world equal. About them that [text] of Plutarch (bk. 2 *On the Opinions [of the Philosophers]*, ch. 16) can be understood: *"Anaximenes [held] that the stars, both around the earth and above the earth, are turned in the same way. Plato and the Mathematicians [held] that the Sun, Venus, and Mercury are moved with equal motions."*

[Margin: Anaximenes. — Eudoxus. Callippus. Aristotle.]

But chiefly Eudoxus of Cnidus and Callippus of Cyzicus, who, since with Plato's opinion they judged the celestial motions to be circular, uniform, and perpetual, attempted to explain every real variety of the motions by orbs concentric with the center of the universe—which very [thing] Aristotle confessed [could be done only] by adding other orbs, as is plain from Simplicius (on bk. 1 and 2 *On the Heavens*) and from Aristotle himself there and [in bk.] 12 of the *Metaphysics*. Whom Averroes followed there, and Achillinus (in the book *On the Orbs*), and the Conciliator [Pietro d'Abano] (diff. 1). Which opinion, when Sosigenes, Hipparchus, and Ptolemy had repudiated it (Eccentrics and Epicycles being called in), and when all the Astronomers thereafter had followed Ptolemy—nevertheless a very few called [it] forth again into the light from the rubble: namely John Baptist Amicus of Cosenza (in the opusculum *On the Motions of the Celestial Bodies*, published in the year 1537), John Baptist Turrianus, and his heir in this [matter] Hieronymus Fracastorius (in the *Homocentrics*, [published] in the following year, that is, 1538), Lucillus Philalthæus (on 2 *On the Heavens*, text 51), Andreas Cæsalpinus (bk. 3 of the *Peripatetic Questions*, q. 4), and at last John Anthony Delphinus, a Franciscan of Casale Maggiore (in the book *On the Celestial Globes and Orbs*)—whom Alpetragius [al-Bitr■j■] favors in many things in his celestial physics. Our [own] Bartholomew Amicus, however, is mistaken (tract. 5, *On the Heavens*, q. 5, dub. 2, art. 2) when, among these authors, he reckons all the Astronomers who posit the heaven [to be] fluid, and the stars in it [to be] going like birds in the air or

fishes in the sea; since neither Tycho, nor Kepler, nor Bullialdus, nor finally any of the more recent Astronomers who assert the heavens of the Planets [to be] fluid, has used mere concentric circles in his hypotheses.

[Margin: A lapse of Bartholomew Amicus.]

[Margin: 2. Opinion — positing Eccentrics.]

[V.] The **second opinion** was that of the Eccentrists, that is, of those who, in setting forth the motions of the Planets, used circles, or Ellipses, or as it were circular spirals, but having a center diverse from the center of the world; or [used] concentrics indeed, but bearing various Epicycles equivalent to eccentrics. The inventors of this opinion were the Pythagoreans, as Simplicius reports from Nicomachus (on bk. 2 *On the Heavens*); who also reports that Aristotle's opinion about Concentric orbs was rejected by Sosigenes, on the ground that it could not safeguard the greatest part of the motions—especially the stations, retrogradations, [and] elevations from and depressions toward the earth—where, nevertheless, [Sosigenes] describes no determinate hypothesis [of his own]. Hipparchus, however, and Ptolemy everywhere in the *Almagest*, and thereafter Albategnius, Alfraganus, Geber, Thebit, Peurbach with his expositors, Copernicus (in the work *On the Revolutions*), Maginus and Piccolomineus (in [their] *Theorics*), and from Tycho onward all the Astronomers, persisted in the same opinion. But [some] disputed on its behalf and, with distinct arguments, asserted it—chiefly Maior (on 2, dist. 14, q. 4), Peter of Ailly [Alliacensis] (q. 13 on the *Sphere*), Christopher Clavius (on ch. 4 of the *Sphere* of Sacrobosco), and Bartholomew Amicus (tract. 5, *On the Heavens*, q. 5, dub. 2); and these very [men] of old were confirmed by many indications [by] Pliny (bk. 2, from ch. 15 to 17) and Martianus Capella (bk. 8, *On the Nuptials of Philology and Mercury*, in the chapter [showing] that the Earth is not the center for all the Planets).

THE SINGLE CONCLUSION

The motions of the Planets are not made through circles Concentric with the center of the World, but through Eccentric circles, or quasi-circles, or through [things] equivalent to Eccentrics.

[VI.] The **first argument** could be drawn from the Authority of all—

[…continues on p. 253 (PDF 288): the first argument from authority — the great multitude of Astronomers, both ancient and modern, who used Eccentrics and Epicycles…]

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*(printed p. 253 — completing **[VI.]**, the first argument, from authority:)*

[Margin: 1st argument, from the inequality of the intervals.]

[VI.] [The first argument could be drawn from the Authority] of nearly all the Astronomers from Hipparchus down to this our age, who through seventeen centuries held this method of setting forth the celestial motions, with very few resisting—and those (if you except Fracastorius) unskilled in celestial observations. But in an Astronomical question it is better to confirm our assertion by reasons. The **first reason**, then, is taken from the unequal distance of each Planet from the center of the earth: for within one [and the same] period they are now farther from the earth, now nearer, now at a certain middling interval. For we proved the Moon's unequal distance from the earth, from the diversity of the Lunar parallaxes, in bk. 4, ch. 14. And, diverse distances of it being posited, there follows necessarily a varying distance of the Sun from the earth, on account of the Astronomical connection which the Sun's distance has with the phase of the dichotomous [half] Moon, as is established from the problem of Aristarchus, and from our careful and legitimate use of it, often reduced to practice and set forth in bk. 3, ch. 7. Wherefore, although from the diversity of the Solar parallaxes the diversity of distances cannot be shown so evidently, yet from the Moon's distances, and from the time between the appearance of the half-Moon and the moment of Quadrature, it can be gathered. And, the varying distance of the Sun from the earth being acquired, the distances of the remaining Planets become known, because they have no less a connection with the Sun's distance than their motions have with the

motion of the Sun, as can be established from what was said in bk. 7, sect. 2 and 3, and sect. 6, ch. 2. For equations congruent with the true motions and observed places of the Planets cannot be deduced, except by supposing in their hypothesis a diverse distance from the Sun and from the earth.

Moreover, in all seven planets a diverse apparent magnitude is observed—and in the Luminaries indeed both outside Eclipses and in Eclipses, whose magnitude is varied according to their varying recession from or approach to the earth. But in Mercury, Venus, and Mars, that variety too has been observed with Telescopes, so that they appear sometimes full of light, sometimes gibbous, sometimes crescent [falcate], as we showed in bk. 7, sect. 1, ch. 2. Finally, how much larger Mars and Venus appear at perigee than at apogee, we taught clearly in bk. 7, sect. 2, ch. 3 (in the scholia), and sect. 6, ch. 4 (likewise in the scholia), and ch. 10 (likewise in the scholia). If the Reader has well understood these [things], there will hardly remain to him any doubt about that variety of apparent magnitude.

[Margin: The true cause of the diverse apparent magnitude.]

But now the aforesaid variety cannot be referred either to vapors of the air now thicker, now thinner, nor to parts of the heaven now denser, now rarer—as Fracastorius, Amicus, and Delphinus dared to refer it. For there both stands in the way the most invincible argument drawn from the parallaxes, which shows the diversity of distance (from which necessarily follows the diversity of apparent magnitude); and besides, the same planets appear frequently larger when either there are no thick vapors in the air, or [the vapors] are far from them; and finally [there is] the wonderful agreement in the proportion of the increase and decrease of this apparent magnitude with a determinate situation with respect to the Sun—for the three superior Planets always appear very large in opposition with the Sun, and in the acronychal [midnight] position [when] made retrograde; and very small around conjunction with it; and Venus and Mercury always appear largest when crescent—and these Phenomena are discerned whatever, in the end, be the season of the year, and in whatever part of the Zodiac. Besides, if a diverse density of the heaven running underneath were the cause of this variety, the magnitude of the Fixed [stars] too, and the brightness and splendor of the Planets, would also be changed from time to time—for [their light] would either be blunted by the density, or, the rays converging, would appear more intense by the force of refraction. Finally, it would be necessary to multiply so many heavens or celestial Zones slipping beneath the seven Planets, with denser and rarer parts—and indeed one heaven below the Moon—which would happen by no necessity, nay by scarcely the slightest probability, since the same could be done far more naturally and more simply through the alternating elongation of the Planets from the earth, and [their] approach—that is, through that [same cause] by which the inequality of motion in longitude is also said to come about. But if anyone be unwilling, in this matter, to use Eccentrics or Concentro-epicycles, but [will use] concentric circles now larger now smaller—yet, in order to make them continuous, as the observations demand—it will be necessary that these circles, becoming ever wider and wider, follow rather the form of a spiral gyration than of perfect circles returning into themselves, concentric with the world.

[Margin: 2nd argument, from the unequal motion.]

[VII.] The **second argument** is taken from the inequality of the motions in longitude and latitude, which we have already described in bk. 3, ch. 19 (where [we treat] of the Sun), and bk. 4, ch. 18 (where of the Moon), and bk. 7, sect. 1, ch. 7 (where of the remaining Planets), but chiefly from the inequality of the Stations and Retrogradations, about which [we treat in] bk. 7, sect. 5, ch. 2. But although this argument makes our conclusion more probable, and although the aforesaid varieties are better and—according to the laws of Geometry—more elegantly and more beautifully set forth by Eccentrics and Epicycles (or [by] line-tracings equivalent to them), and the physical cause of such inequalities is in a manner set before the eyes; yet, to profess frankly what I think, it is not an evident argument; and, if the varieties of the parallaxes and the vicissitudes of the apparent magnitudes did not stand in the way, we could set forth all that interchange of speed and slowness through mere concentric circles, and through laws of motion rhythmic and logistic rather

than geometric, as we shall say below.

[Margin: 1st objection resolved.]

[VIII.] It remains that we dissolve the arguments of the Homocentrists. **First**, it is objected against Eccentrics and Epicycles [that the center of the earth would not be at the center of the heaven, or the center] of the heaven would not be at the center of the World; but that this is absurd. *It is answered* by denying the Major as regards the supreme heaven of the Fixed [stars], and so as regards the whole heaven of the Planets, which is single and fluid, and whose convexity is bounded by the concavity of the Firmament. But if there be solid orbs, the Minor, taken of any [particular] heaven [you please], is denied, and conceded only of the supreme.

[Margin: 2nd objection.]

Secondly: to the elements of the Sun [the sublunary world] there belongs simple motion upward and downward; but to the celestial bodies straight motion does not belong, but simple circular [motion]. Yet if they were moved by the force of Eccentrics and Epicycles, upward motion would belong to the celestial [bodies]. Therefore. *It is answered* by conceding the Major concerning motion upward and downward along a straight line perpendicular to the globe of the earth—in which sense the Minor is denied.

[Margin: 3rd objection.]

Thirdly: every heaven, according to Aristotle, is perfectly spherical; but it would not be, Eccentrics being posited. *It is answered*, the Major being granted, by denying the Minor: for if the heaven of the Planets is fluid, it is really one and spherical with respect to the center of the universe; but if it consists of solid orbs, every Eccentric orb (as to its outermost surface), and every Epicycle (with respect to [its] proper centers), are spherical.

[Margin: 4th objection.]

Fourthly: if Eccentrics and Epicycles were granted, they could not be moved without penetration or splitting of the heavens, nor without [their] rarefaction and condensation, so that a less deep part should enter a deeper one: but this is unfitting. *It is answered* by denying the Major; for in the hypothesis of a fluid heaven the objection ceases; and in the hypothesis of a solid heaven too, the two Eccentrics are not moved in such a way (in a certain respect) that the less deep part of the one should succeed into the place of the thicker and deeper [part], as the Averroists imagine out of inexperience; but they are revolved proportionally in such a way that perpetually the thicker part of the lower Eccentric lies beneath the less deep [part] of the higher, and the narrower part beneath the deeper—so that the Eccentric simply has no other motion than the whole heaven of the Planet.

[Margin: 5th objection.]

Fifthly: according to Aristotle, the more a Planet is distant from the supreme heaven (which has simple motion), the more motions it needs in order to obtain its perfection; but in the hypothesis of Eccentrics and Epicycles the Sun has fewer motions than the three superior Planets. *It is answered* by denying the Major; for even according to the opinion of the Homocentrists, if they wish to safeguard the Sun's phenomena, fewer motions are to be assigned to it.

[Margin: 6th objection.]

Sixthly: all the phenomena [φαιν■μενα] of the heaven can be defended by concentrics and a plurality of motions, as Aristotle affirms (bk. 2 *On the Heavens*); therefore Eccentrics and Epicycles are multiplied in vain—especially since the two Eccentrics carrying the apogee of the Planet seem superfluous, and a single one seems to suffice, as Augustinus Niphus says. *It is answered* by denying the Antecedent; for upward and downward motion cannot be defended through mere concentrics; but, solid orbs being posited, each Eccentric is necessary in the Ptolemaic hypothesis—not for carrying the apogee precisely (as Niphus thinks),

but for this: that the whole heaven of the Planet should have a proper motion about the center of the world; for in other hy—

[…continues on p. 254 (PDF 289): "…potheses these motions are ordered otherwise. Seventhly Fracastorius objects: If the Sun is farthest (or most) distant when it is at the beginning of Cancer, and least when at the beginning of Capricorn, [either] it will describe on both sides parallels equally distant from the Equator (and so the Sun's maximum declination will not be equal on both sides…)…" — Riccioli answers the 7th–9th objections (of Fracastorius, and of Averroes), then turns to Aristotle's own modesty, and opens Chapter III on the motion of the Prime Mobile.]

(printed p. 254 — continuing ***[VIII.]****, the resolution of the Homocentrists' objections: the page opens mid-sentence, completing the remark that in other hypotheses these motions are ordered otherwise.)*

[Margin: 7th objection, of Fracastorius.]

Seventhly, Fracastorius objects: If the Sun is more (or most) distant when it is at the beginning of Cancer, and least when at the beginning of Capricorn, [then] either it will describe on both sides parallels equally distant from the Equator—and so the Sun's maximum declination will not be equal on both sides, [namely] 23½ degrees, which is contrary to the observations (for the angle made at the center of the world, or at the surface of the earth, by two lines—the one terminated at the periphery of the Equator, the other at the center of the solar globe—will be narrower when the Sun is higher than when [it is] lower, as the laws of Geometry and Optics require); or, if the maximum declination of the Sun is on both sides equal, it will be necessary that the Sun, at the beginning of Cancer, describe a parallel more distant from the Equator than when it is at the beginning of Capricorn, and so that the diurnal arc of the longest day, in an oblique sphere, be not equal to the nocturnal arc of the longest night—which likewise is contrary to Astronomical experience and observations. *It is answered:* the maximum declination of the Sun is indeed equal on both sides, and the diurnal arc of the longest day [is] unequal, compared with the nocturnal arc of the longest night in the same oblique horizon; but that inequality is not perceived, on account of the immense distance of the Sun from the earth in each case, and the insensible parallax, which for us does not exceed 30″ [seconds]—besides that the varied refractions, accelerating the rising of the Sun and retarding its setting, not rarely compensate that inequality. You should remember, nevertheless, that the Sun's Apogee is not always situated at the beginning of Cancer.

[Margin: 8th objection, of Fracastorius.]

Eighthly: it would follow, from Ptolemy's opinion, that the Epicycle of Venus is of such magnitude that it would reach almost to the earth; for its semidiameter contains 43 degrees, and if it contained 45 degrees it would pass through the center of the earth. *It is answered* by denying the antecedent: for the semidiameter of Venus's Epicycle does not contain 43 degrees of the heaven of Venus (as Fracastorius falsely assumes), but 43 such parts as 60 of which are contained in the semidiameter of its Eccentric. Then, if you consult the Ptolemaic and Alphonsine least distance of Venus from the earth—which we set down in bk. 7, sect. 3, ch. 1, and sect. 6, ch. 2—you will see it to be 179 terrestrial semidiameters [and] 2′, according to Fernel, but 167 [semidiameters] 57′ according to Maurolyco and Clavius. But in our hypothesis, which we think truer, the least distance of Venus is at least 1917 terrestrial semidiameters.

[Margin: 9th objection, of Averroes and Fracastorius.]

Ninthly: if the Moon were revolved in an Epicycle, we would not always see the same face of the Moon, but one [face] at the apogee of the Epicycle, another at the perigee. But we always see the same. Therefore. *I answer:* Unless any other motion were attributed to the Moon, I concede the Major; but I deny [it] if there be attributed to it either a turning [vertigo] about its proper center toward the part contrary to the motion of the Epicycle (as Fernel attributes [it], in his *Cosmotheoria*), or [if] you transform the Epicycle into another Eccentric (as Maginus does), or [if] you use other equivalent hypotheses—about which [there is] enough in

bk. 4, from ch. 26.

The remaining objections rest either on false observations, or on the mere authority of Aristotle defending concentrics—who, however, just as in this he subscribed to Eudoxus and Callippus, certainly, if he had lived after Ptolemy and had learned Astronomy from him, would have accepted other hypotheses; since he himself professed that in these matters the more skilled Astronomers are to be consulted. For in bk. 2 *On the Heavens*, ch. 7, text 34, he says:

> *"When, therefore, anyone has attained the more certain necessities, then he ought to be grateful to those who find them out; but for now, what seems [probable] must be said."*

And in 12 *Metaphysics*, text 45, on the motions [lations] of the Planets, he says:

> *"But how many these are, we now say—for the sake of understanding—those things which certain of the Mathematicians assert, that we may perceive in the mind some determinate plurality. But for the rest, it befits us in part to inquire ourselves, in part to ascertain from the investigators of these matters, if anything beyond what has hitherto been handed down should appear, to those who occupy themselves about these things, to be so; and [it befits us] to esteem both indeed, but to adhere to the more certain."*
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> *[Margin: The modesty of Aristotle's genius.]*

And a little after he confesses that he has spoken only probably about these [things], and that the necessary demonstrations must be sought from those more skilled in these matters, when he says:

> *"Wherefore the substances also, and the principles—both the immovable and the sensible—are so to be reckoned [to be], rationally (in Greek λογικ■ς [logik■s]), that is, topically and probably: for what is necessary, let it be left to be said by [those] more powerful [than I]."*

Let those Peripatetics hear [this] who contend that Aristotle—even against his will—always utters infallible oracles, and who try to carve him out for posterity, not as one walking in the Peripatos and ready to follow better [things], but as a stone statue immovably fixed to opinions once conceived.

CHAPTER III

Whether there is a Motion of the Prime Mobile distinct from the motion of the Fixed [stars] and the Planets, and in what subject [it is]; and whether the motion of the secondary Mobiles is contrary to it; and by what reasoning these two motions can be reconciled together

[I.] No motion among the celestial [motions] is better known than the motion of the prime Mobile, by which, namely, we see all the stars—but especially the Fixed [stars]—daily, in 24 hours, revolved from the same point to the same point of the heaven toward the West; and yet nothing is more obscure, whether [we ask] about the subject of this motion, or about its difference from the remaining motions of the stars, and about the manner of composing them among themselves without any physical repugnance. I touched on this controversy in bk. 6, ch. 18, in setting forth the Theoric of the Eighth sphere and of the Fixed [stars]; but because afterward I obtained other authors, and a repeated contemplation of this motion brought forth certain considerations not unworthy of being known—and because here at last is its proper place, where we treat of the universals common to all the stars—it pleases [me] to call the same [matter] back to the anvil.

[Margin: 1st opinion, placing the Prime Mobile in the single motion of the Fixed [stars].]

[II.] The **first and most ancient opinion** was that the Fixed Stars are set in motion by no other motion than the diurnal and common [one] toward the West—the [motion] peculiar to them upon the poles of the Zodiac, with the change of declination, not having yet been detected by certain observation, inasmuch as [it is] sensible only after many years, nor evidently demonstrable within the ordinary lifetime of one observer. This

being posited, the first motion was nothing other than the very motion of the Fixed [stars], or of the Eighth sphere, about the axis of the Equator and upon its [the Equator's] own poles; and the eighth sphere itself was the Prime Mobile and the supreme Astronomical heaven, and the universal time was visible, and a most well-known measure, inasmuch as [it is] nothing other than the revolution of any one Fixed star—say, the Dog-star [Sirius]—to the same point of the same fixed Meridian. And that the Babylonians, and some of the Egyptians and Greeks—but especially Eudoxus and Callippus, and so too Aristotle—were of this opinion, is gathered from Aristotle himself (bk. 2 *On the Heavens*, from ch. 9, or from text 57 to 70; and 12 *Metaphysics*, from text 42 to 51), where, together with Eudoxus and Callippus, he attributes a single and most simple lation to the sphere of the non-wandering [fixed] stars; and among the other causes for which that [sphere] is filled with innumerable stars, he adduces this:

[Margin: Authors of this opinion: the Babylonians, the Egyptians, Eudoxus, Callippus, Aristotle.]

that by the multitude of stars the simplicity of the motion may be compensated, and—just as the spheres of the wandering [stars] have a single star but several motions—so the sphere of the non-wandering [stars] should have a single motion, but several stars: for thus [says] he (2 *On the Heavens*, text 67). And that this method of Astronomy flowed from the Egyptians and Babylonians to the Greeks, he relates (2 *On the Heavens*, text 60). Therefore the most ancient Babylonians and the Egyptians (as Albategnius relates, ch. 27, *On the Science of the Stars*), defining the Year, said that it is the Revolution of the Sun to the same Fixed star—just as if the Fixed stars were fixed points, and movable by no other motion than the diurnal. And Nimrod [Nembroth] the Chaldean, in his Astronomical work (in [the citation of] Augustinus Riccius, in the treatise *On the motion of the Eighth sphere*), ascribes to the signs of the heaven only a single motion. But neither were Hesiod and the other most ancient Poets of the Greeks of a different opinion, when they placed nine Muses in the heaven; for to the supreme [Muse], namely Calliope, they ascribed no peculiar voice, nor any motion, as Glareanus notes (bk. 2 of the *Dodecachordon*, ch. 8 and 13)—but the supreme, sharpest voice (on account of the greatest velocity of motion), which to Glareanus himself is the *Mese* [μ■σον]—

[…continues on p. 255 (PDF 290): "…they gave to Urania, [as] moderating the sphere of the Fixed [stars]: wherefore Calliope, as the mistress of the celestial harmony, presided over the rest of the Muses and over keeping the motions of all eight heavens together in concord, and contained the voices of all, as Macrobius (bk. 2, on the Dream of Scipio) teaches expressly from Hesiod. But about Plato's opinion there are [some] who doubt…"]

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*(printed p. 255 — continuing **[II.]**, the first opinion, mid-digression on the Muses-as-spheres: the highest and sharpest voice, answering to the swiftest motion, was given to Urania as moderating the sphere of the Fixed stars, while Calliope, mistress of the celestial harmony, presided over the other Muses and over the concord of all eight heavens, as Macrobius teaches from Hesiod.)*

[Margin: Cicero's opinion.]

But about Plato's opinion there are [some] who doubt; yet he, in book 10 *On the Republic*, introduces a certain Pamphilius [Er]—slain in battle and reviving from the dead, and asserting that he had seen the traces of eight celestial motions, of which the eighth was driven with a most rapid course—and in the *Epinomis* he says: "The Philosopher ought not to be ignorant how the seven circuits are turned beneath the first." Nor indeed would Aristotle, his disciple, have kept silent about it, if Plato had taught another motion in the Fixed [stars] besides the diurnal; nor [would] Cicero, in the Dream of Scipio (translating much into Latium from Plato's books *On the Republic*)—for there he mentions Nine globes, among which the lowest he assigns to the immobile earth, but the highest [to] the heaven of the fixed [stars] with a single motion. For he says:

"Nine orbs, or rather globes, are all things connected, of which one is the celestial, the outermost, which embraces all the rest—the supreme God himself, confining and containing the others—in which are fixed those everlasting revolving courses of the stars; to which are subject the seven, which are turned backward by a motion contrary to the heaven."

And, the seven globes of the Planets being enumerated, he adds: "for that which is the middle and ninth, the earth, is neither moved, and is the lowest." And a little after: "but those eight courses, in which there is the same force of two, produce seven sounds distinct by intervals." Nay, a little before he had said: "and nature brings it about that the extremes sound, on the one side, low [grave], on the other, high [acute]. For which cause that highest course of the star-bearing heaven, whose revolution is swifter, is moved with a high and rapid sound, but this lowest and Lunar [one with the] gravest."

[Margin: Macrobius's opinion about Cicero's opinion.]

Granted that Macrobius (bk. 1, on the *Dream of Scipio*, ch. 17) thought that the proper motion of the Fixed [stars] was known to Cicero and indicated by him; for he says: "Besides the two Luminaries and the five stars which are called wandering, some [held] all the rest fixed in the heaven and moved only with the heaven; but others (whose assertion is nearer the truth) said that these too, by their own motion—besides that they are carried along with the revolution of the heaven—advance [precess]: but, on account of the immensity of the outermost globe, they consume ages exceeding a believable number in one circuit of their course, and therefore no motion of them is perceived by man, since human life does not suffice to detect even a brief point of so slow an advance." Hence Tully [Cicero], not ignorant of any school approved by the ancients, touched at once

[Margin: Philo's opinion.]

upon both views, by saying ("in which are fixed those revolving everlasting courses of the stars"): for he both called them fixed, and did not keep silent that they have courses. But who would not recognize that Cicero is violently dragged hither, since from that whole context of words it is plain that no other course was understood by him in the Fixed [stars] than the course of the supreme heaven, by whose running they run? Philo too (in the book *On the Cherubim*), a Platonist certainly, says: "The celestial orbs have motions contrary among themselves; of which the one carries the fixed stars to the right [*dextrorsum*], the other the wandering [stars] to the left [*sinistrorsum*]. But that outermost orb of the fixed stars is single, which is rolled from East to West: but the inner seven, namely of the wandering [stars], whose course—at once compelled and voluntary—has two motions contrary among themselves: but the compelled [one is] such as [the motion] of the fixed stars, etc."

[Margin: The opinion of St. Ambrose and St. Damascene.]

This opinion St. Ambrose too expressed (bk. 2 of the *Hexaemeron*, ch. 2, whose words we shall report in sect. 3, ch. 1, num. 9); and [St. John] Damascene, when (bk. 2 *On the Orthodox Faith*) he conceded a motion toward the East to the seven Planets alone, saying: "For they assert there are seven Planets—the Sun, the Moon, Jupiter, etc. But they called these the Planets, that is, the wandering [stars], because they accomplish their motion opposite to the heaven: for the heaven and the rest of the stars are moved from East to West; but these alone have a motion from West to East." Which opinion some of the Scholastics seem to have held—chiefly St. Bonaventure (on [*Sentences*] 2, dist. 14, art. 1, q. 1) and Aegidius [Giles of Rome] (part 2 of the *Hexaemeron*, ch. 26), in these words: "Therefore the orbs of the Planets, [because they] abound in motions, are deficient in stars; but the Eighth sphere, because it abounds in stars, is deficient (so to speak) in motions, because it has only one motion." Rubius too (2 *On the Heavens*, ch. 5, q. 1) and Hurtado (disp. 1 *On the Heavens*, sect. 1) called into doubt the proper motion of the Fixed [stars]. There is also extant a little book of Aben-Ezra [Ibn Ezra] entitled *Mishpetei ha-Mazzalot* [■■■■■■■■■■■■ ■■■■■■■■■■■■■], that is, *On the Judgments of the Stars*, where it is said: "The great and glorious orb, where are the glorious armies of God, is called the heaven of heavens, because beneath it are the orbs of the seven Planets." Wherefore this author does not seem to recognize any other heaven above the seven Planets than the single [heaven] of the Fixed [stars]—which, however, he wrongly confounds with the Empyrean. But neither Pliny (bk. 2, ch. 8) recognized any motion of the Fixed [stars] other than this, nor Vitruvius (bk. 9, ch. 4). But as for the fact that Joseph Scaliger (in the book *On the Emendation of Times*, p. 283, and in the *Diatribe on the Equinoxes*, ch.

1) contends that Thales of Miletus, Meton, Euctemon, Aristyllus (or Aristarchus) and Timocharis, from the difference between the Tropical Year and the Sidereal [Year] of the Fixed [stars], came into the suspicion of some proper motion of the Fixed [stars]—by which they would gradually recede from the equinoctial points *in consequentia* [eastward]—that is rather Scaliger's suspicion than a proven assertion. For that first conjecture and recognition of the proper motion of the Fixed [stars]—indeed from their places observed by Aristyllus and Timocharis, but [from] Hipparchus comparing his own [observations] with the observations of those [men]—Ptolemy attributes [to Hipparchus] (bk. 3 of the *Great Syntax* [*Almagest*], ch. 2; and bk. 7, ch. 2 and 3); which [recognition] Ptolemy himself afterward made more certain, his observations being collated with Hipparchus's.

[Margin: 2nd opinion, distinguishing really two motions, and heavens for them.]

[III.] The **second opinion** was of those who thus recognized in the Fixed [stars] two apparent motions (Hipparchus and Ptolemy leading the way): one upon the poles of the Equator, from East to West, most rapid, and revolved in the space of 24 hours; the other upon the poles of the Ecliptic, from West to East, very slow—so that, for the diurnal motion, they thought a heaven really distinct from the heaven of the Fixed stars (that is, the Eighth sphere) [to be] necessary, by which all the inferior spheres would be carried toward the West—which motion accordingly they called [the motion] of **Rapture** [*Raptus*]. But in this opinion three classes of authors are to be subdistinguished.

[Margin: 1st class, positing 9 movable spheres.]

The authors of the **first class** posited only nine celestial spheres, and so recognized a Ninth [sphere] for the prime Mobile: Rabbi Moses [Maimonides], Rabbi Joshua (in the *Book of Demonstrations*), Haly (in the *Quadripartite*, ch. 11), and many Jews—nay, Aben-Ezra himself (in the book *Te'amim*, or *of Reasons*, as Augustinus Riccius relates, ch. 4, *On the motion of the eighth Sphere*); Sacrobosco (on ch. 1 of the *Sphere*), Scotus (on [*Sentences*] 2, dist. 4, q. 2; and 12 *Metaphysics*, comm. 44), Cajetan (on 2 Corinthians [12]), Delphinus (*On the Celestial Globes*, ch. 30). Finally Mastrius and Bellutus (disp. 2 *On the Heavens*, q. 1, art. 2) distinguish the Prime Mobile from the starry heaven, but posit a single starry [heaven]. Of whom Cajetan and Delphinus say the Prime Mobile is the crystalline heaven.

[Margin: 2nd class, [positing] 10 spheres.]

The **second class** posited ten movable spheres—namely, a tenth for the prime Mobile; a ninth for the motion from West to East to be imparted to the Fixed stars and to the Apogees of the Planets (the Moon excepted); but an eighth for the motion of access and recess from the equinoctial points, that is, [for] the libration or trepidation in longitude. In which class were many Arabs, Moors, and Jews, but especially Alfonso King of Spain, Georg Peurbach with his followers, John Regiomontanus (in the theoric of the Eighth sphere, and bk. 7 of the *Epitome of the Almagest*, prop. 6), Peter Apian (in the *Caesarean Work* [*Astronomicum Caesareum*]), John Baptist Amicus (*On the celestial motions*), and Peter of Ailly (q. 2 on the *Sphere*, who reports the opinion of 10 movable spheres and does not reject it), Maurolyco (dialogue 1 and 3 [of the] *Cosmography*, p. 24, and [p.] 29), Fernel (bk. 2 of the *Cosmotheoria*, ch. 1 and 7), Joseph Lang (in the *Astronomical Elements*, ch. 4), Clavius (in the earlier editions of the *Sphere*, p. 44 and 72), the Conimbricenses (2 *On the Heavens*, ch. 5, q. 1). To which class can be recalled Thebit, Arzachel [al-Zarq■l■], and Isaac the Israelite (in the second treatise *On the Foundation of the World*), inasmuch as they admitted a motion of trepidation of the Fixed [stars] in longitude—granted that they ascribed its cause to the ninth heaven rather than the eighth, or left this disposition of the orbs in doubt.

[Margin: 3rd class, [positing] 11 spheres.]

The **third class** posits eleven movable spheres: the eleventh indeed for the prime Mobile; the tenth for the trepidation or libration in latitude, to be imparted to all the inferior spheres, that they may follow the variation of the obliquity of the Ecliptic; the ninth for the trepidation or libration in latitude, by force of

which the anomaly of the motion of the Fixed [stars], and of the precession of the Equinoxes, is effected; the eighth, finally, for the equal or mean motion of the Fixed [stars] toward the East. So indeed John Werner (in [the work] of Erasmus Oswald [Schreckenfuchs] on the Peurbachian Theoric of the eighth sphere), John Anthony Maginus (in the *Theorics*, bk. 1, and in the *Secondary Mobiles*,

[…continues on p. 256 (PDF 291): "…canon 18); Leupold of Austria (in his Compilation); Clavius (in the last edition of the Sphere, p. 36) — which system Scheiner accordingly calls the Clavian system (in the Mathematical Disquisitions, num. 22); and the same number of movable spheres, of the ancient opinion, Antonius Deusing and Peter Gassendi set forth in their Astronomical Institutions. Some, however, of the authors of the second class — chiefly Clavius and the Conimbricenses — admit an eleventh heaven [as] immobile, that is, the Empyrean…"]

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*(printed p. 256 — continuing **[III.]**, the third class of the second opinion: the enumeration of its adherents concludes with Maginus, Leupold of Austria, and Clavius — whence Scheiner calls it the Clavian system — while Deusing and Gassendi set forth the same number of movable spheres in their* Astronomical Institutions.*)*

Some, however, of the authors of the second class—chiefly Clavius and the Conimbricenses—admit an eleventh heaven [as] immobile, that is, the Empyrean; nay, Clavius thinks the aggregate of the 9th and 10th heavens to be the glacial and crystalline heaven, which would have merited the name of "the waters above the heavens" in Sacred Scripture, on account of its transparency, and because in it there are no parts denser than others.

[Margin: 3rd opinion, of Turriano and Fracastorius, on 14 movable heavens.]

[IV.] The **third Opinion** was that of John Baptist Turriano and Hieronymus Fracastorius (in the *Homocentrics*, section 2, from ch. 1 to 17), where he posits, above the Aplanes (or sphere of the non-wandering [stars]), other movable orbs really distinct, but diverse in number and order and office from those which the authors of the second opinion posited; and he hands down diverse hypotheses of these motions, according as each one shall wish to acknowledge the motion of Trepidation, and [the motion] of the Fixed [stars, as] direct and retrograde, or direct only. But because he himself at last had thought it more probable that the motion of the Fixed [stars] is always retrograde, yet unequal, therefore in ch. 17 he concludes that above the Aplanes there are 14 orbs. The **first** or supreme is the **Prime Mobile**, with wonderful velocity in 24 hours carrying with itself, from East through West to the same East, all the orbs enclosed within it. The **second** is the **Circumducens** [Carrier-around]; which, cutting the Equator of the prime mobile orthogonally, and carried around through the upper colure from North to South in 3600 years in latitude, bears all the inferior orbs with itself—except insofar as some [orbs], contravected, hinder it. The **third** is the **Circitor**, proceeding through the lower colure of the Equinoxes; it is moved by the Circumducens *per accidens* in 3600 years from South to North, but *per se* it is moved toward the opposite region. The **fourth** orb is the **Contravectus** [Counter-carried], both to the Circitor and to the Circumducens; and through the upper colure it is borne from South to North with a doubly swifter motion, that is, in 1800 years. The **fifth** is the **Anticircitor**, which is carried around by the Contravectus always toward the part opposite to the Circitor. The **sixth** is the **Contravectus** to the Anticircitor, yielding to it imperceptibly, lest the Aplanes be carried around by a sensible motion in latitude. And beneath it, finally, is the **Aplanes**, the orb bright with so many lights and distinguished by the Milky circle, which *per se* completes one degree in 100 years, and in 36,000 years completes its revolution—but within that [revolution] it is now slower, now swifter. Wherefore above the eighth sphere these authors posit six movable orbs, so that they are 14 in all.

[Margin: 4th opinion, of a Prime Mobile distinct but not carrying [the rest].]

[V.] The **fourth Opinion** admits indeed a Ninth heaven really separated from the eighth sphere, which would be the prime Mobile; but it denies that the inferior orbs are carried [*rapi*] by it—that is, physically dragged or borne—nor does it absolutely concede that the participation of the first motion is composed of two motions

really distinct and contrary; but it does not explain in the same way how the sphere of the Fixed [stars] and the spheres of the seven Planets are moved by that prime mobile.

[Margin: First class of this opinion.]

For Alpetragius [al-Bitr■j■] (in his *Physical Theoric of the celestial motions*) and—nearly—Achillinus (in the book *On the orbs*) deny that the prime Mobile carries the inferior orbs by identity, continuation, or immediate contact; but they say that the first Mover, or first Intelligence, impresses upon the separated orbs a turning motion from East to West, just as an impetus is impressed by one throwing a stone or hurling an arrow—which impetus becomes weaker and weaker the farther the spheres of the secondary mobiles are distant from the Prime Mobile. Hence all are indeed carried *per se* from East to West by a simple motion in longitude, but do not attain by their motion the velocity of the prime Mobile, and so *per accidens* the Fixed [stars] and Planets seem to retrocede toward the East, and to strive against the prime Mobile; but in reality this motion is single, toward the West—slower, however, in the Fixed [stars], and still slower in Saturn, and slowest in the Moon. But because he knew this motion to be oblique, and [to proceed] through helices, or a gyrating line (which the Arabs call *Lacalabinum*), and [knew] that the Fixed [stars] change their declinations, therefore he said this motion is made upon diverse poles going around the poles of the World by the force of little circles; and because, with Hermes, Theon, and Arzachel, he suspected the motion of the Fixed [stars] to be sometimes retrograde, or at least unequal, he posited the motion of the poles of the eighth sphere in circles about the poles of the world [to be] unequal. By which means he proportionally explains the anomalies and the directions, stations, and retrogradations of the Planets, without Epicycles and Eccentrics. But against him rise up Augustinus Riccius (*On the motion of the eighth sphere*, ch. 10), Fracastorius (in the *Homocentrics*, sect. 2, ch. 3), and Clavius (on the *Sphere*, p. 48), and other more recent Astronomers—but in that Alpetragius, by this hypothesis, does not explain or safeguard the motion of the Planets in altitude (thinking, I believe, that [the altitude motion] is apparent, not true), he is deservedly reprehended; whereas in that he safeguards the oblique motion of the Fixed [stars], or the anomalies of the Planets in longitude and latitude, he is undeservedly reprehended, as if he had explained that motion upon the same poles and through the same line.

[Margin: Second class of this opinion.]

The other mode of this opinion is that of Peter of Ailly, Cardinal and Bishop of Cambrai, who (in questions 2 and 9 on the *Sphere*) posits a tenth orb [as] immobile, [serving] to safeguard, from its influxes, the diverse properties of the terrestrial regions ([which are] immobile); but a ninth heaven he posits for the prime Mobile—and that in question 4. Yet he too denies that the inferior orbs are carried or dragged by it, or carried properly and physically by the prime mobile; for he says that the individual orbs have their own Intelligences, and that from the prime Mobile (or mover) there flows into the inferior [orbs] a certain power, which inclines them to a motion similar to the motion of the prime Mobile—just as nature inclines heavy things to upward motion, that a vacuum may be avoided—and so that such motion is neither purely natural nor violent; but that it would be violent and impossible if they were carried [*rapt*] by the prime Mobile. He concedes, moreover, that this motion is made upon diverse poles and axes; and (q. 13) he admits Epicycles and Eccentrics, or a motion equivalent to them, on account of the elevation and depression of the Planets. Wherefore in this opinion the Fixed [stars] and Planets are really moved by a single motion toward the West, and try to imitate the Prime Mobile; but because they do not imitate [it] perfectly, they seem by their slowness to go back toward the East.

[Margin: 5th opinion, positing a Prime Mobile [as] a ninth heaven, but crystalline, and without rapture.]

[VI.] The **fifth Opinion** is that of John Anthony Delphinus, of the Franciscan family, who in his book *On the globes and celestial motions* (ch. 19, 29, 30) affirms, with Alpetragius, that there is a Prime Mobile, and that it is the ninth heaven; but that this is the crystalline or watery heaven (which Sacred Scripture names by the name of "the waters above the heavens"); and that all the orbs are concentric with the world; but he says that

the individual [orbs] are moved by their proper Intelligence, or by the Angels, always from East to West—yet in such a way that they move [them] more slowly than the first Intelligence [moves] the Ninth heaven, and besides now toward the South, now toward the North; and indeed not by natural necessity, but by free will, because they willingly serve the Creator commanding such a motion. Finally, he calls the denomination "Ninth mobile" metaphorical, inasmuch as it does not physically move the inferior spheres or globes, but [is] only, as it were, the first exemplar of the swiftest motion toward the West; and that the apparent motion toward the East comes from this, that they are abandoned by the swifter motion of the prime Mobile. Hither can be recalled Claramontius [Chiaramonti] (bk. 2 *On the Universe*, ch. 18; and bk. 6, ch. 1), inasmuch as he posits for the prime mobile a ninth heaven, which the other spheres—moved by the Intelligences with the diurnal motion alone—do not attain, and so seem to be retarded toward the East.

[Margin: 6th opinion, denying a Prime Mobile distinct from the 8 spheres, but positing two motions.]

[VII.] The **sixth Opinion** denies that there is a Prime Mobile really distinct, by an adequate distinction, from the eighth sphere and the remaining seven; but it says [the Prime Mobile] is distinguished only as a whole from the parts taken individually; yet it admits two motions. For [it holds] that the whole World, except the globe of the earth, is moved from East to West—that is, the eighth sphere, the seven orbs of the Planets, and the Element of fire and of air; and that the prime Mobile, under one aspect, is the aggregate of all eight spheres, which by priority of nature is so moved before [its] parts; under another aspect, it is the eighth sphere, inasmuch as the Intelligence moves it principally, as the nobler heaven—just as the soul is said to move first and principally the heart, then the other members. Yet, just as the heart does not move the other members, so neither does the sphere of the Fixed [stars] carry [*rapit*] the other spheres, but is moved together with the whole by the same Intelligence, as the whole body [is moved] by the same soul. And [it holds] that in the individual heavens there is a double appetite—one for the motion of the whole toward the West, the other for the proper motion—

[…continues on p. 257 (PDF 292): "…[the other] for the proper motion toward the East; and that these motions do not conflict with each other, just as the proper motion of the hand toward the opposite part does not conflict with the motion of the whole animal body toward one part. So Augustinus Riccius (in the treatise On the motion of the eighth sphere, ch. 1, 13, 14, etc.) and Orontius Finaeus [Finé] (bk. 1 of the Sphere, ch. 5), saying: 'The Prime Mobile, therefore, must be called the World itself, and not some particular heaven…'"]

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*(printed p. 257 — completing **[VII.]**, the sixth opinion, on the double appetite: Riccius and Orontius Finé hold that the Prime Mobile is the World itself, the particular orbs striving eastward by their own motion without conflict, as a hand may move against the motion of the whole body. Related unnamed views in Fracastorius posit one or two Intelligences per orb. Clavius refutes the opinion as impossible, and Fracastorius objects that the Intelligences would perpetually resist and impede one another, which is violent and unfitting.)*

[Margin: 7th opinion, denying two motions and a prime Mobile above the 8th sphere.]

[VIII.] The **seventh Opinion** is similar to the opinion of Alpetragius set forth at num. 5, but differing in this, that it denies that there is, above the eighth sphere, another heaven which would be the prime mobile; for it says that the prime Mobile is the eighth sphere, inasmuch as it revolves the swiftest of all toward the West, and in the space of 24 hours restores the same stars to the same point of the same Meridian or Horizon, from which that motion began on the first day of the World. But this [eighth sphere] does not carry [*rapit*] the other inferior spheres, as the Authors of the first opinion (set forth at num. 2) posited; for it says that the remaining inferior spheres—whether moved by their own power, or by an Intelligence—are borne *per se* toward the West, and strive after the same kind of motion which the eighth sphere accomplishes, but cannot attain its velocity, and arrive somewhat more slowly than it, each day, at the same point of the same Meridian or Horizon—and the more slowly, the more [each] is distant from the eighth sphere. Whence it comes about

that, because daily the slower Planets are left behind by the swifter Fixed [stars], and ever more separated, the Planets seem to retrocede toward the East—granted that in reality they do not retrocede, nor are moved by a double motion, but by a single [motion] toward the West, slower however; and which is said to be a motion toward the East not absolutely nor truly, but comparatively to the swifter [one], and apparently.

[Margin: Anaxagoras, Democritus, Cleanthes.]

The authors of this opinion Plutarch indicates [to be] sufficiently ancient (bk. 2 *On the Opinions*, ch. 16), subjoining however the contrary opinion, when he says: "Anaxagoras, Democritus, [and] Cleanthes think all the stars are borne from East to West; Alcmaeon and the Mathematicians [held] the wandering [stars] to be turned by a motion contrary to the non-wandering [fixed] stars, namely from West to East."

[Margin: Ptolemy's judgment on this opinion.]

And at the same time, but somewhat younger than Plutarch, Ptolemy (bk. 1 of the *Almagest*, ch. 8) indicates that the same opinion can stand, if the apparent motion of the Planets were always made in circles parallel to the Equator, without change of declination; but that, since it happens otherwise, [it] cannot. For Ptolemy [says]: "And so, if the advance of the wandering stars were made, in equal instants, in circles [parallel] to the Equinoctial—that is, around those poles around which the first revolution is made—anyone could rightly enough think that there is one and the same revolution of all, which would follow the first. For it would seem credible that their advance comes about not on account of an opposite motion, but because [each] is left behind by the first. But now, together with the advance toward the East, they also approach toward the North or toward the South, in such a way that not even an equal quantity of this approach is observed—so that this accident seems to come about in them by certain pulsions, etc." From which he concludes that two greatest and distinct circles are necessary: namely, the Equator, for the prime Mobile carrying the Fixed [stars] and Planets around toward the West; and the Zodiac, within which the Planets proceed obliquely toward the East. Wherefore, since (in bk. 7, ch. 2 and 3) he acknowledged that the Fixed [stars] too slowly advance toward the East upon the poles of the Ecliptic, he seemed to some to suppose a ninth heaven for the prime mobile, but to others [to put] both motions in the eighth heaven. But these [things] about Ptolemy [are said] in passing. The same opinion Martianus Capella attributes to the Peripatetics (bk. 8 *On the Nuptials of Philology*, in the chapter on the orbs of the Planets), saying: "Finally, the doctrine of the Peripatetics too contends that these stars are not moved forward against the world, but are outrun by the swiftness of the world, which they could not follow."

[Margin: Fracastorius's judgment on the same.]

Furthermore, Fracastorius mentions this seventh opinion (no one being named) in the *Homocentrics*, sect. 2, ch. 3, and from this he refutes [it]: that, if all the orbs are borne *per se* toward the West according to longitude, they would *per accidens* be moved in latitude, and so by the force of some higher orb or Intelligence—but this is unfitting, because it would follow, he says, that the Planets are so bent by that orb which moves [them] sideways, that on the same day the Sun, which rises in the summer northern East on this side of the Equator, would set beyond the Equator in the winter southern West—which is against the observations. But this inference is not necessary; for they can, by the same motive force, be borne *per se* toward the West, and at the same time obliquely—through spirals or helices gradually deflecting from the parallels to the Equator—in such a way that they seem to rise and set in nearly the same parallel, by so much the less difference as the bending sideways is less, by which they vary the declination from the Equinoctial and the latitude from the Ecliptic. Wherefore neither Fracastorius's, nor Ptolemy's, nor Clavius's refutation of this opinion (which is partly that of Alpetragius and Achillinus, [Clavius] impugning it on p. 49 of the *Sphere*) is solid, as to the oblique motion of the Planets; yet there remains a difficulty on account of the proper and oblique motion of the Fixed [stars], which appears to us. For if they too seem to advance toward the East, because they are moved somewhat slowly, then their motion is not the first motion, but another swifter motion toward the West seems to be assignable, in comparison with which the Fixed [stars] are

slower. About which matter our discourse will recur below.

[Margin: 8th opinion, of Joseph Scaliger, denying the motion of the Eighth sphere.]

[IX.] The **eighth Opinion** was that of Joseph Scaliger (in his *Diatribe on the Anticipation of the Equinoxes*, and bk. 4 *On the Emendation of Times*, from p. 284), who says that the motion of the eighth sphere toward the East upon the poles of the Ecliptic is a certain monster, and an old-wives' and trifling fable; for [he holds] that the Fixed [stars] are neither moved by a motion in longitude—ε■ς τ■ ■π■μενα [*eis ta hepomena*, "toward the following"], that is, not *in consequentia* [eastward]—nor change their declinations or distances from the Poles of the World (which he posited [as] immobile); but [that] the equinoctial and solstitial points are moved ε■ς τ■ προηγο■μενα [*eis ta proegoumena*, "toward the leading"], that is, *in praecedentia* toward the West; and [that] not the stars recede from the Sun, but the Sun [recedes] from the Stars, and the Equinoxes and Solstices are celebrated each year in more and more western points of the Equator; and so [that] to Hipparchus and Ptolemy the Fixed [stars] seemed to be moved toward the East, and that they persuaded credulous posterity of this. Then he says that the poles of the E—

[…continues on p. 258 (PDF 293): "…quator are distant from the Poles of the World, and are moved toward the West through little circles described about the poles of the world… The foundation of this opinion is that the pole star, which shines in the tail of Ursa Minor, was seen to be equally distant from the Pole of the world — that is, 12° 24′ — both in the time of Eudoxus (Olympiad 103, the year 367 before Christ) and of Eratosthenes (227 before Christ), [and in the] time of Marinus of Tyre and Ptolemy, who flourished in the year 130…"]

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*(printed p. 258 — continuing **[IX.]**, Scaliger's eighth opinion and its refutation: Scaliger's arguments from the unchanged distances of stars from the pole and from Hipparchus's risings and settings are recounted, along with his appeal to the mathematicians for help. No one adopted his offspring; rather four Jesuits — Petavius, Guldin, Furnerius, and Clavius — with Bullialdus smothered it, and Riccioli himself subverted its foundation, adding that Scaliger's account of precession through westward-moving equinoctial points is almost impossible to maintain.)*

[Margin: 9th opinion, attributing the Prime Mobile and all motion of the Fixed [stars] to the Earth.]

[X.] The **ninth Opinion** denies to the Fixed stars all motion—both the diurnal toward the West and the proper [motion] toward the East; but to the Planets it attributes a proper motion toward the East, while it denies to them too the diurnal [motion] toward the West. For the diurnal motion, which appears in the Fixed [stars] and in the Planets, it says is really the motion of the Earth about its own center and axis, by which, in a 24-hour turn, it is revolved toward the East; and so [it says] that it is we who go to meet the stars toward the East, and that rather we rise to them than they to us. But the proper motion of the Fixed [stars] it attributes to the equinoctial points on the terrestrial Equator, preceding toward the West, by force of a certain libration about the earth's axis (indicated in bk. 3, ch. 28). But the authors of this opinion went off into two Classes.

[Margin: 1st class, attributing the annual motion to the Earth.]

For the **first** attributes the annual motion (which makes for us the vicissitude of the four seasons) not to the Sun, but to the Earth, which not only daily revolves about its own center, but yearly is carried, together with its center, along [the line of] the Ecliptic toward the East around the Sun resting in the middle of the world, or not displaced.

[Margin: Philolaus. Aristarchus. Copernicus and [his] followers.]

So once Philolaus (in Plutarch, bk. 3 *On the Opinions of the Philosophers*, ch. 13), then also Aristarchus of Samos (as Archimedes relates in the *Sand-Reckoner*); which opinion Nicolaus Copernicus revived—not from hypothesis (as some excuse him), but absolutely, as is plain from the preface to Paul III prefixed to the books of the *Revolutions*, and from bk. 1, ch. 8, 10, and 11, and bk. 5, ch. 2; to whom adhered Maestlin, Rheticus, Caelius Calcagninus, Rothmann, Galileo, Diego de Zúñiga [Didacus a Stunica], Paul Anton.

Foscarini, Antonius Laurentius Politianus—but most zealously of all John Kepler (in his *Mars*, and in the *Epitome of Copernican Astronomy*, and in the *Mysterium Cosmographicum*, and in the *Harmonica*).

[Margin: 2nd class, denying the annual motion of the earth.]

But the **second Class** attributes to the Sun—as well as to the other Planets—its proper motion (and to the Sun indeed the annual [one]); but to the earth it leaves the diurnal turning of [24] hours about its immobile center, nor does it transfer the Earth from place to place.

[Margin: Heraclides, Ecphantus. Nicetas.]

So once Ecphantus and Heraclides (in Plutarch, bk. 3 *On the Opinions*, ch. 13), [and] Nicetas [Hicetas] of Syracuse (in Cicero, *Academica* 2, and *Tusculans* 1). Whom afterward followed Longomontanus (in his *Danish Astronomy*, bk. 1 of the *Theorics*, ch. 2 and 4), William Gilbert (bk. 6 of the *Magnetic Philosophy*, ch. 3), Origanus (vol. 1 of the *Ephemerides*, in the dedicatory Epistle), and Andreas Argolus (in the *Pandosion Sphaericum*, ch. 3). The same opinion Aristotle ascribes to Plato in the *Timaeus* (bk. 2 *On the Heavens*, text 75), [as do] Cicero (*Academica* 2) and [Diogenes] Laertius (in the Life of Plato). But we, from the Platonic *Timaeus* itself, shall make [it] plain (sect. 4, ch. 2, num. 2) that Plato stood for the immobility of the earth.

[Margin: 10th opinion, leaving the proper motion to the Fixed [stars], but attributing the diurnal [motion] to the Earth.]

[XI.] The **tenth Opinion** attributes to the Earth both the diurnal and the annual motion, but nevertheless does not take away the proper motion from the Fixed [stars] toward the East—much less from the Planets. So at last Philip Lansberge (in the *Tables*, precept 11), Jacob Lansberge the Physician (in the *Apology for Philip*, against Fromondus and Morin), and Ismael Bullialdus (bk. 1 of the *Philolaic Astronomy*, ch. 2), for the reasons which I adduced in bk. 6, ch. 18, num. 14. They differ, however, in that Lansberge posits the motion of the Fixed [stars] upon the poles of the Ecliptic [as] unequal, on account of the unequal motion of the equinoctial points; but Bullialdus posits it [as] equal. But neither this [tenth opinion], nor the ninth, is it permitted us to follow, by reason of the divine Scriptures or the Ecclesiastical decrees.

[Margin: 11th opinion, explaining all things by a simple motion through gyres and spirals.]

[XII.] The **eleventh Opinion** is very similar to the seventh, but it does not posit that the prime Mobile is the eighth sphere; rather it says that all the proper motions which appear toward the East—both in the Fixed [stars] and in the Planets—can be reconciled with their diurnal motion toward the West, through a single oblique motion made toward the West, screw-wise [*cochleatim*], through helices and spirals, or through helicoid spirals, by which the stars do not exactly complete the same diurnal circle, nor return to the same point of the Meridian or Horizon today in which they were yesterday, but bend somewhat toward the sides of the World toward the poles—yet in such a way that the Fixed stars revolve to the same Meridian more quickly than Saturn, and Saturn more quickly than Jupiter, and so of the rest (understand [this] when the Planets are direct; for if they become stationary, then they appear equally swift as the Fixed [stars]; but when they are commonly called Retrograde, then they are swifter than the Fixed [stars]; and only slower when direct). Again, the Planets are borne along this gyrating line so that now higher, now lower they proceed. So teach—but in other words—Scotus (on [*Sentences*] 2, dist. 14, q. 2), Hurtado (disp. 2 *On the Heavens*, sect. 3), Mastrius and Bellutus (disp. 2 *On the Heavens*, q. 4, art. 1), Cabeus (on 1 *Meteorology*, text 38, q. 2), Amicus (tract. 5 *On the Heavens*, q. 6, dub. 9, art. 3; who, at num. 2, had adduced for this [view] Philoponus, Alexander, Vimercatus, Galtius, [William of] Auvergne, [and John] Maior), Arriaga (the single disputation *On the Heavens*, sect. 4 and 5), Oviedo (the single controversy *On the Heavens*, point 4), John Punch (disp. 22 *Physics*, q. 9, conclusion 3), [and] Balthasar Téllez (disp. 45 *Physics*, sect. 3, num. 6). And in the same opinion were, for the most part, Alpetragius, Achillinus, [Peter of] Ailly, and Delphinus (adduced at num. 5 and 6); and before these, Anaxagoras, Democritus, and Cleanthes (about whom at num. 7). But Scotus,

Mastrius and Bellutus speak in such a way that they seem to admit a Prime Mobile distinct from the eighth sphere, with Alpetragius; whereas Téllez does not acknowledge that first motion to be made really in any body, but [says] it is only imaginary, and that to its measure neither the Fixed [stars] exactly nor the Planets come up. But others do not sufficiently explain whether any motion of the prime Mobile—true or imaginary—is given, which the Fixed stars emulate but do not attain by their diurnal motion; and those who retain solid heavens, like Amicus and Mastrius, can scarcely safeguard the aforesaid spirals.

[Margin: 12th opinion, on imperceptible little pauses.]

[XIII.] The **twelfth Opinion**, which I handed down as devised by me (bk. 6, ch. 18, num. 16)—but which, after many months, I found indicated by Amicus (tract. 5 *On the Heavens*, q. 6, dub. 9, art. 3), in these words: "Fourthly, others, thinking those motions to be two, say [they] are not exercised at the same time, but by an alternating vicissitude—

[…continues on p. 259 (PDF 294): "…while the Intelligence moves the heaven toward the Poles of the Zodiac, it does not move [it] from East to West; and because that lateral motion happens in the twinkling of an eye, the orb does not appear to cease from the diurnal motion." But this way of speaking, as it lacks a suitable author, so it cannot be probable… yet if that interruption through imperceptible little pauses cannot be refuted by any observation, it is not altogether improbable — and Punch touched on the same, saying it is manifest that something can be moved at once by two motions, one E→W and the other W→E, without any intermission perceptible to our senses.]

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*(printed p. 259 — completing **[XIII.]**, the twelfth opinion: the alternating-vicissitude view is judged not altogether improbable, Punch conceding that a body can be moved at once, without perceptible intermission, by two motions from East to West and from West to East; the manner of this was explained in bk. 6, ch. 18.)*

By so many, then, and so wonderful modes—partly worthy, partly unworthy of the human genius—has the reconciliation of these two motions been attempted. But what our opinion is—although it was indicated in bk. 6, ch. 18, from num. 15—must nevertheless be set forth more fully in this place through the following Conclusions.

FIRST CONCLUSION

[Margin: 1st Conclusion.]

Both the wandering and the non-wandering stars can be moved toward the West by [or: toward] the motion of the Prime Mobile—[a Prime Mobile] really distinct from their own proper heaven, or from the stars—and meanwhile can at the same time be moved, truly or apparently, by a proper motion toward the East, without any physical repugnance.

[XIV.] For if there were any repugnance, it would be either between the moving and the movable bodies themselves (which could not be, or be conjoined or assigned together to that [task]), or it would be in the very mode of effecting each motion. But that repugnance arises from neither head; therefore what is asserted in the conclusion can come about. For as to the first: diverse celestial bodies can be assigned which would discharge the office of the prime Mobile.

[Margin: 1st body for the prime Mobile.]

First, indeed, this can be the watery heaven, [made] of the waters which (according to the more probable opinion of many Fathers, consonant with the letter of the divine codices) we showed to be above the heavens (sect. 1, ch. 2, q. 3; and ch. 3, conclusion 3). Which heaven does not flow apart hither and thither, on account of [its] equal distance from the center of heavy [bodies], or because there it is outside the place of heavy and light [bodies]; and yet the whole is moved, in the space of 24 hours, by one or several Intelligences, if need be.

[Margin: 2nd body.]

Secondly, this can be the glacial or crystalline heaven, which is above the sphere of the Fixed [stars], as Delphinus and Clavius posit; and [it] is conformable to those Doctors and Fathers who believed the waters above the heaven of the Fixed [stars] to have been solidified by God in the manner of ice or crystal (per what was said in sect. 1, ch. 2, num. 8)—of which sort were Josephus the Hebrew, Pope Clement, Severianus, Anselm of Laon, [Walafrid] Strabo, Bede, [and] Peter Comestor. That this heaven could equally be revolved toward the West, by one or several Intelligences, in the space of 24 hours.

[Margin: 3rd body. — 4th body. — 5th body.]

Thirdly, it could be the heaven of the Fixed [stars] itself, but fluid, which would move the Fixed [stars] toward the West immediately, but the Planets by means of the heaven of the Planets (fluid or solid). **Fourthly**, it could be the heaven of the Planets itself (fluid or solid), which would itself move the Planets immediately—nay, even the Fixed [stars], which it would immediately touch by its convexity—or [move] these and all the rest, by moving the heaven of the Fixed [stars] (fluid or solid). **Fifthly**, some body could be assumed [taken up] by one Intelligence, or carried around (granted [it be] not properly an assumed body), which would not be a heaven; and [the Intelligence] would carry this around about the Firmament in the space of 24 hours, as a sensible exemplar of the universal time, in imitation of which the Fixed [stars] and Planets would have to be moved by the Intelligences—either immediately, or by means of the orbs. Just as, in the first three days, some say that bright cloud was that primigenial light, which made the three natural days.

[Margin: 6th body. — 7th body.]

Sixthly, without the motion of any body about the heaven, there could be various clocks measuring the time of 24 hours—and far more excellent than ours—which likewise would have to be imitated by the movers of the Fixed [stars] and of the heavens in the motion toward the West. **Seventhly**, there could be, above the heaven of the Fixed [stars] or in it, a certain Equator, or belt of the World, made of solid material, and really distinct from it, which would be moved by an Intelligence toward the West in the space of 24 hours. For in these enumerated bodies there is nothing which could not have come about physically; but the immediate conjunction of the first two [bodies] with the heaven of the Fixed [stars] neither is repugnant nor absurd in Astronomy. For no sphere is required between it and the prime Mobile for the trepidation or libration in longitude or latitude—for we have already taught (much more truly) that the obliquity of the Ecliptic is not varied (namely bk. 3, ch. 27), nor that the Equinoctial or Tropical Year is unequal (namely bk. 3, ch. 28), nor that the precession of the Equinoxes, or the motion of the Fixed [stars], is either retrograde or anomalous (namely bk. 3, ch. 28; and bk. 6, ch. 17).

[XV.] But as to the mode of moving the other heavens or the stars toward the West, in such a way that nevertheless they seem—truly or apparently—to be moved somewhat toward the East:

[Margin: 1st mode.]

the **first** could be through imperceptible little pauses [*morulae*], already set forth in bk. 6, ch. 18, num. 16, and indicated in this chapter at num. 13.

[Margin: 2nd mode. — 3rd mode.]

The **second** could be through continuous rapture—whether it be called traction, pulsion, conveyance [*vectatio*], or circumduction—which, however, on account of the resistance of the heaven or star being carried, would not move toward the West so swiftly as it would have moved if nothing resisted it; and therefore could not, within the space of precisely 24 hours (in which the prime Mobile itself completes its entire revolution), equally revolve the inferior globes to the same Meridian or Horizon. The **third** [mode] is, if the movers of the sphere of the Fixed [stars] and of the Planets try to imitate the motion of the watery or crystalline heaven, or of a body or clock equivalent to them, but in the space of 24 hours do not revolve [them] to the same Meridian [as] their globe, but daily arrive at it somewhat more slowly—and this through

spiral helices, as we said at num. 12 in explaining the 11th opinion.

[Margin: 4th mode.]

The **fourth** [mode] is, if the heaven—both of the Planets and of the Fixed [stars]—be fluid, and be moved by one or several Intelligences in the space of 24 hours; and in imitation of it, other Intelligences move the Planets and Fixed [stars] toward the West indeed, but daily by degrees, and always falling short toward the East. But lest as many Intelligences had to be multiplied as there are Fixed stars, the Fixed [stars] could be bound together among themselves, as in a certain solid net [*reticulum*] invisible to us (as we said in bk. 6, ch. 18, num. 17, in the 2nd mode). For in none of these four modes is there any repugnance, nor [are there] two motions contrary to each other; but a single motion, slower however, or less swift, than the motion of the prime Mobile.

SECOND CONCLUSION

[Margin: 2nd Conclusion.]

Nevertheless, that double motion which appears in all the stars—one toward the West, the other toward the East—can come about and be explained without any movable body really distinct from the star-bearing heavens, or from the stars themselves, the other motions of the stars also being saved, without any physical repugnance.

[XVI.] This is proved by the modes [already] indicated, of which the **First** is:

[Margin: 1st mode.]

if one or several Intelligences moving the sphere of the Fixed [stars] from East to West have, in [their] impressed and divinely-infused species [ideas], a perfect idea of a time of 24 hours—not [hours] of which the days consist (which we are wont to measure from the revolution of the Sun or of the Fixed [stars]), but somewhat shorter, and such as they would be if there really were a prime Mobile distinct from the star-bearing heavens and from the stars. But [if], in moving the orb of the Fixed [stars], they exceed the perfect quantity of that intellectual measure, and so revolve it more slowly to the same Meridian—that is, in a time somewhat longer than that intellectual 24 hours (and such as perhaps was the time of the first three days). But the Intelligences of the remaining orbs or globes would have, as the measure of the motion to be accomplished by them, not that intellectual day, but the day made by the single revolution of the Fixed [stars]—yet so that they too revolve their globes somewhat later, and the later, the more they are distant from the Fixed [stars]; and accordingly the sphere of the Fixed [stars] would be, with respect to the Planets, a prime Mobile [that is] not physical, but [operating] in the manner of a moral cause, or as it were exemplary. But all these motions would have to be made through spirals and gyres (about which I spoke at num. 12), so that the variety of declinations and latitudes be saved; and when the Planets are called Stationary, they would have to be moved equally swiftly as the Fixed [stars]; but when Retrograde, they would have to be hastened by the Intelligences somewhat more swiftly than the Fixed [stars].

[Margin: 2nd mode.]

The **second** mode would be, if all the Intelligences, in the aforesaid motion of both the Fixed [stars] and the Planets toward the West (through spirals, however, etc.), looked to that single time—imaginary to us, but mental or intellectual to them, and shining in their impressed species, divinely infused from the beginning of the world.

[Margin: To imitate the motion of the Fixed [stars] by a mechanical experiment.]

[XVII.] But since to some the motion of the Planets in a Fluid heaven, through the aforesaid spirals, seems easy, but [that] of the Fixed [stars] difficult—because they are accustomed to their me—

[…continues on p. 260 (PDF 295): "…mechanical [globe], resting on poles fixed to the Meridian: let them take any star-bearing globe or Aratean sphere, not fixed by its vertices or any axle to the Horizon or Meridian, but supported by some concave vessel or resting on water or sand; and let them fix a little peg into any one point of it, or of a star depicted on the globe, by which, grasped as a handle, they carry the globe around toward the East, bending it spirally and imperceptibly toward the poles…"]

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*(printed p. 260 — completing **[XVII.]**, the mechanical-globe demonstration: a star-bearing globe resting free on a vessel, water, or sand, carried around by a peg fixed at one point, shows that all the stars move together with their declinations changing. From this one learns how easily one or several Intelligences could move all the Fixed stars spirally by a single motion, whether they are affixed to a solid firmament or bound together in a fluid one.)*

THIRD CONCLUSION

[Margin: 3rd Conclusion.]

It is more probable that there is no body which is the Prime Mobile, nor two motions in the stars made at once toward opposite regions of the World, but a single [motion] toward the West through helicoid spirals—those of the Fixed [stars] indeed in a solid heaven, but those of the Planets in a fluid [one]; and that the place of the prime Mobile is supplied by an intelligible time, that is, an idea of the diurnal motion infused into the mind of each moving Intelligence.

[XVIII.] The **first part** is proved, because—as is trite in the schools—"what can be done by fewer is done in vain by more," as Ptolemy advised (bk. 13 of the *Almagest*, ch. 2), whose words I recited [in] ch. 2, num. 3: *that motion is to be attributed to the celestial bodies which so answers to the Phenomena that it is as simple as possible, and exposed to the fewest impediments.* And such is [the motion] we stated in the conclusion; for it is made through a single spiral line, accommodable to all the motions of the stars, and describable by Intelligences having the highest skill about the path and leading [*ductus*] by which they must revolve the stars at God's prescript; nor can any violence from rapture, or any resistance from the middle or surrounding body, be feared—since the fluid heaven of the Planets yields both to the Planets and to the concave surface of the heaven of the Fixed [stars], above which the watery heaven is fluid. Whence also, even if some body were posited for the prime Mobile, whose motion at least the Intelligence would have to imitate—yet it would be necessary that its motion be understood by [the Intelligence], and so that [the Intelligence] have at least expressed species of it in its mind, which, if it beheld [them] by another, as it were reflex, act, it could use as the impressed species and Idea of that motion. Therefore, through these species (which we cannot avoid), whatever would be done by them with those [bodies] and with that movable body can be supplied by the Angels; and so the motion of that distinct orb or body is multiplied in vain. Nay, not only in vain, but even against the dignity of the Angelic nature. For that Musician is more excellent who knows how to sing, or to strike the strings, according to the harmonic number, using the time which he has in [his] mind, and needs no sensible percussion of the hand, nor an extrinsic sign, for the regulation of the voice. So too more excellent is the mode which we have ascribed to the Intelligences, since they need no corporeal—as it were—clepsydra [water-clock] in order to move skilfully and harmonically the stars or globes committed to them, and to accomplish their dances (so to speak), or this hidden harmony [*concentus*] of the World.

[Margin: 2nd part of the Conclusion.]

But the **second part**—about the distinction of the solid heaven from the fluid—has already been proved (sect. 2, ch. 7, num. 21), and is confirmed, because thus it is much easier for the Fixed Stars to preserve their distances among themselves perpetually, and to be moved uniformly, at the motion of one or a few [stars], by one or a few Intelligences, than if they were moved in a fluid heaven.

[Margin: 3rd part of the Conclusion.]

The **third part**—about the intellectual time, known by each Intelligence and used as the immediate measure of the motion to be accomplished—is proved, because it cannot be denied that that time is known by them; therefore it would be posited in vain [if] it needed that sensible time by which the heaven of the Fixed [stars] is moved; and it is better that there be one common measure to all of them, to which they may attemper [adjust] their motions and revolutions. For thus they also know that time which was not from the World itself, but could have been; thus they know that diurnal time, by which the ninth heaven would be moved, if it were the prime mobile, and how much faster it would arrive at the Meridian than the Fixed [stars] or Planets. This, therefore, they can use immediately; and it is more worthy that they need no other sensible motion and time, even though they must move sensible bodies. Nor is it absurd that the first and most universal time, with respect to an intellectual nature, be really only intellectual—that is (as they say), to exist intentionally, and not to exist except objectively, in the Angelic mind or in ours. For this happens in very many other ideas, which we use in artifacts and sensible works. "For the house which is outside the soul comes to be from the house which is within the soul," says the Philosopher (7 *Metaphysics*, text 23)—namely, from the Idea, and the impressed species, which shines objectively in our mind, and is the image of the house to be made. Therefore, if there were a more perfect Architect, who—without a mechanical and external model or exemplar—knew how, and was able, to direct the workmen, or himself to build with his own hands: more perfect too will be the motion of an Intelligence, if it needs no external and sensible exemplar for accomplishing the diurnal motion.

[Margin: What if the Prime Mobile be some sensible body?]

[XIX.] But if nevertheless someone should require that that time—which is the universal measure of all motions, and as it were the norm of the rest—be still, or at least once was, the motion of some sensible body, or its number or measure: I would persuade [him] of those three more probable modes.

[Margin: 1st mode, through a simple Equator.]

The **first** is the [one] which I indicated at num. 14, in the seventh place: namely, through a certain Equator—in, or above, a celestial globe—divided into 360 Degrees and subdivided into minutes [*scrupula*], or rather immediately into minutes (not such as ours, but far more subtly, into [tiny] particles), [with] all the points and tiny differences of the motions in the Fixed [stars] and Planets, [reckoned] from the Meridian, suitable for discerning—from the beginning of the World to the end—the [motions] to be carried out; which [divisions], nevertheless, on account of the vastness of that belt, would be very large, if compared with the minutes, or even the degrees, of our spheres or astronomical instruments. For if that 24-hour motion could be represented by the motion of this belt, made of solid material, the whole machine of some ninth, tenth, or eleventh heaven would be posited in vain to be moved, in order to supply this single motion. This motion, therefore, being posited [as] made by a single Intelligence, and revolving that Equator to the same meridian, the remaining Intelligences would have so to move the Fixed [stars] and Planets spirally, or screw-wise, toward the West, that—when the beginning of the Equator arrives at one Meridian, say, of Jerusalem—a Fixed star, which yesterday had been beneath the initial point of the Equator, would on the following day not yet be brought by its center to the same Meridian, and much less Saturn [when] direct, etc.

[Margin: 2nd mode, through the crystalline Heaven.]

The **second** mode is, that we choose that Watery or crystalline heaven, which is above the Firmament, as that body which, by its motion (made by an Intelligence), would represent the motion of the Prime Mobile; for thus it will be confirmed that those waters were not placed above the Firmament by God in vain—[but] as a second [end], just as others have assigned several other ends [purposes], about which [in] sect. 1, ch. 2, num. 10. The **third** mode could be through the mere memory of the primigenial light made by God on the first day of the World, and of its motion or successive production—just as the first three days of the World were completed. For there were not lacking [those] who said that that [light], or even the Sun (made on the first day), had no other motion than [that] of the prime Mobile, but that on the fourth day a proper motion was

added to the Sun and the rest of the stars (per what was said in sect. 1, partly ch. 1, num. 34—to be referred to Aegidius's opinion—partly ch. 4, num. 3). For thus that first natural day, or even the first three days, would have been the most perfect and shortest of all, inasmuch as that light was revolved most swiftly—no less swiftly than the Equator of the Prime Mobile is now said to be moved in the spherical treatises; therefore the memory of that day, or of those days, would suffice for the Angels, so that they could revolve their spheres or stars to the same Meridian in a not so [short], but a slightly longer, time. But the rest, which seem to need to be added to this subtlety, I shall indicate soon in the Scholia.

*[…continues on p. 261 (PDF 296) with the **SCHOLIA** to this chapter.]*

(printed p. 261:)

SCHOLIA

[Margin: Whether two contrary motions can be given.]

[I.] On the occasion of reconciling the motion of the Prime Mobile with the proper motion of the stars toward the East, it is wont to be disputed by the Physicists whether two continuous and contrary local motions can be given—that is, [motions] by which the same movable, to be carried according to the same part of itself, is carried toward one region of the World and at the same time toward the opposite [region]—if not *per se* and by force of the same moving principle, at least by diverse acts, and by force of diverse moving principles. Which controversy is touched by Maior (on [*Sentences*] 2, dist. 24, q. 1), Mayronis (ibid., q. 3), Fracastorius (in the *Homocentrics*, sect. 1, ch. 8), Clavius (on the *Sphere*, p. 52), Rubius and the Conimbricenses (bk. 2 *On the Heavens*, ch. 5, q. 4, art. 2), Mastrius and Bellutus (disp. 2 *On the Heavens*, q. 4, art. 1, num. 129 and 130), Amicus (tract. 5 *On the Heavens*, q. 6, dub. 7, art. 3), Hurtado (disp. 2 *On the Heavens*, sect. 3, paragraph 22), Arriaga (the single disputation *On the Heavens*, sect. 5, num. 56), Oviedo (the single controversy *On the Heavens*, point 4, num. 6), Punch (disp. 22 *Physics*, q. 9, num. 94), and Téllez (disp. 44 *Physics*, sect. 2, num. 4 and 5). Among whom Punch and Téllez seem to concede two contrary motions—one *per se* or from within, the other *per accidens* and from without; and they use the now-trite example of an ant or weasel creeping upon a wheel turned around to the contrary part, or of a man walking in a ship toward the East, from prow to stern, while the prow of the ship is borne toward the West. For what Téllez adds, about a stone naturally about to descend downward along a straight line, but carried crosswise by an external impulse, and so moved by two motions, does not make for the matter, since they are not two contrary motions, or [motions] toward contrary termini. More to the matter is a stone [drawn] from prow to stern, spontaneously drawn by someone sitting on the bank of the river, meanwhile while the ship is borne to the opposite part by the river.

[Margin: Resolution.]

The rest of the aforesaid Authors, however—and at last Punch himself—answer that it is naturally impossible for the same part of a subject to be moved by two simply contrary motions; that is, so that at the same time it approaches the same Fixed point of the World, and at the same time recedes from it. For although metaphysically the contradiction may seem to be removed by distinguishing two diverse moving principles, yet physically this is repugnant to the nature of local motion: for [local motion] is an action, by force of which either the whole movable, or a part of it, recedes from one place as the *terminus a quo* [terminus from which], and approaches another as the *terminus ad quem* [terminus to which] along the same line, and acquires another "where" [*ubi*] distinct from the prior—so that it is naturally impossible for the same movable to be also in two adequate places at the same time, and to approach, actually and really, that terminus from which it recedes; because recession includes (with the motion) the privation of approach and of local presence, but a privation and the form opposite to it cannot physically be founded in the same instant of time. (Although, if by divine omnipotence a body were replicated [bilocated], the [body] thus replicated could be moved into opposite parts.) Yet the same [body], according to the same part of the subject, can be

moved by a double impetus—of which one is, by its nature, impulsive of one motion toward the East, the other toward the West—but in such a way that only one prevails, and moves [the body] toward one part, more slowly however than if it were not retarded by the other impetus; for if neither prevailed, the movable would be moved toward neither part. And so they deny that there are two motions, but [say there is] a single, slower [one]. But in the motions of animals, which raise their legs in walking, there is intermixed an up-and-down motion, which is not contrary, nor directly opposite, to the motion of the ship or the wheel. Which response, although it is good, and admitted by me elsewhere, can nevertheless be explained by a still more perfect distinction, as will be done presently in the following scholium.

[Margin: Explanation of two opposite [yet] compossible motions.]

[II.] Two [things], therefore, are to be noted and distinguished, in the motion—whether of animals from within, or of inanimate [things] from without—which are moved not upon an immobile place, but upon a mobile place, that is, within it as a vessel. For in such a motion a double *terminus ad quem* can be regarded: one fixed and immobile in a determinate part or point of the World; the other mobile in the vessel and place itself—which terminus is moved at the motion of the vessel, as a part [is moved] at the motion of the whole. Secondly, a motion **to** some terminus (that is, relative, or respective, or comparative, or even hypothetical, **toward** it) is to be distinguished from an **absolute** motion, by which that terminus is approached. Therefore, if some body resting within some vessel be carried, at the motion of the vessel, toward the West, and meanwhile that body be carried by another moving principle toward the Eastern part of the vessel: if each impetus be equal, [the body] will indeed approach the mobile eastern terminus by an absolute motion, but from the immobile eastern terminus it will neither recede nor approach, but will remain there, absolutely. But if the impetus by which the vessel is carried toward the West prevails, that body will absolutely recede from the fixed eastern terminus, and will absolutely approach the mobile eastern terminus; but to the immobile eastern [one] it will not approach except respectively (inasmuch as its proper motion is directed toward the East), or comparatively (because you recede less from it than if it were moved by no proper motion within the vessel, or upon that vessel), or finally hypothetically (inasmuch as it would have approached it, if it had used its motion alone, and the vessel had stood still). If, finally, the impetus of that body prevails, it will either approach, or pass beyond, the fixed eastern terminus absolutely; but it will recede from it only respectively, or comparatively, or hypothetically.

Which, for the sake of aiding the imagination, it pleases [me] to set forth by an appended diagram. In it, let there be a portion of a river **AEB**, bisected at **E**; of which the half **AE** is equal to the length of the ship **CCDC**, and the other half **EB** [equal] to the length of the same ship **DCDD**—[the ship] now translated from the place beneath the fixed points of the World **CQH**, to the place beneath the fixed points **HLK**. But when [the ship] has completed [traversed], with the middle of its hull, the half of the space **AE**—namely the space **ME**—let the same ship be under the fixed points **QHL**; and let **G** be the eastern terminus, **K** the western.

*[Figure (river/ship diagram): a horizontal river-line marked, left to right, **A · M · E · I · B**. Above it the ship is drawn in five successive positions as nested arcs, the stern/prow points labelled (top row) **G, Q, H/O, L, K** and (below them) **C, C, DC, D, D**, with dotted verticals dropping to the baseline. It shows the ship gliding westward while a man walks prow-to-stern (eastward), so the curves trace the combined (resultant) path.]*

[Margin: 1st case.]

Now, at the beginning of the whole motion, let, **First**, the man **O** be in the prow **D**, under **H**, and let him begin to walk toward the stern **C**, toward **G**; so that in one clock-minute—in which the ship, carried by the river, has traversed the whole space equal to its [own] length, and has come under the points **HLK**—he himself has arrived at the stern **C**. For he will still be under the same fixed point **H**, under which he was at the beginning of the motion, because under it is the stern of the ship, to which he has come. Wherefore, although he has been moved absolutely, and has approached the mobile terminus (the stern), yet to the immobile terminus **G** he has approached no further absolutely—to which, however, he was going to

approach, if the ship had not been moved.

[Margin: 2nd case.]

Secondly, imagine the man **O**—while the whole ship, in one clock-minute, traverses the whole space **AE** (which is under the fixed space **GQH**)—to be moved twice as slowly, and so in one minute to arrive from the prow to the middle of the ship; for he will be in **D**, under the point **L**. Wherefore, although he has approached the stern **DC** absolutely—nay, respectively his walking has been directed toward **G**—yet absolutely he has receded from **G**, the fixed eastern point, and has approached **K**, the western terminus, since at the beginning of the motion he was under it. But if the ship had meanwhile not been advanced at all, he would have come from **DC** to **C**, under **Q**; but this motion is only hypothetical. On the contrary, if the ship alone had been advanced, he himself walking not at all, he would have been, at the end of the motion, in the prow **D**, under **K**; wherefore, since on account of the aforesaid walking he is in **D**, under **L**, he has indeed receded from **G** absolutely, but comparatively to the recession which was going to be [had he been] in **D**, under **K**, he has approached, because he has receded less.

[Margin: 3rd case.]

Thirdly, while the man **O**, in one clock-minute, runs through the whole ship from prow to stern, [and] the ship, twice slower, completes half the space **ME** of its [own] length—so that, when the prow was under **H** and the stern under **G**, at the end of the motion the prow is under **L** and the stern under **Q**—then that man will be under **Q**; and so he has indeed approached absolutely both termini, the mobile [stern] and the immobile **G**; but from the immobile **G** he has receded only comparatively or hypothetically.

And proportionally are to be understood the motions of an ant on a wheel turned around to the contrary part, and of water stirred by a finger toward the left in a vessel revolved toward the right, and so of similar [cases]; for in reality, in the ant and in the water there are two motions conflated into one, which are not contrary, since the termini-to-which are not the same (since one is fixed, the other mobile), nor is there, to the fixed [terminus], absolutely an approach and recession of the same part, etc.

[Margin: Whether we have any example of the First Motion?]

[III.] You will ask whether, of the motion of the Prime Mobile—which in our Idea we attributed to a rational [conceptual] Equator, and which we said above shines in the minds of the Intelligences moving the heaven of the Fixed [stars] and the Planets—we can have any sensible specimen [example];

[…continues on p. 262 (PDF 297): "…for commonly we have no other exemplar than the motion of one Fixed star revolved once from the same to the same Meridian; and still more commonly we use the revolution of the Sun. I answer: since any Fixed star completes one degree of its proper apparent motion in 72 years (bk. 6, ch. 16)… [Riccioli computes the daily increment, ~8 thirds of arc, and concludes that no pendulum is precise enough to measure the difference between the sidereal day and the "rational Prime Mobile" day — so in practice one uses the sidereal day]."]

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*(printed p. 262 — completing **[III.]**, the Scholium on a sensible specimen of the First Motion: since a Fixed star's apparent proper motion amounts daily to only a few thirds of a degree, a pendulum fine enough to distinguish the ideal day from the star's revolution to the same Meridian is impossible to construct. The differences can be gathered by calculation, and for astronomical practice the day exhibited by a Fixed star's revolution more than suffices, as treated in bk. 3, ch. 21.)*

CHAPTER IV

Whether the Proper Motion of the Stars is, of itself and by the primary Intention of nature (or rather of God and the moving Intelligence), Equal, or rather Unequal—yet ordered, and Regularly unequal, and sufficient for manifesting God and his Providence

[Margin: The restriction and state of the question.]

[I.] I do not raise the question about the motion of the Prime Mobile, for all confess that it is most equable and uniform, as the most universal rule of all the motions which take place in this sensible world; and concerning this hold those words of the Philosopher (2 *On the Heavens*, ch. 6, text 35): "But about the motion of the heaven—that it is regular and not irregular—it must next be reviewed." But I say this of the first heaven and of the first lation. And speaking of this very [thing] (8 *Physics*, text 76), he says: "For indeed, since the measure of motions is circular revolution, this must be first—for all things are measured by [what is] first; and because it is first, it is the measure of the others; and moreover it happens to be regular." Nor do I raise a doubt about the proper motion of the Fixed [stars] in longitude, for I already suppose it to be equal, from what was said in bk. 3, ch. 28 and 30, and bk. 6, ch. 17. There remains, therefore, the controversy about the motion of the Planets, composed of several mixed kinds—namely, according to longitude, latitude, and depth or altitude. But neither about this is there a doubt that it appears to us unequal, and that, with respect to the center [or] surface of the earth, it traverses unequal parts of the heaven in equal times; for this I now think is established by the most manifest experiments of the observations, and persuaded to the reader from what was said—about the Sun in bk. 3, from ch. 13; about the Moon in bk. 4, from ch. 18; and about the rest of the Planets in bk. 7, sect. 1, ch. 7, and sect. 2 and 3.

We ask, therefore, about the motion of the Planets—*per se*, and from the nature of the movable Planets, or rather from the intention of God the Creator and first institutor of such motions, and so from the intention of the Intelligence moving the Planet (and obeying the divine intention in every way): namely, whether it is unequal as it appears; or whether, to us indeed (placed *per accidens* outside the place from which it ought to be regarded) it seems unequal, but *per se*, and regarded from the place whence it ought to be regarded, is equal and uniform—just as if a Ruler [straightedge] be straight in itself, but on account of refraction in water appear curved, like an oar; or [as] a man be really shaggy and of a longish beard, but, regarded from afar, appear smooth and beardless, the hairs not standing out, or not appearing, from too great a distance.

[Margin: 1st opinion, for the equality of the celestial motions.]

The **first Opinion** was that the motions of all the stars are equal in their circles.

[Margin: Anaximenes. — Aristotle.]

For Anaximenes said that the stars are turned in the same way, both above and around the earth (as Plutarch relates, bk. 2 *On the Opinions of the Philosophers*, ch. 16); and Aristotle (8 *Physics*, text 76; and 2 *On the Heavens*, from text 35) adduces such reasons for the regularity of the first motion of the supreme heaven that they hold equally for every circular motion which takes place in the heaven. For he says it is regular for this reason: because, being circular, it has no beginning or end, by approaching which it must be carried more swiftly.

[Margin: 1st reason of Aristotle.]

For he says, in that text 76: "Moreover, it happens that only the circular [motion] is regular; for those [motions] which are made along straight [lines] are carried irregularly from the beginning and to the end—for all [bodies], the more they are distant from that which is at rest, are carried the more swiftly. But of the circular alone, neither beginning nor end is in it by nature, but outside"—where he speaks of the merely natural motions of simple bodies. But (2 *On the Heavens*, text 35), speaking more universally, he says: "For if it were moved irregularly, it is manifest that there would be in it intension, and a standing-still, and

remission of the lation; for every irregular lation has both intension and a standing-still. But the standing-still is either in the *terminus a quo*, or in the *terminus ad quem* to which the movable is carried, or in the middle. And in those [motions] which are carried by nature, the rest is in the *terminus ad quem*; but in those which are carried violently or beside nature, the rest is in the *terminus a quo*; but in [things] thrown, in the middle. But of circular lation there is no *terminus a quo*, or *ad quem*, or middle; for neither beginning, nor end, nor middle is of it simply, for it is eternal in time, and at once drawn in length into itself and least interrupted. Wherefore, if there is no standing-still of the lation itself, neither will there be irregularity; for irregularity comes about on account of intension and remission." And this is the first Aristotelian reason.

[Margin: 2nd reason of Aristotle. — 3rd reason of Aristotle.]

The **second** he subjoins (text 36), taken from the exclusion of the causes of irregularity. For, he says, since everything that is moved is moved by another, it is necessary that the irregularity of motion arise either from that which moves, or from that which is moved; but it can arise from neither head in a celestial body, because both that which moves and that which is moved is incorruptible and simple and altogether immutable. The **third** reason is adduced (text 37) thus: For either the whole period of the celestial motion would be unequal—now slower, now swifter—or the parts of it; but it has not yet been observed that the parts of it have become swifter or slower; for since an infinite time has preceded, in which this motion has existed, the distance of the stars would already have become infinite. But neither could the whole period be changed and become slower; for remission comes about on account of impotence [weakness], but impotence is beside nature; but in the first bodies there is nothing beside nature (for they are simple and unmixed, and in their proper region, nor is anything contrary to them); wherefore neither will there be impotence, and accordingly neither remission, nor intension—which connotes a remission before it, if not after it. Besides that, says Aristotle (text 38), it is absurd that, in an infinite time, that which moves be impotent, and again, in another infinite [time], potent; for all things in the infinite are indeterminate. It is plain, therefore, that the Aristotelian reasons hold not only about the motion of the prime Mobile, or of the supreme heaven, but about every motion of the Planets, which he thought to be circular and eternal (12 *Metaphysics*, text 43).

[Margin: Simple and Regular motion are not the same.]

But since (bk. 1 *On the Heavens*, text 23) he had said, "For of a simple body the motion must be simple," and the Astronomers take "simple motion" for the mean between swift and slow—that is, for "equal [uniform]"—hence there flowed into the schools of the Physicists and Astronomers this, as a Peripatetic axiom: that of a simple body (such as the heaven is), the motion must be simple and equal, or regular. But this, certainly, Aristotle did not there [understand so]—

[…continues on p. 263 (PDF 298): "…for in the same text he at once subjoined: 'But we say that these alone are simple — the [motion] which is circular, and the [motion] which is made along straight [lines]; and of the latter, two parts: one indeed from the middle [center], the other to the middle.' Therefore the motion of the elements — which are themselves also simple bodies — [is simple, yet not equal]…" — i.e., Riccioli begins to dismantle the "simple = regular/equal" axiom.]

(printed p. 263 — completing the refutation of the "simple = regular" axiom: Aristotle himself counts the rectilinear motion of the elements among simple motions, yet teaches that such motion is irregular, growing swifter as bodies near their place of natural rest. Hence the Peripatetic axiom that a simple body like the heaven must move regularly and uniformly was badly derived from the name of "simple motion.")

[Margin: Plato.]

Plato too, as Theon of Smyrna relates in his *Astronomy*, adhered to the Pythagoreans, and judged the celestial motions to be circular, regular, and equal.

[Margin: Ptolemy's opinion.]

[II.] But of the Astronomers, the chief of them, Ptolemy (bk. 3 of the *Almagest*, ch. 3), expressly affirms that equality belongs *per se* to the celestial and perpetual bodies. For thus he begins that chapter: "But since it follows that we should demonstrate the apparent inequality in the Sun's motion, it must be premised universally: that the motions of the wandering [stars] too, *in consequentia* of the signs [eastward], no otherwise than the lation of the whole universe *in praecedentia* [westward], are all, by their nature, equal and circular—that is, that all the lines which are understood to carry around the stars or their circles intercept, in all simply equal times, equal angles at the centers of any [given] circulation. But the inequalities which appear in them [the planets]—these come about on account of the positions and orderings of the circles by which they are moved, and [in which] they are enclosed in their spheres. Nor does anything foreign from their perpetuity in any way really come about, on account of the confused order of [their] appearances." But he attributes the apparent inequality of the Sun either to our eye placed outside the center of the circle carrying the Sun (described from a [center] other than the earth's center), or to the composition of a Concentric with an Epicycle carrying the Sun; wherefore, if our eye were in the center of the circle carrying the Sun, it would see equal portions of the Ecliptic traversed by it in equal times. And in bk. 9, ch. 2, he speaks thus: "But since it is proposed to us (as we did concerning the Sun and Moon) so concerning the five Planets too to demonstrate all their apparent inequalities to come about through equal and circular motions—for such motions befit the nature of the divine bodies, from which disorder and irregularity are far removed—we ought to value highly whatever we shall attain in this matter."

[Margin: Fracastorius's opinion.]

Ptolemy was followed thereafter by the Arabs, and very many Astronomers—whether asserters of Eccentrics and Epicycles, or of Homocentrics. For Fracastorius himself, in the *Homocentrics* (sect. 2, ch. 20), has these words: "But the revolutions of this inequality are not equal among themselves, neither the whole nor their parts, etc. But this is *per accidens*; for *per se* they are all equal, [especially] if they be measured by the mean motion of the first 'circitor'."

[Margin: Copernicus's opinion.]

But how tenaciously Copernicus asserted the equality of the celestial motions, is gathered from this: that in Ptolemy he could not stomach the Moon and the five lesser Planets [to have], besides the Epicycle, two Eccentrics—of which one would carry the center of the Epicycle, but unequally, while the other would not carry [it], yet, with respect to its [own] center, the center of the Epicycle would be moved equally (which second Eccentric the Astronomers call the **Equant**, and about which [we treat] sufficiently in bk. 7, sect. 2, ch. 1, scholium 1). For Copernicus thought it absurd that the celestial motion should beg [borrow] its equality from a foreign center—that is, from that center from which the circle of such a motion was not described. The words of Copernicus (bk. 4, ch. 2) are these, about the Ptolemaic Lunar hypothesis: "The motion of the Epicycle in its Eccentric, which he describes, is therefore unequal. But if this be so, what shall we answer to the Axiom—that the motion of celestial bodies is equal, and doubtless at least seems equal—if the motion of the Epicycle, [though] appearing equal, were in reality unequal, and there will happen [something] utterly contrary to the established principle and assumption? But if you say that it is moved equally about the earth's center, and that this suffices to safeguard the equality—what kind of equality, then, will that be, in a foreign circle, in which its motion does not exist, but in its own Eccentric? So indeed we wonder, etc." And after a few [words]: "So too the Moon, traversing its Epicycle unequally—if now from unequals we should wish to prove the inequality of the appearance—what kind of argumentation that will be, one may observe. For what else shall we do, than that we shall give a handle to those who detract from this art?"—namely, Astronomy.

[Margin: Copernicus's opinion.]

[III.] There was, therefore, with Copernicus, an axiom and principle now established and assumed as certain: that the motion of celestial bodies is equal—namely, *per se*, and the motion being regarded from the proper center of the circle. Nay, this Author was so addicted to the equality of the celestial motions, and so averse

from that kind of inequality which Ptolemy had admitted in the five lesser Planets besides (the Equant circle being introduced into their hypothesis), that it was a goad for him to assert the motion of the Earth. For he himself professes thus (bk. 5, ch. 2): "The ancient Mathematicians, who held the earth immobile, imagined in Saturn, Jupiter, Mars, and Venus eccentr-epicycles, and besides another Eccentric, with respect to which the Epicycle would be moved equally, and the Planet in the Epicycle." After which he describes their hypothesis (which we set forth with a clearer diagram in bk. 7, sect. 2, ch. 1). Then against them he infers: "But it is established that the equality of the Epicycle had to be made with respect to the center of its Deferent, etc." Therefore here too they concede that the equality of a circular motion can be made about a foreign center, and not [its] proper [one]; similarly too in Mercury this happens more. But about the Moon, this has already been sufficiently refuted. These [things] and similar gave us occasion of thinking about the mobility of the earth, and other modes, by which the equality and principles of the art might remain, and the account of the apparent inequality be rendered more constant. Wherefore in this place too he [Copernicus] assumes, among the first principles of the Astronomical art, the equality of the celestial motion about that point which is the center of the circle, in whose periphery the motion is made—whether of the Planet, or of the center of the circle carrying the Planet.

[Margin: Reinhold's opinion. — And Clavius's.]

Nor did his follower Erasmus Reinhold the elder judge otherwise (in the preface to the *Theorics* of Peurbach), whose words—as embracing the opinion of many Astronomers—it will not irk [me] to recite: so, after the inequalities indicated which appear daily in the motions of the Planets, he subjoins: "Since, therefore, the variety of the celestial motions and appearances (which the Greeks call φαιν■μενα [*phainomena*]) is so manifold, the Astronomers, with the highest diligence, with the greatest vigils and labors, have scrutinized the causes of appearances so dissimilar. For that so great a diversity in the motions of the Planets does not arise from a certain irregular motion of their celestial orbs (which carry the bodies of the Planets), as the unskilled imagine—the whole periods or revolutions of the orbs (which are established to be equable among themselves) manifestly cry out against [this], and convince [us otherwise]. Wherefore, of this so great irregularity, which is discerned in the parts of the periodic motions, the Astronomers hand down an erudite and plain cause: namely, that motions equable, and by their nature uniform, appear to us dissimilar—either because they take place in eccentric orbs, or also because, from many simple motions variously, as it were, compacted together at once, some one [motion] out of all these is made irregular." Which author, further below, in the Theory of the Sun and in the scholium added to Peurbach's Theory (p. 31), repeats things similar to the aforesaid: "We said above," he says, "that, the observations of whole revolutions being collated, reason gathers that the motions of celestial bodies are altogether equable, constant, and fixed; but that, if the parts of any [single] revolution be compared among themselves, a varied and manifold anomaly is detected."

But with much graver words, and a severer brow, our Clavius reprehends the men of the contrary opinion (on ch. 4 of the *Sphere*, p. 434), so that he does not hesitate to break forth into this sentence: "But the later men, and [those] of sounder mind, when they had begun to regard celestial things more rightly, more subtly, and more scrupulously, came into this opinion: that they pronounced it to be of the highest madness to think that in the motions of celestial bodies any irregularity, deformity, or inequality is found; but, on the contrary, that in them the highest equality, uniformity, and regularity ought to be posited." And he goes on to confirm this—both *a fortiori*, from some motions of sublunary things (which, although they be perishable and mutable, yet keep a certain law and order in their motions); and from the Aristotelian reasons: namely, that in circular motion there is no beginning or end, by approaching which the approach must be made swifter and swifter (and therefore irregular); and that in the celestial movers there is no corruptibility nor impotence, from which a more remiss, and so—

[…continues on p. 264 (PDF 299): "…a slower, motion could happen [in the heavens]; finally, from the certain law of the periodic motion recurring into itself, by force of which the Astronomers most certainly predict the future conjunctions and syzygies of the Planets. And the same was the opinion of the Conimbricenses, Suessanus, Philalthaeus, Jandun, Albert of Saxony, Paul of Venice, Achillinus, Amicus…"]

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*(printed p. 264 — continuing the **first opinion** (for the equality of celestial motions): the page completes the argument that nothing in the heavens could cause a more remiss and slower motion, and appeals to the fixed law of periodic motion recurring into itself, by which Astronomers most certainly predict future conjunctions and syzygies of the Planets.)*

[Margin: Other authors for the 1st opinion.]

And the same was the opinion of the Conimbricenses (2 *On the Heavens*, ch. 6, q. 2), of Suessanus [Agostino Nifo] (2 *On the Heavens*, text 40), of Philalthæus (ibid., text 35), of Jandun (q. 8), of Albert of Saxony (q. 13), of Paul of Venice (ch. 15), of Achillinus (1 *On the Orbs*, dist. 3), of Amicus (tract. 5 *On the Heavens*, q. 6, dub. 6; and q. 5, dist. 3, art. 1)—although they use a varied distinction; for some distinguish *irregular* motion from *deformed* and *unequal* [motion]. But all agree that, if the whole periods of one [and the] same planet be compared among themselves—for example, the Tropical Solar years among themselves, or the revolutions of Saturn among themselves—those are altogether equal, and the whole circle of them is accomplished in an equal time; but if the parts of one period be compared among themselves—say, the Northern semicircle, in which the Sun is, with the Southern semicircle—they confess that the motions are indeed unequal, because they are not made in an equal time; but they refer this very inequality to appearance (on account of the situation of the eyes of those observing these motions), or to the composition of several circles or partial Orbs, of which the individual ones, regarded in themselves, are indeed equal motions, but compose one unequal motion.

[Margin: Tycho's opinion. — Bullialdus's opinion.]

Finally, into the opinion of Copernicus Tycho was swept away, when (vol. 1 of the *Progymnasmata*, p. 11) he said: "But that all the celestial motions are *per se* regular and equable, and are carried circularly by a constant law, has long since been received by all Astronomers as an Axiom." But—what you may wonder at more—Ismael Bullialdus, although he contends that the motions of the Planets are made through an Ellipse, not through a circle (and in this he would seem about to favor the physical inequality of the motions, which the inventor of this Elliptical way, Kepler—as we shall say presently—had built up), yet attempted to reduce this very hypothesis to equality; and therefore (in bk. [1] of the *Philolaic Astronomy*, ch. 13) he premises, among other principles, these six propositions:

***1.** That the Planets are moved by a single motion through a single line—which we have already shown.*

***2.** That the revolutions of the Planets are equal, perpetual, constant, and uniform, and each [is] similar to all the prior and posterior [ones]; and the observations of all ages prove them such.*

***3.** That they must therefore be regular, and composed of regular [motions];*

***4.** Because, being perpetual motions, they cannot otherwise [be] except circular, or [made] through a line returning into itself.*

***5.** That they are composed of circular [motions], because they are accomplished by the laws of circles.*

***6.** That the revolutions themselves have a principle of equality, which the Planet by its nature regards.*

[Margin: 2nd opinion, for the inequality of the celestial motions. — Kepler.]

[IV.] The **second Opinion**, however, is that the motions of the Planets have a **physical** inequality, and not only an **optical** [one] arisen from mere appearance—so that, with respect even to some proper center of the orbit through which the Planet proceeds, there really, and from the nature of the Planetary motion, correspond to equal times unequal portions of such an orbit. So indeed Kepler (in the commentaries on Mars,

ch. 22, 32, 33, 34, 39, 44, 57, taken together; and in the *Epitome of Copernican Astronomy*, bk. 4, part 3, and bk. 5, especially p. 711). Nay, even before [Kepler], Ptolemy in the Moon and the five lesser Planets admitted an Equant—that is, a circle, with respect to whose center the Planet or the Epicycle would be moved equally, but by which it would not be carried; wherefore in the Eccentric carrying the Planet he admitted an unequal motion with respect to its proper center, and so, as to this, a Physical inequality. (But about this Equant, and the distinction of Physical inequality from Optical, I here suppose many things already explained—bk. 3, ch. 2[1]; and bk. 7, sect. 2, ch. 1, scholium 1.)

[Margin: Cabeus.]

But our [own] Cabeus too (bk. 1 *Meteorology*, text 38, q. 2) teaches that the figures of the Astronomical hypotheses, by which the celestial motions are reduced to equality, are rather devised for our use, and as a foundation of geometrical calculation, than really exercised in the heaven; for he says (p. 221): "For just as a mean motion is not truly given, although it is necessarily supposed for the calculation, so neither is it necessary that a motion of the Eccentric or of the Deferent be given." And (p. 222) he inclines wholly to the true and physical inequality of the motions. But for us, in a controversy of this kind, there is need of a certain distinction, so that we may open [reveal] our opinion, and [tell] for which [side] it is.

FIRST CONCLUSION

[Margin: 1st Conclusion, on the whole Period of the motions.]

Although it be probable, it is nevertheless not yet certain, that the whole periods or revolutions of the celestial motions are equal among themselves; nay, about the Moon it is certain that they are unequal.

[V.] What I said about the Moon is already known to Astronomers—nay, even to those skilled in the Ecclesiastical Computus.

[Margin: 3rd part of the conclusion is proved.]

For the period of the Moon—whether it be taken for the periodic month, in which it traverses the Zodiac, or for the synodic month, in which it is again joined to the Sun—is sometimes more than 30 days, sometimes less; and the variety of these months becomes manifest, more than once, in individual years; and about it [enough] has been said, more than enough, in bk. 4, from ch. 18. And so the third part of the conclusion remains proved.

[Margin: 1st part of the conclusion is proved.]

But the **first part** is proved, both by the authority of very many who think thus about this equality (some of whom—[speaking] from their own and many others' opinion—I already adduced speaking at num. 3), and by reason: because an equality of this kind both *per se* has a beauty to be desired, and [because] the very small difference between the periods of the other Planets observed by [different] Astronomers is rather an indication of equality—but [an equality] not yet so perfectly known that all Astronomers must admit the same measure. But if God had willed the periods of those [planets] to be unequal, and [if] this were more befitting the nature of sublunary things and the perfection of the universe, then surely, at length, they would differ among themselves by some notable difference, and [one] manifest after some ages—just as has happened in the Lunar periods. So the motion of the Solar Apogee, which was unknown to Ptolemy on account of the small interval between his and Hipparchus's observations (compared with the slowness of such a motion), at length nevertheless became patent after many other ages.

[Margin: 2nd part of the conclusion is proved.]

Furthermore, the **second part** of the conclusion is proved: because, although the period of the Sun, or the equinoctial Years, more probably are equal among themselves (as I taught in bk. 3, ch. 30), yet probable reasons of the inequality of the years are not lacking, which I adduced in the same place with their authors; and to this also contributes somewhat the so-diverse quantity found of such a year, which we exhibited in the

synopsis (bk. 3, ch. 15, num. 9). But the inequality of the Solar period being posited [as] probable, much more probable becomes the inequality of the period of the other Planets, whose motions are bound up with the motion of the Sun and depend on it (as is plain from bk. 7, sect. 1, ch. 7); and besides, it becomes probable from the diverse opinion about their periodic motions, as is to be seen in the tables which I set forth in bk. 7, sect. 2 and 3, when I exhibited the various measures for foreknowing the Theory of the Planets according to different Astronomers. And so, not incongruously, John Anthony Delphinus (in the book *On the celestial globes and motions*, p. 53) infers, from the uncertainty of the Solar motion, the uncertainty of all the celestial motions. So, although the Period of the fixed [stars] more probably is equal (according to what I already said in bk. 6, ch. 17), yet that diversity of this period asserted by various Astronomers—which I reported in the same book (ch. 16) and represented in a table—makes its inequality probable; although, from a peculiar cause, its equality or inequality remains still uncertain, because not yet has one period of it been completed, and so not yet could either [alternative] be established by observation; for it requires far more than twenty thousand Solar years, and yet from the beginning of the World not yet have seven thousand years elapsed.

SECOND CONCLUSION

[Margin: 2nd Conclusion, on the parts of the Revolutions.]

Although the motions of the Planets are ordered, and **regularly unequal** in the parts of their periods; yet they are absolutely unequal—not only *per accidens*, on account of mere appearance, or on account of [their] composition from several equal motions, but *per se*, from the primary intention of God, and from the end for which they are ordered.

[VI.] The **prior part** of the conclusion, which is affirmative, is proved from the admirable symmetry of the partial motions among themselves, as far as it was permitted to detect by observation through so many ages; for they have such fixed laws that the Artificers [astronomers] have been able hitherto to reduce the motions of the Planets into Ephemerides, and to predict them long beforehand without an error which would be notable in most kinds of motions, or which could exclude Astronomy from the number of the practical sciences or arts—especially in these later ages.

[…continues on p. 265 (PDF 300): "…For not for this reason do they lack fixed laws, that in predicting the Eclipses of the Moon and Sun there is still a tiny error; for, for this Art — in things so abstruse and so far removed from our regions — it suffices if such motions and aspects of the stars as the Astronomers predict from the Astronomical hypotheses and tables come to pass as nearly as possible [to the truth]…"]

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*(printed p. 265 — completing **[VI.]**, the affirmative part of the Second Conclusion: the planets do not lack fixed laws merely because eclipse predictions retain a tiny error, for in matters so abstruse it suffices that predictions come to pass nearly and for the most part, safely enough for human uses. Hence the art is far more perfect in the minds of the presiding Intelligences, and the rules of these motions more certain in nature than with us.)*

[Margin: Plato's opinion.]

[VII.] But the assertion of the same prior part [of the conclusion] is confirmed from this: that not only the Writers of the true Religion, but the Gentiles too, from the order of the celestial motions, and the admirable harmony [*concentus*] by which, at fixed times, that inequality and discord of the motions is reduced to concord, rose up to acknowledge the Divinity of the Godhead, and the Providence of God, and to extol [it] with mild—but never sufficiently worthy—praises. So Plato in the *Timaeus* said: "But to us it is to be asserted, for this reason especially, that God begot eyes—that, having beheld the circuits of mind which are accomplished in the heavens, we might apply [them] to the use of our [own] mind, and might recall the discoursings of our knowledge (akin to those [celestial circuits], but in a way perturbed) to the temper [evenness] of those [celestial ones]. And when we have recognized them, and—endowed with right reason

according to nature—have perceived the order of the individual [motions], let us imitate the conversions [revolutions] of God, which are carried on without any error, and compose the vague and erratic discoursings of our thought after the example of the gods." He calls the moving Intelligences of the heavens "gods"; and their motions he calls "conversions of God himself," inasmuch as [they were] first instituted by him and ordered with the highest harmony.

[Margin: The opinion of Plutarch, and again of Plato.]

But more clearly does Plutarch propose Plato's opinion (bk. 1 *On the Opinions of the Philosophers*, ch. 6), where, when he had said of mortals in general: "But they had a notion of God taken first from the beauty of the things which are beheld; for nothing beautiful is made rashly or by chance, but it is made by the use of a certain art that sets [things] in harmony; and that the world is beautiful is plain from [its] form, color, magnitude, and the variety of the stars surrounding the world"—he subjoined, after the mind of Plato (whom he there praises): "And those things which are conspicuous in [the heaven] complete the beauty of the heaven; for the oblique circle [the Zodiac] is distinguished with various images." And, the signs of the Zodiac being enumerated, he concludes: "Innumerable others of this kind the same God scattered through the convexities of the heaven; whence Euripides says: the starry splendor of the heaven—*Chronos* [Time], honorably distinguished, the work of a skilled craftsman. Truly, we have hence greatly taken a knowledge of God; for with a perpetual tenor the Sun, Moon, and the rest of the stars, having sunk beneath the earth, come up again of one [same] color, and besides of equal magnitude, from the same places, and at exactly the same time." Excellent, but more prolix, are the [things] which Cicero (bk. 2, *On the Nature of the Gods*) declares to this argument.

[Margin: Seneca's opinion.]

And so let us hear Seneca, beginning thus the very first chapter *On Providence*: "You asked me, Lucilius, why, if the world is governed by providence, many evils happen to good men. This we would more conveniently prove in the context of the work, when we should prove that providence presides over all things, and that God is concerned with us." And presently he premises this as a most well-known argument: "It is superfluous, at present, to show that so great a work does not stand without some guardian, and that this fixed coursing of the stars is not [the work] of a chance impulse; that this unoffended [smooth] velocity proceeds by the command of an eternal law; that [the heaven]—bearing so many things on land and sea, so many of the brightest lights, and shining in such a disposition—[that] this order is not [the order] of erratic matter, nor do the [things] which have come together by chance hang together by so great an art." But nothing more magnificent could be said than was said in Psalm 18 [19]: "The heavens declare the glory of God, etc."—where Lorinus our [Jesuit] is especially to be seen; and in Job 38, by God himself: "Dost thou know the order of heaven, and wilt thou set down its reason on the earth?" and a little below: "Who shall declare the reason of the heavens, and who shall make the harmony [*concentus*] of heaven to sleep [be silent]?"—where Pineda [is to be consulted]. And so not undeservedly does St. John Chrysostom (homily 10 to the people) call the heaven βιβλ■ον μ■γιστον κα■ ■δι■ταις κα■ σοφο■ς—a greatest book, open to the unlearned and to the wise. And Minucius Felix (in the *Octavius*) says: "You see the heaven itself: now you will know how great is, in it, the wondrous and divine balancing [*libratio*] of the supreme governor." But more about this book written in golden letters, see in St. Basil (*Hexaemeron*, homily 11) and Nicephorus (bk. 11 of the *Ecclesiastical History*, ch. 43).

[Margin: 1st argument for the 2nd part of the conclusion.]

[VIII.] The posterior [latter] part of the Conclusion is shown thus. **First**: although inequality without any order, rule, and rhythm is a certain imperfection, yet an inequality [that is] ordered, regular, and having rhythms and recurrences of the motions at fixed times, is a great perfection, and has far greater beauty than simple equality; therefore this rather befits the celestial motions—or at least this too ought to have been in the heaven, and not equality only—so that in the fixed stars indeed (which most imitate the prime mobile), as

to the motion of longitude there would be no inequality, nor as to latitude from the Ecliptic, nor as to their distance among themselves or from the center of the World, but there would be only some variation (yet very slow) in the motion of declination. On the contrary, in the Moon (which is nearest the earth, and closest to the sphere of changeable things) there would be the greatest inequality. But in the Sun there would be only a middling inequality—namely in the motion of longitude, altitude, and declination—but not in the motion of latitude (since it is without latitude), nor in the motion of libration about its axis, nor that variation or second anomaly which is in the Moon and the other Planets; among which the two nearer to the Fixed [stars], Saturn and Jupiter, have obtained a smaller inequality than those which are below the Sun and become nearer to the Moon; and of these very [latter ones], which are more tightly bound to the Sun and do not depart from it by a whole semicircle, Mercury and Venus have obtained a smaller inequality than Mars.

The antecedent [of this argument] is manifest by an induction made from all the most beautiful things, whether they come about by nature or by art. For as to nature, neither the bodies of animals, nor the branches, foliage, leaves, [and] flowers of plants, keep an equality of members or of parts—whether in figure, or in quantity, or in color—but [keep] only a symmetry, and a consent [agreement] of unequal parts, with incredible variety. Nor are all fruits—nay, scarcely any—spherical or cubic, nor do they affect the mathematical beauty of any regular figure; and scarcely among minerals [fossils] would you find one or two which have a regular figure from nature. The spaces of the lands—and, as it were, the plots [beds] of this great garden—and the spaces of the seas within them: did God, from the beginning of the world, force [them] within the limits of a circular, or quadrangular, or triangular figure? By no means indeed. But as to artifacts, although the beauty of some requires a certain equality in figures or motions, yet the greater part requires inequality and disparity, measured out by fixed rules. This is to be seen in Architecture, in Sculpture, and Painting, and the like; this in the liberal arts; this, finally, in every kind of Music—which makes for our matter—shines forth especially: for if you should try to reduce its motions and sounds to equality, or to deduce their laws from the equality of the parts (as if [the parts] regarded that [equality] primarily *per se*), [take care] lest you snatch from them all the sweetness of the harmonies, and destroy the soul of harmony. For what is wont to be tolerated as more unpleasant, and with greater tedium, than monotony and uniformity in singing and in modulation? Or what [is] more inelegant than if dancers to the beat [number], or [those] striking the cithara, primarily *per se* aimed to describe a circle, or some figure, with equal motions?

[Margin: 2nd argument, from the figures of the stars, the aspect [phases] of the Moon and Planets, and the spots of the Sun.]

[IX.] Secondly: if to a celestial body—because it is supposed to be simple—there were due, *per se*, an equality of motions and a most simple uniformity, then to it also would be due a beauty of regular figures in the disposition of the Stars, and a most exactly spherical figure of the Planets without any roughnesses, and a most shining splendor and brightness without any spots, and finally a perpetual light without any vicissitude of obscuration. But we discern the opposite—as many of us as look up at the heaven, whether with naked eyes or armed with a Telescope: for the configurations of the Stars are so far removed from regular figures that, if you except one or two triangles (and that not equilateral but Isosceles), the other stars might seem to be sown by chance and at random through the fields of the heaven, and very many [are] to be numbered among the σπορ■δες [*sporades*, the "scattered" stars] and the ■μορφοι [*amorphoi*, the "shapeless" / unformed stars]—unless this incredible variety had at length become patent, to those contemplating these [things] deeply, [as] serving in a wonderful manner Agriculture, Navigation, Medicine, [and] Astronomy itself. The roughnesses in the globe of the Moon, and either the roughnesses or the spots in the face of the Sun, in the bands of Jupiter, and in the boss [*umbo*] of Mars, and finally the Eclipses of the satellites of Jupiter, and the overshadowings of Saturn by its attendants [the lateral bodies]—now in our age—

[…continues on p. 266 (PDF 301): "…the Tube-glass [telescope] has revealed [these things], not a fiction of Prometheus's wand, but a most true experiment of the Tube-glass; and yet from these very [things], no otherwise than from the Eclipses of the Moon and Sun, there arises a greater elegance and beauty than if all things had

been disposed in the heaven in a simple and uniform manner. [X] Thirdly: the End to which the celestial motions are ordered requires in them some inequality (yet regulable and ordered)…"]

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*(printed p. 266 — completing **[IX.]**, the second argument, on the telescopic evidence: what the telescope has revealed in our age is no fiction but a most true experiment; and from these very irregularities, no otherwise than from the Eclipses of the Moon and Sun, there arises a greater elegance and beauty than if all things in the heaven had been disposed in a simple and uniform manner.)*

[Margin: 3rd argument, from the End.]

[X.] Thirdly: the End, to which the celestial motions are ordered, requires in them some inequality—yet regulable and ordered—namely, the diversity of effects in sublunary [things], and the incredible variety of influxes, and of changes to be effected for the sake of living and animate [beings], but especially for the sake of man, who from it [this variety] was going to obtain far more goods, and far more abundant matter for praising and loving his Creator, who is the End of all. And so, that for this variety the inequality which I have spoken of is a more apt means than mere equality, is too manifest to need proof.

[Margin: The heaven and the Stars were made for the sake of men.]

But that the heaven, and [whatever is] sensible, and whatever stars shine for us in it, were created for the sake of men—[this is so], whether the Epicureans will or no, and certain Copernicans (who [would have] the Earth rather [go] around the Sun than the Sun and all the stars around us, and around the immobile Earth as a center, act—will, I say, or no, it is true). For not only does Aristotle say (2 *Physics*, text 23), "for we too are in a manner the end of all things"; and (1 *Politics*, ch. 5) "that nature made all things for the sake of men"; and Cicero (1 *On the Laws*). But the infallible authority, divine Scripture, by this most valid argument, tries to deter men from [giving] divine worship to the stars; Deuteronomy 4 says: "Lest perhaps, [thy] eyes being lifted up to heaven, thou see the Sun and Moon, and all the stars of heaven, and, deceived by error, adore them, and worship the things which the Lord thy God created for the service of all the nations that are under heaven." For what is more foolish than that, by a man (to whom the supreme Lord has granted a certain useful dominion over the visible creatures), worship and adoration should be displayed to His ministers and handmaids? For God, as is held in Genesis 1, placed the stars in the firmament of heaven not that they might shine for themselves mutually, [or for] the heaven [alone], but "That they might shine upon the earth"; where Lippomanus rightly [says], in the *Catena*: "But if for this reason they were placed by God—that they might illuminate the earth—then not [were they placed] that they might lord it over man; for [God] is the Lord, who created them for the use of men." Likewise the sacred interpreters can be heard on that [text] of Psalm 8, where, when David had said, "For I will behold thy heavens, the works of thy fingers, the Moon and the stars which thou hast founded," at once, astonished that God has subjected these too to man, he exclaimed: "What is man, that thou art mindful of him, or the son of man, that thou visitest him? etc. And thou hast set him over [all] the works of thy hands." Which [words], although they must be understood especially of Christ—at least in the mystical sense, to whom it more properly belongs to be "the son of man," that is, of the Virgin Mary alone (since the others are sons either of no man, like Adam and Eve, or of two men; and so St. Paul understood [it])—yet, to the letter, not a few Fathers teach that [it] can be taken of any man whatever (as is to be seen in John Lorinus on that Psalm); and some [teach] that the former part, "What is man?", pertains to every man, and the latter, "or the son of man," peculiarly to Christ. And certainly to men pertains that [text] of the Apostle (1 Corinthians 3): "All things are yours, whether the world, or life, or death, whether things present or things to come."

[Margin: St. Chrysostom's opinion.]

But that those who deny the stars to have been made for our sake favor the error of the Gentiles, I gather from St. John Chrysostom (homily 6 on Genesis), saying: "For let us teach those preoccupied with the Gentile [error], with all gentleness, lest they confound the order, and—the Creator being abandoned—adore

the creatures which were made for our salvation and utility; and if what we teach displeases the Gentiles, do thou nevertheless cry out with a clear voice that for the sake of the human race all these were made; for the Maker had need of none of these things for himself, but, that he might show toward us his indulgence and benignity, he produced all these—showing with how great honor he attends the human race, and that, led by the hand by these [things], we might ascend to an adoration befitting him." But here this golden Doctor was explaining the Work of the fourth day, and the formation of the Luminaries and stars.

[Margin: Lactantius's opinion.]

But Lactantius too (the book *On the Wrath of God*, ch. 13 and 14) [teaches] that the heaven was made for our sake; just as St. [Gregory of] Nyssa too (the book *On the Formation of Man*, ch. 1 and 2) teaches; and (bk. 7 of the *Divine Institutes*, ch. 3 and 4) he [Lactantius] inveighs not only against the Epicureans, denying that the world was made for our sake, but also against the Platonists, who indeed asserted the Providence of God, [but] did not expressly teach that the World was made for our sake—which, however, the Stoics taught: "It was necessary, therefore," he says, "for Plato too, and those who thought the same, to teach and explain what cause, what reason, there was for fabricating so great a work—why, or for whose sake, he made this. But the same Stoics say [that] the world was made for the sake of men." And a little after, against Plato (who asserted the future eternity of the world), he argues against this [view]: "If for the sake of men the world was made, and so made that it should be eternal, why then are they, for whose sake it was made, not everlasting? If [they are] mortal, for whose sake it was made, then it too [is] mortal and dissoluble; for it is not of more [worth] than those for whose sake it was made. And again: But whoever denies that it was made for the sake of men—he holds no reason [account]; for if he says that the Maker himself wrought these so great works for his own sake—why, then, were we born? why do we enjoy the world itself? why do we intercept goods belonging to another? etc. Doubtless God willed to be seen [to appear], and to fashion, by his various images (as it were, seals), with which he might delight himself; and nevertheless, if it were so, he would have care of living beings, and especially of man, to whose command [empire] he subjected all things." But as to what the same Lactantius says (ch. 4), "The world, therefore, [was made] by God not indeed for his own sake—for he needs neither the heat of the Sun nor [its] light, etc.; and all these things which are in the heaven, and which are generated, God himself does not use"—[this] must be corrected; for indeed, "The Lord has wrought all things for his own sake," as is said in Proverbs 16. And so Fromondus, in his *Vesta*, rightly teaches from Tertullian that "both the stars and the elements serve [are subservient to] man"; and John Baptist Morin, against Lansberge, observes that it was fitting for God to regard the utility of men, and not only the facility or shortcut [economy] of nature in these motions; and Fr. Nicholas Zucchi (in the new Philosophy *On Machines*, part 5, sect. 11) is angry against those who strive to suppress this truth, Scripture and the disposition of the whole universe resisting. Nor let it seem to anyone too much, that such vast and sublime bodies were made for the sake of men: for since they were made that the contemplating creature might thence acknowledge and adore the Creator—and [since] the Angel, being himself without senses, would not need the beauty of the sensible world for that—it remains that all these sensible things were made only for the sake of men; but man himself, and all things, for the sake of God.

[Margin: Andreas of Jerusalem.]

Wherefore, significantly, Andreas of Jerusalem said (in the sermon *On the Angelic Salutation*) that man is [the one] for whose sake God o■ραν■ν [■δημιο■ργησε] [created the heaven], etc.—that is, established the heaven, made firm the earth, spread out the air, widened the seas, and finally made the whole [mass and fabric] which is subjected to the eyes [a thing] to be looked up to.

[Margin: St. Augustine. — Arnobius.]

And therefore elsewhere he calls man μ■γα τ■ς ■ργασ■ας κατ■ρθωμα—namely, a vast specimen [masterpiece] of the divine operation; and by St. Augustine (sermon 225 *On the Season*) it is said: "Man, the dear and friendly possession of God; man, for whose sake the heaven was made firm." Nor say that it seems

unfitting that this greatest World, and the immense mass of the heavens, was made for the sake of a three-cubit little manikin: for although man was called by the pagan Philosophers μικρ■ς κ■σμος [*mikros kosmos*, a little world], and is smaller in mass than the heaven, yet in the perfection of [his] nature and in rational nobility he is more august and greater—which Arnobius indeed touched on (bk. 2 *Against the Gentiles*), in these words: "This is that precious [being], the man endowed with most august faculties, who is called a lesser world, and is wholly fashioned into the species of [God's] likeness."

[Margin: Hermias. — St. Gregory Nazianzen.]

Nay, from Protagoras's opinion, Hermias (in [his] *Mockery of the Gentiles*) called man ■ρος κα■ κρ■σις τ■ν πραγμ■των—the boundary [terminus] of things, [their] judgment and norm; but expressly St. Gregory Nazianzen (oration 38) denied that man is a μικρ■ς κ■σμος (a little world), and rather called him μ■γας κ■σμος ■ν μικρ■—a Great world in a small [compass]. But to whom would it seem wonderful or incredible that the heaven and stars were made for the sake of men—if the Son of God (as the Church professes in the Creed), stooping under the burden of [his] immense benefit, sings: "Who for us men, and for our salvation, etc."; and in that sweetest hymn: "Given to us, born to us"?

[Margin: Synesius. — St. Ambrose.]

And so cleverly Synesius (Epistle 57) [says] of man: "τ■μιον ζ■ον ■ ■νθρωπος," etc.—man is a precious animal, if for his sake Christ was lifted up on the cross. And on Psalm 118 [119] St. Ambrose calls him "the Precious work of God"; and in the book *On the Good of Death*: "The whole world is a small [thing] for the loss [expenditure] of one soul." Finally St. Gregory of Nyssa (homily 4 on Ecclesiastes) affirms that not even the whole world is ■ξιον τ■ς ψυχ■ς ■ντ■λλαγμα—a worthy price [exchange] for the soul.

[…continues on p. 267 (PDF 302): "Let Lucretius, then, be gone — [Lucretius] of Epicurus's herd, wont to grunt rather than to sing — when he dares to say: 'To say, moreover, that [the gods] willed to prepare, for the sake of men, the splendid nature of the world, etc., is to dote; for what [profit is it] to the immortal and blessed [gods]…' " — then Riccioli turns to the remaining proofs/objections of Chapter IV.]

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*(printed p. 267 — completing **[X.]**, the argument from the End: the argument closes with a dismissal of Lucretius, of Epicurus's herd and wont to grunt rather than sing, before quoting the verses he dares to utter.)*

"To say, moreover, that [the gods] willed to prepare, for the sake of men,

the splendid nature of the world, etc.,

is to dote [be foolish]; for what [reason is there] that the immortal and blessed [gods]

should undertake to do anything for our sake?"

I recognize, indeed, that there will be [those] who now think me to be wandering outside [the subject], and to be playing the preacher or the ecclesiast rather than the Astronomer; but they will now have to consider, from what has been indicated, that these darts are directed by us against two kinds of enemies. One is [the kind] of those who, attributing to the Earth the annual motion, will not have it to be the center of the celestial motions, nor [will they have] the stars [to be ordered] for the sake of the living beings placed on it—nor even for the sake of man—in such a way that the earth and man do not also, together with it, as a Planet's inhabitant, revolve around another, more principal, body in the world; and for this cause they make light of this doctrine of the Heaven and World made for man's sake. The other kind is [that] of those who, too much addicted to the equality of the motions, when they see them to be unequal with respect to the earth (or the center of the world, from which they are regarded by us), deny that their motions are *per se* ordered to this center, or for our sake.

[Margin: A compendium of the third argument, and [its] double force.]

Against these, therefore, we hurl this twin argument—but set forth more loosely—thus gathered, as it were, into a throwing-strap for [casting] in few [words]: "The motion of the heavens and stars, with respect to the men observing [it], is unequal; but the motion of the stars *per se*—that is, from its primary end and the chief institution of God—is unequal; therefore it is *per se*, and not only *per accidens*, unequal." And again: "The motion of the heavens and stars, in order to the variety of effects which the sublunary [things]—for man's sake—and man himself especially, were to enjoy, had to be unequal; but the same motion *per se* is ordered to the variety of these effects, and especially for man's sake; therefore this motion *per se* had to be unequal."

[Margin: 4th argument, from the order of the parts to the whole.]

[XI.] Fourth: It is admitted among the Astronomers (the defenders of the equality of motions) that, if the whole composite motion of the Planets be regarded, it is unequal—inasmuch as accomplished through diverse circles described from diverse centers; but [they hold] that, if the motions of the individual circles be regarded separately and singly—say, the motion of the center of the Epicycle in the Eccentric, and the motion of the body of the Planet in the Epicycle—they are simple and equal about their proper centers. Now I argue thus: The motion of the parts is not for the sake of the parts themselves, nor *per se* in comparison to the whole; but *per se* it is for the sake of the whole; or at least, comparing parts and whole, that which is had *per se* [as primary] is rather the whole itself, as the end and [as] a perfect thing. But the whole motion, arising from these partial motions, is unequal, granted that the partial [motions] are equal. Therefore the motion of the Planets is *per se* unequal.

[Margin: 5th argument.]

[XII.] Fifth: If the motion of the stars were *per se* equal—inasmuch as regarded in order to [its] proper center—it would be necessary that it had been ordered by God to that center, as to some good and [something] more excellent than the movable [body] itself. For if you say that equality befits them for the sake of themselves, not for the sake of the center—this is what is in dispute, and ought not to be assumed as conceded; nay, rather, they [the stars] are of themselves indifferent to motion around this or another point of the universe. Wherefore, if in their motion they *per se* depend on one point, which is the center of their circle, then surely [they depend] on it—either as an end, or as an efficient and influent [cause]—and acquire perfection [from it]. But neither the center of the Eccentric nor the center of the Epicycle has any dignity in the universe, nor any force for influencing the stars (unless someone gratuitously and rashly fabricate it), but they are unstable points in the universe, and of no quantity, not to say excellence. Incongruously, therefore, is the quality of the motion of the heavens estimated from [its] order to points of this kind; and so equality *per se*, founded on these, has an unstable foundation, and [one] of no moment.

[Margin: 6th argument, from the situation of the observers and from the senses.]

[XIII.] Sixth: If the apparent or optical inequality is *per accidens*—because our eye is now outside the center of the circle through which the Planet is moved, and no eye is in the center of the Eccentric or Epicycle, whence it could regard the motion such as it is *per se*, and as it ought to be regarded—then that perfection [the *per se* equality] lacks a spectator, and only the imperfection (that is, what is *per accidens*) has had a spectator; but this seems to derogate from the divine omnipotence. But if you say that God gave to man not only the eyes of the body, but also [the eyes] of the mind, that by reason he might gather, from the inequality of the apparent motion, the theory of a motion *per se* equal—on the contrary [I say it is so], because the presumption [possession], in this judgment, stands for the senses; and unless from elsewhere the intellect be evidently or certainly bound to correct the judgment which, relying on the senses, it made about these motions, it must pronounce for the senses, and estimate these motions to be such as it is established they have been detected to be by the constant experiment of the observations through all the ages—namely, unequal. Granted that, for the ease of calculation (on account of our weakness), we may feign mean and equal motions, and use, for declaring them, perfect circles—that is, circular motions made equally about their proper centers—yet this equality (or rather, this fiction of equality) holds *per accidens* in this art; therefore

the inequality [holds] *per se*.

[Margin: 7th argument, from rectilinear motion.]

[XIV.] Seventh: Some celestial motions are made through straight lines, or chords of circles, according to Copernicus, Maginus, Longomontanus, [and] Lansberge—as are certain librations; and yet, in order to safeguard equality, they take a law from a circle, and those motions are feigned [as] made in a circle, when nevertheless they are not [so]; therefore, if the path itself, through which they are really accomplished, be regarded, those motions are *per se* unequal. And the same argument holds of the motion made through an elliptical circumference, according to Kepler and Bullialdus; for the Planets really, as these two Astronomers will have it, are carried through the circumference of the Ellipse unequally—granted that Bullialdus adds [that], through any two extremes of the ordinates in the Ellipse, circles can be drawn, and from them some ratio of equality be taken: for the Planet does not proceed through those circles. Then [also], it is one thing to be moved *per se* equally—which we deny to the stars—and another [thing] to take, from an external circle, laws not of equality, but of a motion [proceeding] by some regular increment or decrement (which could be conceded): as if a movable be carried through a straight line, but with that variety which the sines, or secants, or tangents, require, according to an equal number of degrees taken in an equal time. But hence it would rather follow that that inequality is *per se* intended; because, for the sake of preserving it—but [preserving it] with some rule—a feigned motion, equal, through a circle, is assumed from without. Just as, if for describing an Ellipse or Parabola an instrument were made which—turned about in some part of itself through a circle—would be apt for describing an Ellipse or Parabola, surely the Ellipse and Parabola would be intended *per se* as the end, and the motion through the circle as the means. So too, [though] the Harmost [tuning-master], or chief-Musician, by equal elevations and depressions of the hand, in equal time, measures out the tempi for the singers, yet *per se* he intends that they—according to the musical notes—raise and lower, lift up and depress, hasten or retard [the voice], and *per se* regards the inequality of the harmony, not the equality of the beat.

[Margin: 8th argument, from the motion of the Fixed [stars].]

[XV.] Eighth: The motion of declination of the Fixed [stars], and the variation of the right ascensions, is unequal, nor is it varied equally in an equal time, as is known from the Problems of the prime Mobile; and yet it is such [unequal] in order to [its] proper center, and follows necessarily from the equal motion of longitude; nor can it be said, with foundation, that this [declination motion] is *per accidens* intended, but the motion of longitude *per se*. As, therefore, this motion is *per se* unequal, so can others be in the heaven.

[Margin: 9th argument, from reconciling the Planets' motion with the Prime Mobile.]

[XVI.] Ninth: There is no better and simpler reason for reconciling the proper motion of the Planets with the motion of the Prime Mobile than through spirals and helices, as we taught in ch. 3. But the Planets are not ordered to a single center; rather, they are screw-wise [*cochleatim*] loosened and restrained, raised and cast down in various ways. Therefore that equality, taken from perfect circles, is not *per se* intended by Nature and God.

[Margin: An objection is dissolved.]

[XVII.] Furthermore, the adversaries asserting that it is an Axiom long since received in the Schools of Physics and Astronomy—that of a simple body (such as is any celestial body) the motion too must be simple, that is, equal—it would be answered that this is true of the motion of the Prime Mobile, or [true] indeed of the motion of the Secondary mobiles, if equality be taken as it is opposed to irregularity and randomness, that is, to the disorder of the motions. Otherwise [if it means uniform speed], it is denied to be an axiom; or at least it is conceded, but [only] of a body which is simple not only in its being, but also in the character of [its] cause, or in its effects—in neither of which ways are the heaven or the stars simple. Furthermore, Aristotle's reasons are merely topical [dialectical], nor do they contain an adequate cause of the inequality in the motion;

for that [inequality] can arise from elsewhere than from the end, and the terminus in which the movable seeks to rest, or—

[…continues on p. 268 (PDF 303): "…than from the impotence of the mover, or from the resistance of the subject which is moved, as is plain." — and so Chapter IV ends; then CHAPTER V opens (whether the Intelligences geometrize or calculate).]

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*(printed p. 268 — completing **[XVII.]**, the close of Chapter IV: the page opens mid-sentence, concluding that the inequality of celestial motions can arise from causes other than the impotence of the mover or the resistance of the subject moved.)*

CHAPTER V

Whether the Moving Intelligences of the Heaven and Stars *per se* intend the description of some Geometrical Figure, or depend on it as on a Rule; or whether rather they accomplish the motions by the numbers of Logistic [calculation] alone; and whether the same [thing] must be attempted by men in the exposition of these motions

[Margin: Peter Ramus's opinion about Astronomical hypotheses.]

[I.] The occasion of this controversy was given us by Peter Ramus; about whose opinion it is better to hear Tycho, writing and judging thus in [his] Epistle to Rothmann (of the year 1587, on the 20th day of January): "But that that most celebrated Philosopher of our age, Peter Ramus, thought that Astronomy could stand without Hypotheses, by Logical reasons, lacks foundation. He proposed indeed to me, 16 years ago, when we were together at Augsburg, this opinion; and was at the same time an exhorter [urging] that, after I had reduced the course of the stars into exact order through Hypotheses, I should aim to attempt the same without these. For he wished this to be done"—he says, and added the reason, that he had read that the Egyptians of old had a most easy knowledge of Astronomy; "and, since the method of Hypotheses seems difficult and intricate," [he reasoned] that they must have known the courses of the stars by another, more compendious and plainer way—that is, without all hypotheses. Thus he [says], p. 60; to which I subjoined my judgment and censure in these words:

[Margin: Tycho's censure of P. Ramus.]

"But I resisted him, showing that, without Hypotheses, the celestial phenomena cannot be reduced into a certain science, nor be accounted for so as to be understood; but that that Egyptian 'easiness' existed only in the Equatories [the planetary-position instruments] of the Planets, by which they freed themselves from tedious computation, when the ready method of Ephemerides was not yet in use. But although this man, otherwise endowed with a perspicacious genius, and a lover of truth if any [other] was, seemed to me not to have thoroughly inspected the inner sanctuaries [*penetralia*] of this art, and not to have noticed the variety in the motion of the stars, by no means recurring at fixed times of the year—I could neither obtain anything from him in this part, nor [did I] wish [to]. He has still very many followers, who hope that the same can be done; but who do not understand the matter itself, nor will ever bring [it] into effect. For since all things consist of number, weight, and measure, by these too [nothing] can be explained [otherwise] in the invisible world. But Hypotheses show nothing other than the measure of the apparent motion through a circle and other figures, which Arithmetic resolves into numbers: without these, if anyone wish to comprehend the motion of the Stars, let him invoke fortune (as it is wont to be said), and imagine a supramundane reason, beyond human intellect, and plainly incorporeal, and more than Angelic—[which] is necessary." Thus far Tycho against Peter Ramus.

[Margin: Patrizi's opinion, and Kepler's censure.]

And not dissimilar [things are said] against Francesco Patrizi by Kepler (in the commentary on the motion of Mars, ch. 1), where, when he had indicated the ancients' observation about the double motion in the heaven, he subjoined: "This first adumbration [sketch] of Astronomy—which stands by no explanation of a cause, but only by the slow experience of the eyes, and which can be explained neither by figures nor by numbers, nor be drawn out [predicted] into future times, since it perpetually disagrees with itself (so that no spiral is equal to another by a delay of time, [and] none passes into a neighboring [spiral] by a bending of the same quantity)—this [adumbration], I say, some nevertheless today, the labors of these thousand years being trampled under foot, strive to restore by diligence, erudition, [and] science, forcing upon the crowd an admiration of themselves (by an effort not unsuccessful among the unskilled); whom the more skilled judge—rightly and deservedly—to play the fool, or (if the Philosophers will [have it] otherwise, like that Patrizi) to be mad with method [reason]."

To these is added that God is said (Wisdom 11) to have disposed all things "in measure, and in number, and weight," and by Plato [is said] "always to Geometrize" [θε■ς ■ε■ γεωμετρε■, *God always geometrizes*]; and, finally, [that] if it can be done that the Phenomena of the celestial motions be represented by some figure having the beauty of a Geometrical figure, this would be better than to set forth those motions without this appearance.

[Margin: A defense of Ramus and Patrizi.]

[II.] Yet for the opinion of Ramus and Patrizi there occur reasons not to be despised. For, **first**: out of so many Geometrical figures which the Astronomers have hitherto tried to accommodate to the celestial motions—whatever they boast, and especially Lansberge—none yet plainly satisfies all the legitimately-observed phenomena of [even] one Planet; nay, every year some discrepancies are detected, both in Eclipses and in the other vicissitudes of such motions; and this, not a few refer rather to the hypotheses [being] contrived, than to a defect of the observations. But what has not been done through these hypotheses, scarcely seems able to be done in the future through others; since all the combinations of Eccentrics, Epicycles, and Concentrics, and all forms of hypotheses through circles or ellipses, seem [already] to have been tried (as is plain from what was said in bk. 7, sect. 2 and 3); but the multiplication of little circles is liable to several errors, the more it has been complicated from several differences of motions.

[Margin: 2nd reason.]

Secondly: that necessity of a Geometrical hypothesis seems to have arisen rather from our own weakness or habit, than from the nature of such motions. For because, from adolescence onward, we have been versed in the mathematical dust [trained in geometry], and can ill do without the apparatus of Geometrical demonstrations—or, without it, can only with difficulty imagine the causes and rules of the celestial motions—therefore we seem to need these for understanding and thoroughly teaching their Theory; especially since we do not have all and singular the observations which would manifest to us one whole period, explored day by day through its parts, and exhibit its constant law; and therefore the remaining equations for the calculation of the mean motions (which we ourselves feigned for an easier use of calculation) we are in a manner forced to hunt out, from the necessity of some Geometrical figure, by whose laws the Planets may be bound. And hence, doubtless, it seems to be, that we never attain the subtlety of Astronomical truth; for we hunt the path of the Planets by a way feigned by us. But if we had sufficient observations, held on each [single] day, we could perhaps render the account of these motions without the laws of Geometry, and by purely Logistic [arithmetical] laws—that is, by very recondite ratios and proportions of numbers.

[Margin: 3rd reason.]

Thirdly: the motions of the stars are most probably accomplished through spirals, as we already said in ch. 3; and [they] are *per se* unequal, as we taught in ch. 4; but these two conditions do not seem easily to cohere with the termini of any Geometrical figure, but rather to connote the motions of the Planets [as] loosed from them, and bound by other laws outside the jurisdiction of Geometry.

[Margin: 4th reason.]

Fourthly: it pertains to the dignity of the Intelligences moving the heavens and stars, that in these [motions] they follow rather the ideas of numbers (which abstract from sensible and imaginable matter) than [the ideas] of continuous quantity (which does not abstract from it); nor [that] they need, for directing those motions, the contemplation of circles, or ellipses, or similar figures. And if perchance they designate any figures in the heaven by those motions, [these are something] posterior, and a consequent effect, but not an exemplary cause or idea of which they have need. Just as neither to singers, nor to cithara-players, nor to dancers to the beat, are there set forth, for imitating, figures of the various motions which they certainly designate by tongue, hand, or feet—like a footprint passing [vanishing] in the air.

[Margin: 5th reason.]

Fifthly: just as the proportions of the motions, by which various pendulums are agitated to and fro, together with their intervals, follow the ratio of the odd numbers taken in order—so that the heights [amplitudes] of any two pendulums are to one another as the squares of the times; and [just as] the increments of velocity in the natural motion of heavy bodies keep a similar proportion (as we taught in bk. 2, ch. 20 and 21)—nor in these is the law of any figure attended to: so it seems probable that similar, or more sublime, reasons are in the minds of the Intelligences, by which they infallibly carry the stars around, and present them in their places at the fixed time, without the aid of any figure.

[Margin: Conclusion.]

[III.] Let us conclude, therefore, that Geometrical figures are indeed to be used, as long as nothing better and more certain occurs; but that they are not to be vended [touted] as the true causes of the anomaly of the celestial motions, nor [is one] to pass, from the name "Hypothesis," to a real necess—

[…continues on p. 269 (PDF 304): "…ity of such a figure. Yet meanwhile [it is] probable [that] what was said at num. 2 [is true] — namely, that the Intelligences use merely logistic [arithmetical] reasons for the harmony of these motions, without the contemplation of a figure directing them, or [a figure] set before them, by primary intention, for imitating…"]

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*(printed p. 269 — completing **[III.]**, the Conclusion of Chapter V: one may not pass from the name "Hypothesis" to a real necessity of geometrical figure in the celestial motions; probably the Intelligences use merely logistic, arithmetical reasons, though they may also represent the beauty of some figure fitted to the spiral motion. Whatever geometry or harmony be feigned must agree with the phenomena and with the end divine Providence set for these motions, as the analogy of the human body's organs shows; and it is not yet established that such figures repugn that end.)*

CHAPTER VI

Whether the Proportions of the celestial motions are knowable by us in this life, and expressible [effable]; and whether [they are] all rational, or rather some irrational; where [we treat] of the Revolutions of them all into the same [point]

[Margin: Plato's opinion.]

[I.] What Plato thought in this matter will become manifest from his *Epinomis*; for there he calls those who were occupied about the mere observations of risings and settings, and the prognostics to be deduced therefrom, το■ς ■στρονομο■ντας [the "star-gazers"]; but he calls ■στρον■μους [Astronomers] those who investigate the celestial motions themselves; and he says: "You are ignorant of Astronomy; because he who is truly an Astronomer must be the wisest—I do not mean him who practices Astronomy according to Hesiod and all like him, inasmuch as he contemplates the risings and settings of the stars, but him who beholds the seven periods of the eight periods, of which each one traverses the same circle in such a way that universal nature is scarcely, scarcely equal to contemplating them, unless it be a partaker of that wonderful nature." But I believe that, by "the seven periods of the eight periods" (for thus the Greek codex has, τ■ν ■κτ■ περι■δων τ■ς ■πτ■ περι■δους), he understands not the simple revolutions of the Fixed [stars] and Planets separately, but the revolutions of all these together to the same point—which they are wont to call the **Platonic Year**, according to that [saying] of Cicero in the *Dream of Scipio*: "But when all the stars shall have returned to that [point] from which they once set out, and shall have brought back the same configuration of the whole heaven after long intervals, then can it truly be called the 'turning year' [*annus vertens*], in which I scarcely dare to say how many ages of men are contained." Of this year, therefore, and of the proportions and commensurations of the celestial periods, no one can perfectly attain—in Plato's opinion—unless he have obtained a celestial and admirable genius. But Aristotle (bk. 1 *On the Parts of Animals*, ch. 5), notwithstanding this difficulty which he confesses to be found, says that even a modest knowledge of these things is more delightful than the [full] science of certain other [things].

[Margin: Delphinus's opinion.]

Nay, John Anthony Delphinus (in the book *On the celestial globes and motions*, ch. 23) contends that no one, while he remains enclosed in the workhouse [*ergastulum*] of this mortality, can naturally have an undoubted science of the proportions and measures which are precisely in the celestial motions—because those proportions consist in an indivisible [point], and the least difference varies them; but [that], on account of the distance of the stars, differences of this kind become insensible in the life of one man, though afterward, by the lapse of ages, they become sensible.

[Margin: Clavius's opinion.]

Our Clavius too, toward the end of the Commentaries on the Sphere of Sacrobosco (speaking of Copernicus's attempt at emending the celestial motions, p. 452), concludes thus: "It is exceedingly difficult so to define the periods of the motions, that they do not deviate from the truth for many ages of years; since no mortal has ever been able so to determine the period of [even] one Planet, that there do not remain over, or be lacking, some tiny amounts which, in a great interval of years, induce a notable error. So that it is indeed wonderful that God, Best and Greatest, willed to obstruct the motions of the planets with such great difficulties, that no one of men can perfectly attain them, but always finds [something] which he may admire in so great an artifice of such noble bodies, and in so great a harmony and concord of their motions—celebrating their Creator and Mover with perpetual praises. So that, especially on account of the constitution of the heavens and their motions—in which there always seems to remain [something] which may be inquired into, with the highest diligence, by the most skilful searchers of celestial things—it seems to have been written by Ecclesiastes (ch. 3): 'And He has delivered the world to their disputation'—lest, namely, at some time, if men had perfectly understood the number, order, constitution, and motion of the heavens, they should cease to inquire into and admire the works of God; and [their] minds, the cause of exercising [them] being removed, should grow torpid in idleness."

[Margin: Job 38.]

[II.] But from the divine Scriptures, and the sacred writers, we have long since learned how arduous this Astronomical business is. For what else does that thunder of the divine voice to Job, from the whirlwind, signify, speaking thus: "Dost thou know the order of heaven, and wilt thou set down its reason on the earth?"

and again, in the same chapter 38: "Who shall declare the reason of the heavens, and who shall make the harmony of heaven to sleep [be silent]?"—That is, if I am not mistaken: who will so perfectly describe and explain the motions of the heavens, that men, now secure about their course, may cease from observing the motions of the stars in the future, and so sleep [be at rest]? For just as the heavens are said to praise the Lord, because they rouse men to the praises of the Lord, and are an object moving [one] to praise Him, so too they would be said to "sleep," if they were so [perfectly] known that they now invited men to sleep.

[Margin: Solomon's knowledge divinely infused.]

But although Solomon proclaimed the wisdom of these things divinely infused into him (Wisdom 7), saying: "For He gave me the true knowledge of the things which are, that I might know the disposition of the globe of the lands, and the powers of the elements, the beginning and end and middle of times, the changes of vicissitudes, and the conversions of the seasons; the courses of the year and the dispositions of the stars"—yet the same [Solomon], in Wisdom 9, considering the merely natural powers of the human genius, thus professes: "And we estimate with difficulty the things which are on earth, and the things which are in [our] view we find out with labor: but the things which are in heaven, who shall investigate?"

[Margin: Philo's opinion.]

And indeed hence the Fathers press [against] the judicial Astrologers, [arguing] that it is impossible to know exactly the course and aspect of the stars—especially Sts. Basil (homily 6 of the *Hexaemeron*), Ambrose (bk. 4 of the *Hexaemeron*, ch. 4), Augustine (bk. 5 *On the City of God*, ch. 3), [and] Gregory (homily 10 on the Gospels); to whom add Origen (in Eusebius, bk. 6 of the *Preparation of the Gospel*, ch. 9), and Philo (in the book *On Dreams*), who, after relating diverse opinions about the stars, concludes: "The [things] which are circulated about them and the heavens are uncertain and incomprehensible, [and] rest on probable conjectures rather than on certain and true reasons—so that it is lawful to swear that no mortal can ever rightly perceive anything of these."

[Margin: Martinengus's opinion.]

[III.] But whether the periods of the celestial motions are commensurable with one another, and consist of rational proportions, or rather of irrational [ones]—Astronomy has not yet so advanced that it is permitted to settle this controversy with certainty; and it will be enough to have indicated the opinions. For, as Ascanius Martinengus says (in the Great Gloss on Genesis, p. 1045): "Certain most learned Mathematicians, by the best reasons, thought that the conversions [revolutions] of the heaven are incommensurable among themselves; and therefore that the same face of the heaven, and position of the stars, can never return; and they strive to affirm this by no weak reasons."

[Margin: John Anthony Delphinus.]

Certain [others] thought that only after thirty-six thousand years—or, according to others, forty-nine thousand, in which the supreme and slowest sphere will complete [its] revolution—the positions of the Stars return to the same. So John Anthony Delphinus (in the book *On the celestial globes and motions*, ch. 24 and 25) problematically defends each side; and adds that from this it is not sufficiently proved the asymmetry [incommensurability] of these mo—

[…continues on p. 270 (PDF 305): "…tions, [merely] because the Astronomers have hitherto disagreed among themselves about the measure of the Solar Year and the Lunations — for this happened on account of the brevity of life, and the unobserved (or badly-observed) returns of these periods; and on account of this, the Astronomical tables must be reformed every two-hundredth year…" — then the Lunisolar-cycle problem (Vieta, Clavius, Bullialdus), and Kepler's case that the period-ratios are irrational and the Platonic Year impossible.]

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*(printed p. 270 — completing **[III.]**, on the commensurability of the periods: astronomers' disagreement over the measure of the Solar year and the lunations does not prove these motions incommensurable, since it*

arose from the brevity of life and defective observations. Yet no luni-solar cycle has been found that exactly restores the Luminaries to the same point of conjunction; even Vieta's 3400-year period falls short, according to Kepler and Clavius.)

[Margin: Bullialdus's opinion.]

Nay, Bullialdus too (bk. 2 of the *Philolaic Astronomy*, ch. 3), when he had said, "But that measure is false; for the motion of the Sun does not depend on the Lunar; nor did the ancients, with happier auspices, make the annual motion of the Sun commensurable with the Lunar synods," a little after says: "For who hitherto has asserted and demonstrated that the annual motion of the Sun is commensurable with the Lunar cycles?" To these, Amicus (tract. 5 *On the Heavens*, q. 6, dub. 10) teaches that these proportions cannot be known; but [also] that, even if they be irrational, there is no imperfection in the heaven, because they are commensurate to the end fixed by God.

[Margin: Kepler's opinion.]

But Kepler, contemplating these things with a deeper effort of mind (in the *Epitome of Copernican Astronomy*, bk. 4, p. 512), distinguished thus: "The ratio, indeed, of the extreme motions—the slowest and the swiftest—contemplated in any one Planet, [being] most exquisitely harmonic, is the supreme and adorable work of the Creative Mind. But the lengths of the periodic times, if they were the work of mind, would have something of beauty, such as the effable [expressible] proportions are—double, triple, and the like. But now the proportions of the periodic times are ineffable (commonly, irrational), and so partakers of infinity, in which there is no mental beauty, because no finition [bound]." And he confirms that these times cannot be the work of mind, in these words: "Secondly, these times cannot be the work of mind, because the times of one period are gathered from unequal delays in diverse parts of the circle; but those unequal delays (as will be said below) arise from material necessity, as it were from the principle of a balance [steelyard]." Thus he [Kepler], wholly bent on showing that the Planets are not moved by Intelligences, but by the Sun, according to the principles of the balance and lever, and magnetic attractions; and the Sun, [moved] by a certain material soul.

[Margin: The Platonic Year [is] impossible, according to Kepler.]

But the same [Kepler], in the *Mysterium Cosmographicum* (ch. 23), investigating the end [purpose] of the Astronomical World and the Platonic Year, concludes in these very words: "That no terminus can be set for the motion rationally, and that there will be no Platonic Year, I will prove from one postulate. For let it be granted that the Eccentricity is to the orb in a rational proportion: then the radii of the orbs will be mutually irrational, because they are related as [figures] inscribed and circumscribed to bodies, which are irrational—because they follow from the ratio of the subtense [chord] in the square, and of the section according to the extreme and mean ratio [the golden section]—which two are examples of irrationals in Geometry. But now the motions are in proportion to the Radii: therefore the motions too [are] mutually irrational; and so they will never return to the same beginning, even if they should last for infinite ages—because never, in [any] infinite section of time, would there occur a common measure by which, repeated often enough, one terminus of all the motions, and goal of the Platonic Year, might be constituted." Which being so established, he exclaims, with Pliny (bk. 2, ch. 1): "The World is sacred, immense, whole in [its] whole—nay rather, itself the whole—finite and like to the infinite"; and with Copernicus (bk. 1, ch. 10): "So great, indeed, is this divine fabric of the Best and Greatest [God]."

[Margin: A judgment on Kepler's opinion.]

[IV.] But the aforesaid argument of Kepler, drawn from the comparison of the orbs and the eccentricities, holds indeed in a hypothesis employing the figure of an Eccentric orb, or in [one] equivalent to it as to Geometry; but not in every [hypothesis] which is equivalent only as to numbers—say, in a motion made spirally through helices, or if the Angels move the heaven and Planets using merely Logistic rules, and not

regarding circles, ellipses, or similar figures. Nor is it evident that the proportions which are ineffable to us—or at least, because they tend toward infinity—are devoid of all beauty; since the Divine Immensity and Eternity has all the perfection of the infinite, and yet does not lack its [own] beauty. Just as neither is it evident that it is not more beautiful that, in the celestial motions, there be proportions of each kind [rational and irrational]. Finally, it does not please [me] that he [Kepler] makes God the author of the effable proportions, but denies [Him to be the author] of the ineffable.

CHAPTER VII

On the Sound and Concent, that is, on the Harmony, of the celestial motions

[I.] Since this Harmony arises not only from the celestial motions, but also from the intervals of the distances, and other proportions; and does not hold itself in the same way in every [world-]system: it has seemed [good] to defer this controversy to the last Section of this book, in which the Harmonic and Geometric System will be treated—so that, by that last [section], as it were by a [musical] sound, the ears of the erudite Reader may be refreshed.

[END OF SECTION II.] *(The page closes with a tailpiece and the catchword "SECTIO" — Section III begins on printed p. 271 / PDF 306. The harmony-of-the-spheres question raised here is deferred by Riccioli to the final Section of Book IX.)*