

Giovanni Battista Riccioli

ALMAGESTUM NOVUM

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English translation — Book IX, Section III: On the System of the World around the Immobile Earth (printed pp. 271–289)

SECTION THREE — On the System of the World around the Immobile Earth

(printed p. 271 — Section III opens with its title and the list of Principal Authors who treat of the World-Systems. Chapter I then begins, on the Number of the Total Heavens, posing the question whether the heaven is one or many and setting out the First Opinion, that there is a single heaven.)

[Margin: Principal Authors who treat of the Systems of the World.]

Ptolemy (bk. 9 of the *Almagest*, ch. 9, and there Theon and Regiomontanus); Macrobius (bk. 1 on the *Dream of Scipio*, ch. 19 and 21); Copernicus (bk. 1, ch. 10); Fracastoro (in the *Homocentrica*, sect. 1 and 3, ch. 25); Giovanni Battista Amici (in the opusculum *On the motions of the celestial bodies*); John Anthony Delphinus (in the book *On the celestial globes and motions*); Valentin Naibod (bk. 1 of the *Astronomical Institutions*, ch. 10 and 16); Clavius (bk. 1 on the *Sphere*, from p. 64); Francesco Barozzi (bk. 1 of the *Cosmography*, ch. 2); Ascanio Martinengo (the *Great Gloss on Genesis*, p. 968); Galileo (in the *Dialogues on the twofold System of the World*); Longomontanus (in the *Danish Astronomy*, bk. 1 of the *Theorics*, ch. 1); Scheiner (in the *Mathematical Disquisitions*, from num. 13); Andrea Argoli (in the *Pandosion Sphaericum*, ch. 3); Pierre Gassendi (in the *Astronomical Institution*, bk. 2, ch. 14, and the whole of bk. 3); Johannes Hevelius (ch. 7 of the *Selenography*); Baranzano (in the *Uranoscopia*, p. 103 and 115). But first we must treat of the number of the heavens, as [it were] of the Matter of the system.

CHAPTER I

On the Number of the Total Heavens

[Margin: Is the heaven single, or, for Aristotle, several?]

[I.] First, it is wont to be asked whether the heaven is single, or several are to be asserted—to which question occasion was given both by Moses, naming a single heaven in the beginning (about which, St. Thomas, *Summa* part 1, q. 68, art. 4, and we below at num. 2 and 3), and by Aristotle (bk. 1 *On the Heaven*, ch. 6, or text 76), saying: "But let us state why it is not possible that there be several heavens." Yet the same [Aristotle], in the same place, by the name "heaven" understands the World, the denomination being taken from the chief and by far greatest part of the World; for he concludes (text 80): "But since this is absurd, it is impossible that the worlds be more than one." And this he tries to show: both from the name "Universe," which is commonly attributed to the World—but if there were several worlds, the name "Universe" would be attributed to one of them badly, or equivocally; and because, if any worlds were of the same species, the earth of one would strive to tend, by its weight and its own nature, toward the earth of another, and fire toward fire, or else the single elements would be restrained within their single worlds by perpetual violence. But it is necessary that the elements of any world be of the same species—say, fire compared with

fire—because the simple motion which is owed to simple bodies is either circular (and this belongs to the heaven), or straight (and this is either upward simply, or upward in a certain respect, or downward simply, or downward in a certain respect); and the element which tends upward simply we call fire, and that [which tends] downward, earth, etc. Wherefore, since another division of simple motion according to species is impossible, it seems impossible too that there be given other elements of a diverse species. From which discourse it appears that he speaks of the unity of the World composed of the heavens and the elements. Yet above (ch. 4, text 22) he had distinguished the heaven from the elements, saying: "Wherefore, there being, as it were, a certain other first body besides earth and fire and air and water, they called the supreme place 'aether'—imposing on it the name from 'running always' in everlasting time [Greek *aei thein*, αἰεθέρ, 'to run always,' whence αἰθήρ, *aithēr*]. But Anaxagoras misuses this name, and not rightly, for he names 'aether' for fire." Hence it came about that he entitled four books *On the Heaven*, although in [bks.] 3 and 4 he treats only of the elements. But in the heaven—taken strictly for the place of the stars, or that simple body to which circular motion belongs—Aristotle acknowledges several spheres (*Physics* 8, and *Metaphysics* 12), as we shall show below, explaining the Aristotelian system. Now we must treat of the opinions of others.

[Margin: 1. Opinion — on a single heaven.]

[II.] The **First Opinion** posited a single heaven, but not in the same sense. For St. Chrysostom—because in Genesis 1 it is said, "In the beginning God created Heaven and Earth," and [because] he otherwise knew that it is therefore said *Samaim* or *Hasamaim* (Hebrew שָׁמַיִם / שָׁמַיִם, *šamayim / haššamayim*, "heaven[s]") in the plural number, since among the Hebrews "heaven" lacks a name of the singular number (just as, among the Latins, *Athenæ* and *Venetiaë* [are plural in form]); and [because] he otherwise thought that this heaven, named on the first day, is not distinct from the heaven, or Firmament, made on the second day; and finally judged that the whole heaven is immobile, and that the stars are not moved at the motion of the heaven, but move *per se* within the heaven—for these reasons, I say, he thought the heaven to be single, taking "heaven," however, more strictly, and not comprehending the aerial [heaven]. And so, in homily 4 on Genesis, he concludes: "Who, then, after such great doctrine, will bear those who dare to speak from their own brain, and, against the divine scripture, to assert many heavens?"—to which [statements] he has similar ones in homily 12 to the people of Antioch, and homily 25 on the Epistle to the Hebrews.

[Margin: St. John Chrysostom. Tertullian. St. Bonaventure.]

And of the same opinion was Tertullian (in the book *Against Hermogenes*). But, speaking of the starry heaven, St. Bonaventure acknowledges it single (on [the *Sentences*] bk. 2, dist. 14, art. 1, q. 1)—and indeed by a unity of continuation, although he admits that several tracts can be designated in it, according to the plurality of motions; for he says: "According to the common opinion, whether of the Natural [Philosophers] or of the Mathematicians, the Luminaries are placed in diverse orbs; but this distinction or diversity of orbs, according to those who understand [it] better, does not come from a distinction of forms, as air and water are distinguished; nor does it come from a discontinuation of surface, as stone is distinguished from stone; but it comes from a diversity of motions; and a diversity of motions does not remove continuity in that which is subtle and apt for motion, as plainly appears in water, and likewise in air, etc." Wherefore the conclusion is this: "According to this position, then, it must be said that the Luminaries of the heaven are placed in several orbs, yet in one continuous body, which Scripture calls by the name of 'Firmament.'"

[Margin: Téllez. The Tychonics. The Copernicans.]

And indeed, whoever posit the starry heaven to be everywhere fluid have no reason to divide it into several heavens, but ought to confess it single—as Tycho teaches (in the Epistle, p. 149), and as Oviedo remarks (in the single controversy *On the Heaven*, point 4, conclusion 5), asserting: "If the heavens are liquid, only one heaven, of the wandering and non-wandering stars, is to be admitted." For which cause Téllez (disp. 44 of the *Philosophy*, sect. 3, num. 5) affirms a single star-bearing heaven. And such [holders] are Tycho,

Longomontanus, Kepler, Bullialdus, and probably Copernicus, as we shall say at num. 14.

[Margin: *A single heaven, even though solid. Giles [of Rome]. Hurtado.*]

But even if the whole starry heaven were posited [to be] solid, Giles [Aegidius] and Hurtado nonetheless assert it to be single. For he [Giles] (part 2 of the *Hexaemeron*, ch. 32), because Scripture says the stars are placed not "in firmaments" but "in the firmament," says: "If, therefore, the Luminaries and stars are in the firmament of the Heaven, and the Planets are reckoned among the Luminaries of the heaven, it seems that all the Planets are in the firmament of the heaven—which could not be, unless the spheres of the planets made one sphere with the firmament, or with the starry heaven." And a little after: "Yet, positing Eccentrics and Epicycles, nothing prevents all the aforesaid spheres from being one and the same sphere." And finally he concludes that the deferents of the Planets are seven, and that, with respect to these, the place of the Fixed [stars] can be called the eighth sphere—but that all these are enclosed in a single heaven, nay, are a single sphere; and that it is done in vain through many [things] which can be done through one. But Hurtado (disp. 2 *On the Heaven*, sect. 1) so maintains a single heaven, notwithstanding [its] solidity, that in it he admits, with some of the more ancient [writers], vari—

[...continues on p. 272 (PDF 307): "...ous canals, through which the Planets are carried up and down, to the right and to the left; nor does he admit these [to be] void, because a vacuum is a place lacking a body but apt for having one, whereas those canals are not apt to be filled with a body." — then the rebuttal of the canals (Pererius, Oviedo, Arriaga), the single-sphere-with-interwoven-rings view (Cæsalpinus, Aversa, Tanner), and the start of the **Second** and **Third** Opinions.]

(printed p. 272 — The page completes the *First Opinion* (a single heaven) and proceeds through the *Second Opinion* (several heavens, absolutely) and the *Third Opinion* (only two heavens), before opening the *Fourth Opinion*, that there are three heavens.)

...[with some of the more ancient writers] various canals, through which the Planets are carried up and down, to the right and to the left; nor does he [Hurtado] admit these [to be] void, because (he says) a vacuum is a place lacking a body but apt for having a body, whereas those canals are not apt to be filled with a body. Against which canals there rise up, with several [arguments], Pererius (bk. 2 on Genesis, q. 9), Oviedo (above), and Arriaga (the single disputation *On the Heaven*, sect. 4, num. 49). And certainly, if there be considered the innumerable bendings and windings of the Planets—especially of Mars, Mercury, and Venus—it would be necessary that their whole heaven be hollowed out [excavated]; nor does it appear how light could be transmitted to us, from the whole hemisphere of the Planet's body, through those cavities (if it [light] is an accident needing a subject), and so we would see [only] a single point of them.

[Margin: *Cæsalpinus. Aversa. Tanner.*]

But in another way, Andreas Cæsalpinus (bk. 3 of the *Peripatetic Questions*, q. 4) and Raphael Aversa (q. 32 of the *Physics*, sect. 6 and 7) said the heaven is single—nor did Tanner think it improbable (vol. 1 of the *Theology*, disp. 6, q. 3, dist. 3, num. 78)—namely, that the starry heaven is a single sphere, in which, however, there are diverse circles joined together among themselves like rings, or Zones, within the Zodiac, conveying the Planets forward and backward, up and down, without fluidity or vacuity. Finally, all those who receive three heavens taken broadly—namely the Empyrean, the Starry, and the Aerial (about which we shall speak at num. 5)—would seem to favor the unity of the starry heaven; for by this very [fact] they would seem to make the Starry [heaven] single, and Téllez uses this argument too. But, as we shall see (partly at num. 5, partly at num. 7), many of them subdivide the Starry [heaven] into several heavens really distinct.

[Margin: *2. Opinion — for a plurality of heavens.*]

III.] The **Second Opinion** affirms absolutely that there are several heavens. Against these [are] certain Mathematicians—I know not whom—[whom] St. Basil [opposes] (homily 3 of the *Hexaemeron*): "Although

those," he says, "who are wont to use demonstrations are of much graver weight [authority], and by the force of Geometrical proofs necessarily concluding confirm [their view]—that nature cannot bear that, besides this one heaven, it should constitute another—then truly we shall the more freely laugh at the linear trifles of those Mathematicians, contrived with however much artifice and ingenuity, etc." But perhaps they were using the Aristotelian arguments proposed at num. 1, to show that there are not several worlds. Surely the divine scripture indicates that there are several heavens, when (1 Chronicles [Paralipomenon], ch. 2) it says, "If heaven and the heavens of heavens do not contain thee"; and Psalm 113, "The heaven of heaven [is] the Lord's"; and Psalm 148, "Praise him, ye heavens of heavens"; and Ecclesiasticus 16, "Behold the heaven, and the heavens of heavens." Moreover, the sacred Genesis commemorates two heavens, according to the more common opinion of the Fathers (about which [we treated] in sect. 1, ch. 1 and 2)—namely, the Empyrean (or even the Starry) created on the 1st day, [and] the Firmament made on the 2nd day; and St. Paul (2 Corinthians 12) [names] three heavens.

[Margin: *St. Athanasius.*]

Indicating which arguments, St. Athanasius (in the *Questions to Antiochus*, q. 5) said: "What are the heavens? I answer: this question is in doubt among many. For the book of Genesis commemorates two heavens. But the divine Paul says that he himself saw even a third heaven; and the prophet David speaks of a fourth heaven: 'praise him, ye heavens of heavens.' But it must be known that, just as human nature is called one, and one man, yet there are likewise many men, so too the nature of the heavens [is] one, and 'one heaven' is said in the divine scripture, and [also] 'many heavens.'" And [that] this [opinion] does not in fact differ from those positing one heaven, but [only] in name, St. Thomas teaches (part 1, q. 68, art. 4): for [he teaches] that St. Chrysostom takes, by the name "heaven," the whole space which is up above the earth and water, but that others distinguish in it several heavens.

[Margin: *The error of Basilides, of the 365 heavens.*]

It is not permitted, however, to multiply heavens at will; and therefore the error of Basilides—who posited as many heavens as there are days in a year, namely 365—is numbered among the heresies by St. Irenaeus (bk. 2 *Against Heresies*, ch. 21 and 22), Tertullian (the book *On Prescriptions against the Heretics*), St. Epiphanius (in the *Panarion*, bk. 1, heresy 24 and 26), and St. Augustine (the book *On Heresies*, heresy 4)—though this heresy consisted not so much in the multitude of the number as in the [mode of] production; since indeed, as St. Irenaeus relates, he [Basilides] imagined the second heaven [procreated] from the first, and the third from the second, and likewise the others procreated by successive birth. Wherefore our Téllez wittily said (disp. 44 of his *Philosophy*, sect. 3, num. 4): "Although he admits so many heavens, into none [of them], as I rather think, will he have to be admitted." For he was a heresiarch, and therefore deserved to be banished not into heaven, but into the infernal Tartarus. This, then, being dismissed, let us see how many heavens others have reckoned.

[Margin: *3. Opinion — on two heavens. St. Clement. Acacius. Theodoret.*]

[IV.] The **Third Opinion** enumerates only two heavens, but not in the same sense. For indeed St. Clement (bks. 1 and 2 of the *Recognitions*), Acacius (in Lippomanus, in the *Catena*), and Theodoret (on ch. 9 of the *Epistle to the Hebrews*, and q. 11 on Genesis) affirm one heaven [to be] the Empyrean, or [the heaven] created on the first day, but the other [to be] made on the second day. Let us hear Theodoret: "Since the divine scripture teaches that, in the beginning, God created heaven and earth, and then, after the creation of light, says that on the second day the firmament was made—a question of this kind (about the number of the heavens) seems to be full of inexperience [ignorance]. For it behooved [one] to know, from the reckoning of time and the very mode of creation, the diversity of the heavens—both [that] one [was made] before the light, the other after the light; and [that] the former, indeed, [was] founded not from another matter, but the latter from the waters, etc. Whoever, then, does not believe there to be a second heaven, transgresses the straight path; but whoever tries to enumerate several, cleaves to fables, the doctrine of the divine Spirit having been

set aside."

[Margin: *Claudianus Mamertus. Suidas.*]

And in the same sense Claudianus Mamertus (bk. 2 *On the State of the Soul*, ch. 13) said there are two heavens. Likewise Suidas, in his historical work: "There are two heavens—one procreated with the earth, the other which was bidden to subsist in the midst of the waters, which they also called the firmament."

[Margin: *Procopius. St. Bruno. Anastasius.*]

And, speaking of the heaven made on the second day, Procopius (on ch. 1 of Genesis) says: "Some deny that the generation of a second heaven is here depicted; for they think that the present series of words is a brief repetition of the [first] heaven, of which [it spoke] above. These and such things they dare to prate, although the scripture of this second heaven brings [with it] another name and another use." And the same acceptation of these two heavens [is found] in St. Bruno (in the book *On the Novelties* [*De Novis*], ch. 2). But most elegantly, and joining the mystical with the literal sense, [is] Anastasius Sinaita (bk. 2 of the *Commentary on the Hexaemeron*): "On the first day was made the veil of the higher heaven, which approaches the Holy of Holies, whither Christ, our forerunner, entered for us. For this cause, moreover, on the second day is made the second, outer veil, which is called the firmament in the midst of the water—which indeed is the firmament of faith in Christ." Hence, after a few [words]: "We have learned, therefore, from sacred scripture, only the fabrication of two heavens, as a type and figure of the two veils of the Temple, which signify the two natures of Jesus, and of two peoples, and of two Churches, etc."

[Margin: *Mastrius and Bellutus. St. Gregory of Nyssa. St. Justin.*]

Lastly, Mastrius and Bellutus (disp. 2 *On the Heaven*, q. 1, art. 2, num. 30) so admit a Prime Mobile really distinct from the starry heaven, that they say the starry heaven [itself] is single and continuous, and maintain the various motions of the Planets not through whole heavens or spheres, but through circles—or rings and Zones—contained within the Zodiac. But in another way, St. Gregory of Nyssa (in his *Hexaemeron*, especially toward the end) teaches that on the second day a single heaven was made—namely, the fiery element [being] segregated from the others—and that this was divided into two regions: one for the non-wandering [fixed] stars, the other for the wandering [stars]. And finally, in another sense, St. Justin (q. 57 of the [*Questions*] of the Orthodox) says that there are truly two heavens, but that these are disjoined into various spaces, which the scripture calls "heavens"; but he speaks of the ethereal heaven, and of the aerial. For he says, inquiring: "If Moses had set forth to us the creation of a twofold heaven, how does the scripture teach that there are several—sometimes saying 'the heavens of heavens,' sometimes 'and the heavens were opened?'" Then he answers: "Moses indeed spoke of heavens; but as to number, he handed down neither one, nor two, nor several. Furthermore, the divine scripture is wont to name the higher interstices [interspaces] of the parts 'heavens'—as 'the birds of heaven,' and 'the eagle in heaven,' and 'the stars of heaven.' From these sayings, therefore, it follows that we should understand the heavens to be, in substance, indeed two, but, by [their] interstices, several. And if we take 'heavens' in this manner, there will be no contradiction in the words." And so [they posit] two heavens: Theodoret, Claudianus, Suidas, Procopius, Bruno, [and] Anastasius—the Empyrean and the starry; and Nyssen[us]—[the heaven] of the Fixed [stars] and [that] of the Planets; but St. Justin—the Ethereal and the Aerial; Mastrius and Bellutus—the Prime Mobile and the Starry heaven. But if you call in the aerial [heaven], St. Nyssen will acknowledge a third heaven, as we shall show in the following number.

[Margin: *4. Opinion — on three heavens.*]

[V.] The **Fourth**—and most celebrated among the sacred writers—Opinion was, and still is, [the one] about three heavens, arisen from that saying of St. Paul (2 Corinthians, ch. 12): "I know a man in Christ—fourteen years ago, whether in the body or out of the body, I know not, God knows—caught up in this manner even to the third heaven"; which words St. Thomas most learnedly expounds (2-2, q. 175, art. 3 and 4, etc.). But

although, as Oviedo notes (at the end of the controversy *On the Heaven*), some have believed that "three heavens" is put for "many" or "all"—in that manner in which, in Amos 1, it is sa—

[...continues on p. 273 (PDF 308): "...id [that for three and four transgressions of Damascus I will not turn away...]" — Riccioli continues expounding the Fourth Opinion (three heavens), distinguishing the literal three from the figurative use of "three" for an indefinite multitude.]

(printed p. 273 — *The Fourth Opinion (three heavens) is completed, followed by the Fifth (four), Sixth (five), and Seventh (six or seven) Opinions. The page then opens the Eighth Opinion, which posits eight starry heavens.*)

[Margin: *Three heavens metaphorically = three visions.*]

...[in that manner in which, in Amos 1, it is] said, "for three transgressions of Damascus," that is, "for very many"; and 2 Corinthians 11, "Thrice I besought the Lord," namely, several times. Yet the common opinion is that three heavens are enumerated, because in reality, in its whole amplitude, there are three, properly speaking. For metaphorically, as St. Augustine interprets (tome 3, bk. 12 [*On Genesis to the Letter*], ch. 29 & 34), there can be understood three kinds of supernatural visions—namely the Corporeal, the Imaginary, and the Intellectual; and so St. Paul, transcending the corporeal and imaginary vision, was elevated to the intellectual—and indeed to the intuitive [vision] of God; which some call the heaven of the Trinity. To which heaven—that is, to the Beatific vision, as owed to his natural excellence—Lucifer tried not to be elevated, but to elevate himself, when he said, "I will ascend into heaven," as Martinengo thinks (in the *Great Gloss*, p. 623), and before him St. Thomas (1 p., q. 68, art. 4). But to the letter, these three heavens are either the Aerial, the Sidereal, and the Empyrean; or the first, which was made on the first day, the second, on the second day, and the third, to which St. Paul was caught up. But let us recite the words of the Fathers.

[Margin: *St. Basil.*]

St. Basil (homily 3 of the *Hexaemeron*): "In the second place there offers itself to be inquired into, whether this firmament is diverse from that heaven which was made in the beginning—since this too has obtained the name of 'heaven'; and accordingly, whether two heavens are absolutely to be posited." And at length he answers: "We, on the contrary, are so far from doubting at all about two, that we [rather] inquire about a third, of the contemplation of which that admirable Paul was held worthy. Moreover, when the Psalm by name commemorates 'the heavens of heavens,' it has surely served us a clear understanding not of one heaven only, but of several."

[Margin: *St. Ambrose. Cassiodorus.*]

To whom, as is usual, St. Ambrose accords (bk. 2 of the *Hexaemeron*, ch. 3), where at last he thus establishes: "And so we cannot deny that there is not only a second, but even a third heaven, since the Apostle confirms, by the testimony of his writings, that he was caught up to the third heaven. David too sets 'the heavens of heavens' in that choir of those praising the Lord." With whom Cassiodorus also agrees (on Psalm 148).

[Margin: *St. [John] Damascene.*]

But of what kind these three heavens are, St. [John] Damascene taught more openly (bk. 2 of the *Orthodox Faith*, ch. 6): for when he had said, "Since, therefore, the scripture says 'heaven,' and 'the heaven of heaven,' and 'the heavens of heavens'; and affirms that blessed Paul was caught up even to the third heaven: we say that, in the procreation of the whole world, by the making of 'heaven' is understood by us that sphere which certain of the wise (who are not of our own) call the 'starless,' making those dogmas of theirs which are Moses's; then God also called the Firmament 'heaven.'" He subjoined: "There is, therefore, the heaven of heaven, the first heaven placed above the firmament: behold two heavens—for God called the firmament too 'heaven.' It is also the custom of the divine scripture to call the air 'heaven,' from the fact that it is seen above.

For 'Bless [the Lord],' it says, 'all ye birds of heaven'—meaning the air; for the air is the path of flying things, and not 'heaven': behold three heavens, which the divine Apostle spoke of."

[Margin: *St. Gregory of Nyssa.*]

Yet with another notion St. Gregory of Nyssa distinguished these three heavens (in the *History of the six days*, in these words): "I think, therefore, that the extreme part of the sensible World was called the 'third heaven' by St. Paul, dividing indeed whatever appears into three parts, etc. One heaven the scripture names the terminus of the thicker air, as far as the winds and clouds also pertain, and the nature of high-flying birds is borne, etc.; then it names another both 'heaven' and 'firmament,' that which is beheld within, after the sphere of the non-wandering [fixed] stars, in which the wandering stars are conversant. And it names the very extremity also of the sensible World—which is the confine of that creature of His which is perceived by thought—'firmament' and 'heaven.'" Wherefore, for Nyssen the first heaven is the Aerial, the second the Planetary, the third the Firmament of the non-wandering [stars].

[Margin: *St. Thomas. Cajetan.*]

Otherwise St. Thomas (1 p., q. 68, art. 4): for he says these three heavens are the Empyrean, which is wholly luminous; the Aqueous or crystalline, which is totally diaphanous [transparent]; and the Sidereal, partly luminous, partly diaphanous. Again otherwise Cajetan (on Genesis, & on 2 Corinthians, ch. 12) took these three heavens, for in the third place, instead of the Empyrean, he substituted the aqueous heaven, saying: "In sacred scripture mention is made of three heavens. The lowest is the aerial heaven, according to that [text], 'the birds of heaven'; the middle is the Starred heaven, of which in the beginning of Genesis, 'and he placed them in the firmament of heaven'; the third and highest is [that] of all the waters which are above the heavens—of which scripture makes mention several times—which we call the aqueous heaven, but the Philosophers call the Prime Mobile: the Empyrean heaven indeed, handed down by the later [writers], is nowhere found in scripture." But how falsely they exclude the Empyrean, we have said enough (sect. 1, ch. 1, from num. 24).

But to the Damascene's acceptance most of the more recent [writers] have subscribed—chiefly Suárez (*On the work of the six days*, bks. 1 & 2), Oviedo (the single controversy *On the Heaven*, point 4, num. 12), Tanner (in the dissertation *On the heavens*, q. 10), Christopher Borrus (folio 260 of his *New Astronomy*), and Genebrardus [cited] in him; Hurtado (disp. 2 *On the Heaven*, sect. 1)—namely, that the heaven is divided into Empyrean, Sidereal, and Aerial. Not all, however, deny a subdivision of the sidereal [heaven] into several heavens; nay, Sts. Basil, Ambrose, and Damascene subdivide it into eight heavens, as we shall see below. And that the air too is marked with the name of "heaven," even among the Ethnic [pagan] and Profane writers, I have already taught (sect. 1, ch. 1, num. 14).

[Margin: *5. Opinion — on 4 heavens.*]

[VI.] The **Fifth Opinion**, on four heavens, is hinted at by St. Athanasius (q. 5 to Antiochus, whose words I have already transcribed at num. 3); he seems, however, to understand the Empyrean, the Firmament of the non-wandering [stars], the heaven of the Planets, and the Ethereal heaven—but he does not sufficiently express his meaning.

[Margin: *6. Opinion — on five heavens. 7 heavens.*]

[VII.] The **Sixth Opinion** is of 5 heavens—namely that of Oviedo (the single controversy *On the Heaven*, point 4, num. 10), where, not absolutely, but on the supposition that the heaven of the stars is solid, [he holds that] it must be divided into five heavens: namely [the heavens] of the Fixed [stars], of Saturn, of Jupiter, of the Sun, and of the Moon. For since Mars, Venus, and Mercury are sometimes above the Sun, sometimes below, he reckons them to be enclosed within one and the same heaven of the Sun, as [a heaven] common to these four planets. Absolutely, however, he inclines toward liquid heavens, and therefore at num. 12 he posits three heavens—the Empyrean, the Sidereal (single, without subdivision), and the Aerial; wherefore, if to five

solid heavens he had added the Empyrean and the Aerial, he would surely have made 7 heavens aggregated from solid and liquid [ones]. But we below, in another way, shall assert 5 heavens—namely the Empyrean; the Aqueous or crystalline; the Firmament of the Fixed [stars], solid; the Ether or heaven of the Planets, liquid; and the Aerial.

[Margin: 7. Opinion — on 6 or 7 heavens. Philastrius. Bede.]

[VIII.] The **Seventh Opinion** is of 6 heavens, which, together with these opinions, Philastrius heaps up (in the book *On Heresies*), saying: "Concerning the diversity of the heavens, there is a heresy which is in doubt"; and a little after: "Whether, therefore, one will take six heavens according to David, and this Firmament as the seventh, he does not err. For Solomon speaks of three heavens thus: 'the heaven, and the heaven of heaven'; Paul equally, the Apostle, confesses himself caught up even to the third heaven: whether, therefore, one takes seven as David, or three, or two, he does not err, etc." Otherwise Bede (on Genesis, ch. 1), when he had adduced that verse, "The golden-colored ether of the sevenfold heaven is cleft," immediately adds: "Since these are the names—Air, Aether, Olympus, the fiery Space, the Firmament, the heaven of the Angels, the heaven of the Trinity."

[Margin: Rabanus.]

And the same order of heavens, reversed [in inverse order], Rabanus reckons, as St. Thomas too reckons (on [the *Sentences*] 2, dist. 14, q. 4, and 1 part of the *Summa*, q. 68, art. 4)—namely Empyrean, Crystalline, Sidereal, Fiery, Olympic, Ethereal, Aerial. And in the same place [Aquinas] says, according to Rabanus (on ch. 1 of Genesis), that the space which is from the earth to the Moon is divided into four regions, as it were four heavens: and that the supreme [region] of Fire is called the fiery heaven; the lowest of Fire, the Olympic heaven; the supreme of air, the Ethereal heaven; the lowest of air, the Aerial heaven.

[Margin: Eclogue 2.]

And perhaps to here someone may draw that [saying] about the Heptachord [seven-stringed lyre] of the World, indicated by Virgil in those verses: "I have a pipe compacted of seven unequal hemlock-stalks [reeds], etc."; and that: "It echoes the seven distinctions of tones by [its] numbers."

[Margin: 8. Opinion — on 8 heavens, but of the starry [heaven]. Babylonians. Egyptians. Eudoxus. Calippus. Plato. Aristotle. Cicero. Philo. St. Damascene. St. Bonaventure. The Carthusian. Aben Ezra.]

[IX.] The **Eighth Opinion** was of Eight starry heavens, in which were all those who reckoned that the Fixed [stars] are moved by no other motion than [that] of the Prime Mobile; wherefore, since for the 7 Planets they posited just as many heavens, the sphere of the Fixed [stars], or the "Aplanes" [■πλαν■ς, *aplan■s*, "non-wandering"], remained with them the supreme and eighth sphere—which by many later Catholics was called the Firmament. Not all the Catholics, however, excluded the Empyrean heaven or the crystalline, or even the aerial; but, speaking of the subdivision of the sidereal, they distributed it into 8 total spheres. Of this opinion were the most ancient Babylonians and Egyptians, Eudoxus, Calippus, Plato, Aristotle, Cicero, Philo, St. Damascene, St. Bonaventure, Denis the Carthusian, [and] Aben Ezra—as I have already taught (sect. 2, ch. 3, num. 2), the verses of Plato, Cicero, Philo, and Damascene having been adduced; who—

[...continues on p. 274 (PDF 309): "...indeed (bk. 2 of the Faith, ch. 6), when Damascene had received three heavens—Empyrean, Sidereal, and Aerial—subjoins about the sidereal heaven of the Planets: 'But if you should wish to take the seven circles for seven heavens, you will in nothing offend against the reason of truth'..." — then the eight-heaven dossier (Basil, Ambrose, Remigius, Aquinas, Lyra, Tostado, Denis, Burgos, Riccius, Orontius, Arriaga, Amici, Aversa, Cremonini, Rubius, Hurtado), and Opinions 9–II (nine, ten, eleven heavens).]

(printed p. 274 — The Eighth Opinion (eight starry heavens) is completed, followed by the Ninth Opinion (nine heavens) and the Tenth Opinion (ten). The page closes by opening the Eleventh Opinion, which counts eleven heavens.)

[Margin: *St. Basil.*]

...who [Damascene] indeed (bk. 2 of the *Faith*, ch. 6), when he had received three heavens—Empyrean, Sidereal, and Aerial—subjoins, about the sidereal [heaven] of the Planets: "But if you should wish to take the seven circles for seven heavens, you will in nothing offend against the reason of truth." Likewise St. Basil, on the seven heavens of the Planets (homily 3 of the *Hexaemeron*), asserts the most common opinion: "Nor is this other [view] to be believed with any less faith than that by which we believe there to be seven orbs, in which the seven stars are proclaimed, by the consonant mouth of almost all, to accomplish their course: which heavens indeed they assert to be neatly inserted one within another, just as if [heated vessels], or little vessels, were inserted one within another." But he had admitted three heavens on account of the authority of St. Paul, and among them the Empyrean and the Firmament; as also St. Ambrose (bk. 2 of the *Hexaemeron*, ch. 2), and then he subjoins: "David too set 'the heavens of heavens' in that choir of those praising the Lord." Imitating whom, the Philosophers introduced a consonant motion of the seven stars—of the Sun, the Moon, etc.—which [stars], inserted into and as it were inlaid in [their orbs], they judge to be turned backward [retrograde], and to be borne by a motion contrary to the rest.

[Margin: *St. Ambrose. Remigius.*]

To whom must be added Remigius of Auxerre (on Psalm 148), explaining that [verse], "Praise him, ye heavens of heavens": "The heavens, that is, the firmament and the ether, namely the force of the [things] embraced; the heavens of heavens, that is, of the seven circles, where the 'aplanes' [fixed] and the Planets are fixed—let them be to you matter for praising the Lord."

[Margin: *St. Thomas. Lyra. Tostado.*]

By a like reasoning St. Thomas, an asserter of three heavens—the Empyrean, the Crystalline, and the Sidereal—speaks thus of the Sidereal (1 p., q. 68, art. 4): "The third, partly diaphanous and partly luminous from the stars, which they call the sidereal heaven; and it is divided into eight spheres, namely into the sphere of the fixed stars, and the seven spheres of the Planets, which can be called seven heavens, or seven spheres." Hither comes [Nicholas of] Lyra (in the *Postils* on Genesis), saying: "The firmament was made according to the specific form of the sidereal heaven. In which production are understood also to be produced the orbs of the seven Planets, which are comprehended under the name of 'firmament.'" Nor otherwise Tostado [Tostatus] (on ch. 1 of Genesis): "By the name of 'Firmament' is understood the whole magnitude, or celestial mass, containing eight orbs: namely the starred heaven, the heaven of Saturn, of Jupiter, of Mars, of the Sun, of Venus, of Mercury, and of the Moon."

[Margin: *Denis the Carthusian. Burgos [Paul of]. Riccius. Orontius.*]

Likewise Denis the Carthusian (in the *Commentaries* on Genesis, art. 10): "The firmament was made, that is, the starred heaven, which is the eighth sphere, because under it are seven spheres or orbs and heavens of the Planets." With whom agreed Burgensis [Paul of Burgos] (in the *Additions* on Genesis, ch. 1): "The Firmament, of which here it treats, is the sidereal heaven, which is divided into the eighth sphere, which is [that] of the fixed stars, and into the seven orbs of the Planets." But Augustine Riccius (in the treatise *On the motion of the Eighth sphere*, ch. 13 & 14) and Orontius [Finé] (bk. 1 of the *Sphere*, ch. 5) acknowledge indeed an apparent motion of the Fixed [stars] from the East, but teach that it is from the aggregate of 8 heavens.

[Margin: *Arriaga. Amici. Aversa. Cremonini. Rubius. Hurtado.*]

But our Roderick Arriaga (the single disputation *On the Heaven*, sect. 4, num. 52), on the hypothesis that the starry heavens are solid, teaches that they are eight: for he thinks that the eighth sphere can be so moved by Intelligences, that there appears to be in it a twofold motion, one toward the West, the other toward the East. Which Amici also thinks more probable (tract. 4 *On the Heaven*, q. 5, dub. 8), and Aversa (q. 32 of the *Philosophy*, sect. 4). Eight heavens equally affirm Cremonini (*On the motion of the heaven*, sect. 2, ch. 13),

Rubius (bk. 2 *On the Heaven*, ch. 5, q. 1), and Hurtado (disp. 1 *On the Heaven*, sect. 1)—because they think it uncertain whether the Fixed [stars] have a proper and peculiar motion. Arriaga, however, above the sidereal [heaven] acknowledges a ninth heaven, namely the Empyrean.

[Margin: 9. Opinion — on 9 heavens. Macrobius. Alpetragius. Rabbi Isaac. Rabbi Moses. Zacut. Haly. Scotus. Sacrobosco.]

[X.] The **Ninth Opinion**, on nine heavens, does not number them in the same way. For Arriaga, as I just said, numbers the Empyrean and eight sidereal heavens. But others wished the Ninth heaven to be the Prime Mobile, moving with itself the eight lower spheres—of the Fixed [stars] and of the 7 Planets—to each of which singly they attributed its own proper motion toward the East, but a very slow [motion] to the Fixed [stars]: thus Macrobius (bk. 1 on the *Dream of Scipio*, ch. 17); thus Rabbi Isaac, Alpetragius (in the *Celestial Physics*), Abraham Zacut, Rabbi Moses [cited] in Riccius (in the treatise *On the motion of the eighth sphere*, ch. 4), Haly (ch. 11); the fourfold [partition] of Scotus (on [the *Sentences*] 2, dist. 14, q. 2, & *Metaphysics* 12, comm. 44), John of Sacrobosco (on ch. 1 of the *Sphere*); and that this was common in Scotus's time say Mastrius and Bellutus, the Scotists (disp. 2 *On the Heaven*, q. 1, art. 2, num. 30)—who indeed admit a Prime Mobile distinct from the sidereal heaven, although in place of [several] sidereal [heavens] they posit a single solid and continuous heaven, with various circles or Zones carrying the Planets—following Aversa and Cæsalpinus, as also Chiaramonti (bk. 2 *On the Universe*).

[Margin: Whether Hipparchus & Ptolemy [belong to this class]?)

The Authors of this opinion, Averroes thinks Hipparchus and Ptolemy to have been (2 *On the Heaven*, comm. 67), [as do] Albertus Magnus (2 *On the Heaven*, tract. 3, ch. 11), Clavius (on the *Sphere*, p. 43), the Conimbricenses (2 *On the Heaven*, ch. 5, q. 1)—attributing the same [opinion] to Menelaus, or Mileus, [of] Agria, to Alexander, and to Alfraganus; Scheiner (in the *Mathematical Disquisitions*, p. 50), Tanner (dissert. *On the Heaven*, q. 10), Mastrius and Bellutus (disp. 2 *On the Heaven*, q. 1, art. 2, num. 19). Because, namely, the first, Hipparchus and Ptolemy, having compared their observations about the Fixed [stars]—Hipparchus indeed with those of Timocharis and Aristyllus, Ptolemy with the observations of Hipparchus—detected and confirmed that the Fixed stars, besides the apparent motion over the poles of the Equator toward the West, are slowly advanced in consequence [eastward] over the poles of the Ecliptic. But if you read Ptolemy (bk. 1 of the *Almagest*, ch. 8, and bk. 7, ch. 2 and 3) and Alfraganus (diff. 5 & 18), where they treat of these motions, you will nowhere find that they posited two distinct spheres, but only distinct poles, around which those motions [occur]: and Tanner himself concedes that the argument for a distinction of heavens, drawn from the distinction of motions, is not necessary, but that [the heaven] can be so moved by one Intelligence or by several, by a single real motion, that nevertheless a twofold [motion] appears. Nay, Ptolemy and Alfraganus seem to describe the Equator and the Ecliptic in the same heaven.

[Margin: 10. Opinion — on 10 heavens. Alfonso. Amici. Fernel. Peurbach. Regiomontanus. Apianus. Maurolyco. Langius. Thebit. Arzachel. Isaac. [William of] Paris.]

[XI.] The **Tenth Opinion** asserted 10 heavens: namely seven for the seven planets; an Eighth for the motion of trepidation, or of the accession and recession of the Fixed [stars] toward Rising and Setting; a Ninth for the motion of the Fixed [stars] and of the Auges, or Apogees, of any Planet (except the Moon); and a Tenth for the motion of the Prime Mobile. Thus King Alfonso in his Tables, John Baptist Amici (*On the celestial motions*, last chapter), John Fernel (bk. 2 of the *Cosmotheoria*, ch. 1 & 7), Peurbach (in the *Theorica* of the eighth sphere, with his followers), Regiomontanus (there, & on the *Almagest* 7, prop. 7), Maurolyco (dialogue 1 of the *Cosmography*, p. 24, & dialogue 3, p. 89), Apianus (in the *Caesarean* work), Joseph Langius (in the *Astronomical Elements*, ch. 4). The same number, but otherwise, received Thebit, Arzachel, and Isaac the Israelite, but they attributed the motion of trepidation in longitude rather to the ninth sphere, and the continuous motion in longitude of itself to the Eighth. To this class could be reduced those authors who posited 11 heavens in such a way that they called the eleventh the Empyrean—namely the

Conimbricenses, Martinengo, Clavius, and before these d'Ailly [Alliacensis], as we shall presently say; for in the number of 10 mobile spheres they agree with the Alfonsines. But William of Paris (1st part *On the Universe*, ch. 34 & 37) admits a first heaven, most quiet and immobile, that is, the Empyrean; and nine other mobile heavens—namely the prime mobile and the eight remaining spheres: the same holds John Anthony Delphinus (in the book *On the celestial globes and motions*, ch. 30 & 32).

[Margin: Delphinus. 11. Opinion — on 11 spheres. d'Ailly. Clavius. Conimbricenses. Martinengo. Polaccus.]

[XII.] The **Eleventh Opinion** is of Eleven heavens, but not in the same way. For some number, with the Alfonsines, ten mobile spheres according to what was said a little before (num. 11), but above this they acknowledge an eleventh, immobile: namely the Empyrean, or supreme immobile heaven, influencing into the diverse regions of the Earth diverse and stable properties; thus Pierre d'Ailly (q. 2 on the *Sphere*), Clavius (on the *Sphere*, p. 45), the Conimbricenses (2 *On the Heaven*, ch. 5, q. 1), Ascanio Martinengo (in the *Great Gloss*, p. 1021), Georgius Polaccus (in the *Anti-Copernicus*, assertion 172).

[Margin: Polaccus.]

But among these, d'Ailly reports the opinion of 10 mobile heavens, and does not repudiate it, and adds that, besides those, an eleventh immobile heaven is required, on account of the diverse influences—which Clavius too thinks probable; again, Clavius thinks this same heaven to be that Empyrean of which Strabo and Bede [speak]; but the aqueous or crystalline heaven he thinks to be an aggregate from the ninth and tenth heaven of the Alfonsines. But others posited eleven heavens, yet mobile—namely the eleventh, or Prime Mobile; and the tenth for the first trepidation or libration in latitude, by force of which, by alternating turns, the obliquity of the Ecliptic is varied; the Ninth for the second libration or trepidation in longitude, by force of which the Equinoctial points advance and recede, and so the motion of the Fixed [stars] in longitude seems to be hastened and retarded; the Eighth for the proper and equal motion of the Fixed [stars] in consequence [eastward]; and the remaining seven for the motion of the seven Planets in longitude, etc. Thus John Werner (in Erasmus Oswald[s] *Theorica of the Eighth sphere*)—

[...continues on p. 275 (PDF 310): "...Leopold of Austria (in his *Compilation*); Magini; and Clavius (in the last edition of the *Sphere*)—whence Scheiner calls this the 'Clavian System'; so that Clavius, having admitted the Empyrean, admitted in all 12 heavens." — then ¶XIII (Riccioli corrects the ascription of "eleven heavens" to Copernicus, who in fact rejected the multiplication of spheres).]

(printed p. 275 — The page shows that Copernicus was wrongly cited for eleven heavens, his actual view being a two-heaven, fluid one. Riccioli then states his own Conclusion — five heavens broadly counted, two strictly — and introduces the Synopsis table, which begins here and continues on p. 276.)

[Margin: 12 heavens. Tanner's lapse.]

...Leopold of Austria (in his *Compilation*); John Anthony Magini (in the *Theorics*, bk. 1, and in the *Secondary Mobiles*), and—on account of the aforesaid motions asserted by Copernicus, but transferred to the hypothesis of a quiescent earth—Clavius (in the last edition of the *Sphere*), whence Scheiner calls this the "Clavian System" (in the *Mathematical Disquisitions*, p. 36). This same number, not from their own but from others' opinion, expound Antony Deusing and Pierre Gassendi (in their *Astronomical Institutions*). Wherefore, since Clavius admitted the Empyrean heaven, he admitted in all 12 heavens.

[XIII.] But since the assertion of eleven heavens is attributed to Copernicus by Tanner (dissert. *On the heavens*, q. 10, & tome 1 of the theological *Summa*, disp. 6, q. 4, dist. 4, num. 6), it must be known that Copernicus acknowledged this number not from his own, but from others' opinion: for he says (bk. 3 of the *Revolutions*, ch. 1): "For the cause of which [motions] some devised a ninth sphere, others a tenth, by which they judged those [appearances] to come about thus; nor yet could they perform what they promised. Now too an eleventh sphere had begun to come to light—which number of circles, as superfluous, we shall easily

refute in [treating] the motion of the earth." And so Copernicus attributes all the apparent motions in the Fixed [stars], and the very motion of the prime mobile, and the variation of the obliquity of the Ecliptic, to motions of the earth, as I shall teach more fully in Section 4.

[Margin: 2 heavens in Copernicus's hypothesis, or a single one.]

Nor in his hypothesis are the heavens distinct, except into two classes—namely into the immobile sphere of the Fixed [stars], and into the liquid heaven of the Planets, among which Planets is the Earth with the sphere of the elements. For although he did not express that liquidity, yet from those [things] which he teaches (bk. 1, from ch. 8 to 11) it is gathered, by no light conjectures: for in chapter 8 he teaches that not the whole air is carried around together with the earth by the annual motion, but only that [air] which is near to us; just as, therefore, the earth, which is one of the Planets, is rolled with the near air through the rest of the air—liquid, but unmoved—so it is fitting that the same befall the other Planets, namely that they be moved in the liquid ethereal aura. Again, in the same place he says that immobility befits the World, as the place of the stars and Planets, and that it is absurd to ascribe motion to the container, or [the thing] placing, and not rather to the contained and placed, which is the earth; but if this reasoning holds, it holds also of any heaven with respect to its Planet, whose place it is; nor by the name "World" can the sphere of the Fixed [stars] alone be understood. Lastly, in ch. 10 he names indeed the sphere of the Fixed [stars], but never the spheres of the Planets, while he inquires into the order of the celestial orbs; but he names the Planets themselves, and their revolutions—indicating sufficiently that these revolve not at the motion of orbs, but *per se*. But he indicates this most of all [by the fact] that the earth with the Moon is carried through the annual orb, and yet the Moon does not cut it [the orb]: by which argument Bullialdus (bk. 1, ch. 8) gathers that the Moon and the Planets are moved freely through the fluid ether. Accordingly, we acknowledge two heavens in reality in Copernicus's system—one of the Fixed [stars], the other of the Planets—distinguishable, however, by reason and designation into seven heavens: although Longomontanus (bk. 1 of the *Theorics*, ch. 1) thinks that Copernicus, the Ptolemaic Epicycles being removed, nonetheless retained the Eccentricity of the orbs, their reality being safe; and Tycho (tome 5 of the *Progymnasmata*, p. 439) thought the same of Copernicus, but timidly.

[Margin: A corollary of Pererius.]

From what has been said it is sufficiently clear how prudently Pererius said (bk. 2 on Genesis, q. 4) that none of the aforesaid opinions, the error of Basilides excepted, is repugnant to Scripture or to the Fathers.

CONCLUSION

[XIV.] Heavens taken **broadly** are **Five**—namely the Empyrean, the Aqueous or Crystalline, the Firmament of the Fixed [stars], the Ether of the Planets, and the Air. But **strictly**, only **Two**, if the discourse be of heavens really distinct—namely the Firmament and the Ether, that is, the heaven of the Fixed and the heaven of the Planets. For that there is, above all the heavens, the Empyrean, we showed sufficiently (sect. 1, q. 6, from num. 24). That there is, besides, an Aqueous or crystalline heaven—whether it be fluid or solid—above the whole Firmament, I taught (sect. 1, ch. 2, q. 1 & 3, & ch. 3, concl. 4). Moreover, that the Firmament of the Fixed [stars] is solid, and the Ether of the Planets fluid, I taught likewise (sect. 1, ch. 3, concl. 4, & ch. 7, n. 21). And so the heaven of the Fixed is indeed to be distinguished from the Planetary; but of the Planetary—as being continuous—there is no cause to distinguish [it] really, no more than to distinguish the Air or Water into several individuals, from the fact that diverse birds or fishes move in them. Finally, that the Aerial heaven, or Air, is called "heaven" broadly indeed but properly, both by the sacred and by the profane writers, is clear from what was said (sect. 1, ch. 1, num. 9, & sect. 3, this chapter, n. 5). But if you take "heaven" strictly for the simple visible body in which the stars are conversant, it follows that there are only two—namely the solid heaven of the Fixed, and the aerial [heaven] of the Planets; which heavens too are distinguished from each other in species, since the Firmament is from water, and the Ether of the Planets

from fire, as I taught (sect. 1, ch. 3, concl. 4).

[Margin: *The specific difference of the heavens.*]

If, however, anyone wishes to distribute the fluid heaven into one region for the new phenomena—into the heaven of Saturn, the heaven of Jupiter, the heaven of the Sun with its satellites Mars, Venus, Mercury, and into the heaven of the Moon—I do not refuse; nay, I admitted it (bk. 7, sect. 6, ch. 4, scholium 5). But about the specific difference of the heavens, others [hold] otherwise, as may be seen in Suárez (disp. 13 of the *Metaphysics*, sect. 11), Amici (tract. 4 *On the Heaven*, q. 7, dub. 1), the Conimbricenses (2 *On the Heaven*, ch. 5, q. 3, & ch. 7, q. 1), Pontius [Punch] (disp. 22, q. 7), Mastrius and Bellutus (disp. 2 *On the Heaven*, q. 2, art. 4), Arriaga (the single disp. *On the Heaven*, sect. 1), Tanner (tome 1 of the theology, disp. 6, q. 4, dub. 4).

[XV.] Now, since this disputation about the number of the heavens, and their distribution, is greatly diminished or confused among other Writers, it has seemed [good] to compose a brief synopsis of the preceding opinions, and to gather it into the following catalogue—with a brief little explanation added for the subdivision of the opinions into their classes; but their Authors I have already reviewed in their places, from num. 1.

SYNOPSIS — The Number of the heavens according to diverse Authors

Class	Number of heavens (with authors)	Treated at ¶
I	One heaven, that is, one World. <i>Aristotle.</i>	1
I	One heaven, the Starry, as being fluid. <i>St. Chrysostom, Tertullian, St. Bonaventure, Tycho, Longomontanus, Kepler, Bullialdus, Téllez.</i>	2
I	One Starry heaven, though solid. <i>Giles [of Rome], Hurtado, Casalpinus, Aversa.</i>	2
II	Two heavens; that is, the Empyrean (or [heaven] created on day 1), and the Firmament (made on day 2). <i>St. Clement, Acacius, Theodoret, Anastasius Sinaita, Procopius, Suidas, St. Bruno, Claudianus Mamertus.</i>	4
II	Two heavens; the Sidereal and the Aerial. <i>St. Justin.</i>	4
II	Two heavens; of the Fixed, and of the Planets. <i>St. Gregory of Nyssa.</i>	4
II	Two heavens; the Prime Mobile and the Sidereal. <i>Mastrius and Bellutus.</i>	4
III	Three heavens; namely Empyrean, Sidereal, Aerial. <i>Sts. Basil, Ambrose, Damascene; likewise Cassiodorus, Genebrardus, Suárez, Tanner, Hurtado, Oviedo, Téllez, Borrus.</i>	5
III	Three heavens; of the Fixed, of the Planets, [and] Aerial. <i>St. Gregory of Nyssa.</i>	5
III	Three heavens; Empyrean, Aqueous, Sidereal. <i>St. Thomas Aquinas.</i>	5
III	Three heavens; Aqueous, Sidereal, Aerial. <i>Cajetan.</i>	5
III	Three heavens; but mystically, three supernatural visions—Corporeal, Imaginary, Intellectual. <i>St. Augustine.</i>	5
IV	Four heavens; Empyrean, of the Fixed, of the Planets, Aerial—hinted by <i>St. Athanasius.</i>	6

Class	Number of heavens (with authors)	Treated at ¶
V	Five starry heavens; of the Fixed, of Saturn, of Jupiter, of the Sun (with the inclusion of Mars, Venus, Mercury), and of the Moon, if they be Solid. <i>Oviedo</i> .	7

[...the Synopsis continues on p. 276 (PDF 311): the Five-heavens-broadly entry (Riccioli's own), then Seven, Eight, Nine, Ten, Eleven, Twelve, and Fourteen heavens — after which **Chapter II** opens: "What and How Manifold the System of the World is."]

(printed p. 276 — The Synopsis table concludes Chapter I. Chapter II then opens, "What and How Manifold the System of the World is," giving the definition of a World-system and beginning an account of the alternating history of the ancient systems.)

SYNOPSIS — The Number of the heavens according to diverse Authors (continued)

Class	Number of heavens (with authors)	Treated at ¶
V	Five heavens broadly; Empyrean, Aqueous, of the Fixed, of the Planets, Aerial. <i>We [Riccioli]</i> .	7
VII	Seven heavens, confusedly. <i>Philastrius</i> .	8
VII	Seven heavens; that is, Air, Aether, Olympus, Fire, Firmament, Heaven of the Angels, and Heaven of the Trinity (<i>Bede</i>); or: the lowest [region] of Air & the supreme region, the lowest of Fire & the supreme of Fire, Sidereal, Crystalline, Empyrean (<i>Rabanus</i>).	8
VIII	Eight starry heavens; namely the Aplanes (or sphere of the Fixed) and the 7 spheres of the Planets. <i>Babylonians, Egyptians, Eudoxus, Plato, Calippus, Aristotle, Cicero, Philo, Sts. Basil, Ambrose, Damascene, Bonaventure, Remigius, Thomas; likewise Aben Ezra, the Carthusian, Lyra, Tostado, Burgos, Riccius, Orontius, Cremonini, Philalthæus, Amici, Rubius</i> . Of whom, however, Augustine Riccius, Orontius, [and] Amici attribute a proper motion to the Eighth sphere.	9
IX	Nine heavens; namely the Empyrean and the Eight starry heavens, if the starry [heavens] be solid. <i>Arriaga</i> .	10
IX	Nine heavens; that is, the Prime Mobile and the Eight starry heavens. <i>Macrobius, Haly, Alpetragius, Rabbi Joshua, Rabbi Moses, Scotus, Abraham Zacut, Sacrobosco, Chiaramonti</i> ; attributed to Hipparchus and Ptolemy by many, but not safely enough.	10
X	Ten heavens; namely the Prime Mobile, a Sphere for the motion of the Fixed and of the Auges, the Eighth sphere for Trepidation in longitude, and seven Planetary [spheres]. <i>Alfonsines, Fernel, Peurbach, Regiomontanus, J. B. Amici, Apianus, Maurolyco, Langius</i> .	11
X	Ten heavens; that is, the Prime Mobile, a Sphere of Trepidation in longitude, the Sphere of the Fixed, and seven Planetary [spheres]. <i>Arzachel, Thebit, Isaac the Israelite</i> .	11
X	Ten heavens; namely the Empyrean, the Prime Mobile, and eight Starry [heavens]. <i>William of Paris, & John Anthony Delphinus</i> .	11

Class	Number of heavens (with authors)	Treated at ¶
XI	Eleven heavens; namely the Empyrean and the ten mobile spheres of the Alfonsines. <i>Pierre d'Ailly, the Conimbricenses, Martinengo, & formerly Clavius.</i>	12
XI	Eleven heavens; namely the Prime Mobile, a Sphere of the first Libration in latitude, a Sphere of the second Libration in longitude, the Sphere of the Fixed, and seven Spheres of the Planets. <i>John Werner, Leopold of Austria, John Anthony Magini, & later Clavius</i> —to whom, however, admitting the Empyrean, the heavens come out to 12.	12
XII	Twelve heavens. <i>Clavius</i> : to whom, admitting the Empyrean, the heavens come out to 12.	12
XIV	Fourteen heavens. <i>John Baptist Turriano [Della Torre] & Fracastoro</i> —about whom, see what we shall say below in the Fracastorian System.	—

CHAPTER II

What and How Manifold the System of the World is; and on the most ancient Systems, and especially that of Pythagoras, Archimedes, and Pliny, which is wont to be called the Ptolemaic, and flourished down to Clavius

[Margin: *What a System is.*]

[I.] The **System of the World** is nothing other than the Coordination, or composition, of the great parts of the World—namely the Elements and the Heavens: of which the matter, as it were, is the number of the elements and heavens (both total and partial); but the form is the order and situation of them among themselves, and relatively to the center of the Universe.

[Margin: *How manifold the system is.*]

Regarded, therefore, by [its] form, the System of the World is divided into two highest kinds—namely, into that which is constructed around the earth immobile at the center of the Universe; and into that which is constructed around the Sun, immobile at the center of the Universe, or immune from the motion $\tau\epsilon\varsigma\ \phi\omicron\rho\epsilon\varsigma\ \kappa\alpha\tau\ \tau\epsilon\pi\omicron\nu$ [*tēs phorâs katà tópon*, "of locomotion according to place"]—namely of translation [local displacement]—but moving the Earth through the annual orb. Again, each [kind], but especially the first, is subdivided into the Homocentric, the Eccentric, and the [system] mixed from some Concentric orbs and some Eccentric. Now, since enough has been done about the Number of the heavens (as the remote matter of the Cosmic system) in the preceding chapter, it follows that we should treat of the order of the heavens and Planets, and of the number of the partial orbs. And we take our beginning from the most ancient [systems].

[Margin: *The alternating rise and fall of the systems.*]

[II.] It is most worthy of observation that two sects of the Physicists and Mathematicians, alternately—like Castor and Pollux—perished, and again, revived, prevailed in the Schools. For first Pythagoras, with some [members] of his [school], rightly placing the Earth in the center of the World, used Eccentrics and Epicycles, and placed the Sun in the middle of the Planets. But others of the Pythagoreans, retaining Epicycles and Eccentrics, nevertheless placed the Sun in the center of the world, and the Earth in the middle of the seven Planets. Then Plato again restored the earth to the center of the Universe, and so placed the Sun in the middle of the Planets, that nevertheless he reckoned Venus and Mercury to be borne, for the most part, above it [the Sun]; whom Eudoxus, Calippus, and Aristotle followed, [and] strove to explain the whole

motion of the Planets through concentric circles—and so judged that neither Venus nor Mercury goes through Epicycles above and below the Sun, but [are] either always above the Sun, or always below. When these were dead, Others again embraced Eccentrics and Epicycles, and the Earth in the middle of the world—such as Archimedes, Hipparchus, Sosigenes, Cicero, Vitruvius, Pliny, Macrobius, Capella—yet with a varying order of the Planets. Others, moving the Earth from [its] place—such as Aristarchus, and Philolaus the Pythagorean—what they thought about Eccentrics and Epicycles, either they did not set forth, or it has not been handed down to posterity. But again Ptolemy, reawakening the most ancient opinion of the Pythagoreans, so established Eccentrics and Epicycles, that he retained the earth in the middle of the World, [and] the Sun in the middle of the Planets; and, persuading the greatest part of the Astronomers of this opinion, extended it down to the fourteenth century. That order of the Planets, however, Alpetragius and Geber judged should be changed. But the homocentrics too were taken up again by Alpetragius, Amici, and Delphinus, with a few others; on the contrary, Turriano and Fracastoro, the Ptolemaic order being retained, nonetheless recalled into the light homocentrics—and indeed more [of them] than the Aristotelians, not to say the Eudoxians. But about the same time Copernicus not only summoned forth from the tomb the figment of Philolaus and Aristarchus, about the annual motion of the earth around the immobile Sun, but adorned it with arguments so probable that he has persuaded very many of it down to this very day; and he carried Venus and Mercury around now below, now above the Sun, with Plato, Vitruvius, Macrobius, Capella, and Bede. Hence Tycho—and with him Longomontanus—having got a most beautiful handle, not only—

[...continues on p. 277 (PDF 312): "...not only [retained the Earth at the center, but]..." — Riccioli proceeds to the Tychonic system and the modern revival of the geo-heliocentric arrangement.]

(printed p. 277 — The historical survey concludes with the modern systems — Tycho, Argoli, Riccioli's own, and Baliani — and the absurd ancient ones. The chapter then treats the Pythagorean system with its harmonic intervals, Archimedes, and Pliny's system, and opens the account of Ptolemy.)

...[Hence Tycho, and with him Longomontanus, having got a most beautiful handle,] not only ordered Venus and Mercury, but Mars too, Jupiter, and Saturn, to go around the Sun; but the Sun and Moon, with the Fixed [stars], around the Earth—[the Earth] resting in the middle of the world, free from all motion of translation; and, the Eccentrics being retained, he removed the Ptolemaic Epicycles. Finally Argoli, the Tychonic system being dislocated, tried to move the three superior [planets] around the earth, but Mercury and Venus around the Sun, the earth being left in the middle of the world. But we [hold that] around the earth [are moved] Saturn, Jupiter, the Sun, the Moon, and the Fixed [stars]; but we judge that Venus, Mercury, and Mars can be ordered around the Sun. Finally, Don Giovanni Battista Baliani suspected that the Moon could be placed in the center of the World. It is, therefore, worth the effort to discuss singly so many and so diverse attempts and studies, and to weigh the reasons adduced on either side.

[Margin: Ancient systems, but absurd.]

But I have passed over, as of no consideration, those three opinions about which Plutarch (bk. 2 of the *Placita*, ch. 15) [speaks] in this manner: "Xenocrates thinks the stars are moved in one and the same surface. The rest of the Stoics [place them] with varying lowness and loftiness among themselves. Democritus [places] the fixed [stars] in the supreme [place], hence the wandering [stars], and below these the Sun, Lucifer [Venus], the Moon, etc. Metrodorus of Chios and Crates [held] the Sun set as the supreme of all, after which the Moon, [and] below these the wandering and non-wandering [stars]." So that nothing is so absurd that it does not fortify itself with some patron.

[Margin: Pythagoras's system.]

[III.] The most ancient, therefore, but of the tolerable systems, was the Pythagorean; in which Pythagoras so disposed the intervals by harmonic ratios, that, beginning from the earth, he ascended thence to the Moon, hence to Mercury, hence to Venus; hence further to the Sun; but from the Sun to Mars, hence to Jupiter,

hence to Saturn, and at last from Saturn to the Fixed [stars]—as Pliny plainly relates (bk. 2, ch. 22). For he says: "Pythagoras sometimes, from a musical reckoning, calls 'a tone' [the distance] by which the Moon is distant from the earth. From it to Mercury half of that space, and from it to Venus almost as much; from her to the Sun, one and a half times [the amount]. From the Sun to Mars a tone—that is, as much as [from] the earth to the Moon; from it to Jupiter half, and from it to Saturn half, and thence one and a half times to the Zodiac [Signiferum]." With whom Censorinus entirely agrees (in the book *On the Natal Day*, ch. 11, toward the end), in these words: "Therefore from the earth to the Moon Pythagoras thought there are about 126,000 stadia, and that this is the interval of a tone; from the Moon to the star of Mercury, which is called *Stilbon* (στῆλβων, 'the gleaming'), half of it, as it were a *semitone* (ἡμιτονιον); hence to *Phosphoros* (φωσφορος, 'the light-bringer'), which is the star of Venus, almost as much—that is, another semitone; thence further to the Sun three times as much, as it were a tone and a half; and so the Sun's star is distant from the earth three tones and a half, which is called a *diapente* [a fifth]; but from the Moon two and a half, which is called a *diatessaron* [a fourth]. But from the Sun to the star of Mars, whose name is *Pyroeis* (πυροεις, 'the fiery'), there is just as much interval as from the earth to the Moon, and that makes a *tone* (τονος); hence to the star of Jupiter, which is called *Phaethon* (φαειθων), half of it, which makes a semitone; thence to the highest heaven, where the Signs are, likewise a semitone." Thus far concerning the order and symmetry of the heavens according to Pythagoras.

[Margin: *The Pythagoreans [were] the authors of Eccentrics & Epicycles. Pythagoras's system [was] not received by all the Pythagoreans.*]

That the Pythagoreans first devised Eccentrics and Epicycles, Nicomachus is the authority (in Simplicius, comment. 2 *On the Heaven*, where he diligently explains the hypotheses of the ancients); and from him, G. B. Amici (ch. 6, *On the motions of the celestial bodies*), and J. A. Delphinus (*On the celestial globes and motions*, ch. 4), where he attributes this very [thing] to Pythagoras. From what has been said it is clear that it is not rightly called by Paolo Antonio Foscarini "the system of Pythagoras," or absolutely "Pythagorean," that [system] in which the Sun is in the center of the world, and the earth—above Mercury and Venus—is rolled around the Sun, although some disciples of Pythagoras thought thus.

[Margin: *Archimedes's system. And Cicero's.*]

[IV.] To the Pythagorean system, as to [its] order, Archimedes subscribed—if the things are true which Macrobius (bk. 2 on the *Dream of Scipio*, ch. 3) thus relates about him: "And Archimedes indeed believed that he had detected the number of stadia by which the Moon was distant from the surface of the earth, Mercury from the Moon, Venus from Mercury, the Sun from Venus, Mars from the Sun, Jupiter from Mars, Saturn from Jupiter. But also, from the orb of Saturn all the way to the starry heaven itself, he thought he had measured out the whole space by reason. Which dimension of Archimedes, however, is repudiated by the Platonists." Nor Archimedes only, but also Cicero (*On the Dream of Scipio*)—whose words we shall report in a more opportune place, the following chapter, number 4—so that we may dissociate him from Plato.

[Margin: *Pliny's system.*]

[V.] Pliny himself too (bk. 2, chapters 5, 6, 8, 15, 16, 17, taken together) expressed the same order, and acknowledged the Apesides of the Eccentrics and Epicycles, or the perigees and apogees of the Planets—surely from Sosigenes, from whom he was wont to draw much. Therefore in ch. 5 he says: "That the Earth is the lowest and the middle [point] in the whole, and that the same, on the hinge of the universe, stands suspended, balancing the [things] by which it hangs: thus alone immobile, with the universe revolving about it." Soon, in ch. 6: "Between this [earth] and the heaven hang, by the same breath, separated by fixed intervals, seven stars, which from their gait we call 'wandering,' though none wander less than they; in the middle of them is carried the Sun." But with greater distinction, in ch. 8: "Now, the body of the world itself being left aside, let the rest between heaven and the lands be treated. It is certain that the highest is what they call the star of Saturn, and therefore [it] appears the smallest, and goes round in the largest circle, and in the

thirtieth year returns to the shortest beginnings of its seat, etc. But the star of Saturn is of a gelid and stiffening nature; and much lower than it [is] the circle of Jupiter, and therefore [it] is carried round by a swifter motion in twelve years. The third, of Mars—which some call Hercules's—fiery, burning from the nearness of the Sun, is turned round in almost two years; and therefore, by the excessive ardor of this [Mars] and the rigor of Saturn, Jupiter, set between the two, is tempered from each, and made salutary. Then the course of the Sun is of 360 parts [degrees]; but so that the observation of its shadows may return to the marks, five days are added over the years, and over and above a fourth part of a day. For which cause, in the fifth year one intercalary day is added, that the reckoning of the seasons may agree with the Sun's journey. Below the Sun goes round a huge star called Venus's, wandering with an alternating course, and a rival of the Sun and Moon by its very surnames. For, going before and rising before the morning, it takes the name of *Lucifer* [light-bringer], as a second Sun hastening the day; on the contrary, shining from the West [at setting], it is called *Vesper* [evening-star], as prolonging the light and rendering the office of the Moon. Which nature of it Pythagoras of Samos first detected, about the 42nd Olympiad, etc. But it accomplishes the circuit of the Zodiac in 348 days, never standing off from the Sun farther than 46 parts [degrees], as Timaeus holds. By a like reasoning, but by no means in magnitude, nearest to it [is] the star of Mercury, called by some Apollo's, [which] is carried in a lower circle, in a swifter circuit by nine days, shining now before the rising of the Sun, now after [its] setting, never more remote from it than 23 parts [degrees], as this same [Pliny] and Sosigenes teach, etc."

He proceeds hence (ch. 9) to speak of the Moon, and from ch. 15 to 17 he treats of the stations, retrogressions, elevations, depressions, velocity and slowness of the Planets, and refers the causes to [their position] in the circles, according as they approach their apsides or recede from them. But let those words (ch. 15) be noted: "For many causes all these things happen. The first [is] of the circles, which the Greeks call *apsides* in the stars—for one must use the Greek words. These [apsides] are proper to each of them, and another to the world"; and a little after: "Therefore from another center, for each, their apsides arise, and therefore they have diverse orbs, and dissimilar motions, etc." Do you see how Pliny designated Eccentric orbs?

[Margin: *Ptolemy's system.*]

[VI.] As Pliny grew old, Ptolemy began to flourish, who took over willingly the system of Pythagoras—which he knew had pleased Archimedes, Hipparchus, and Sosigenes—and fortified it with several reasons: both as to the Eccentrics and Epicycles (which he used in bks. 3, 4, 5, and 9 to 13 of the *Almagest*), and as to the order of the Planets, and the state of the immobile earth in the center of the universe—whose arguments about the situation and immobility of the earth (from bk. 1 of the *Almagest*, ch. 5 & 7), although they were not neglected by us (bk. 2, ch. 2 & 3), nevertheless below, in section 4, must be more diligently treated and weighed with the solutions of the Copernicans. As regards the order of the Planets: behold his own words (from bk. 9 of the *Great Construction*, ch. 1): "The sphere of Saturn, which is the greater, and of Jupiter, which is second and nearer to the earth, and of Mars beneath it, are more remote from the earth than the rest. The Solar [sphere] too is said by almost all the first Mathematicians [to be] in nearly the same way. But the spheres of Venus and of Mercury are by the Ancients placed below the Solar [sphere]; by some of the younger [moderns], however, these too are set above it, because the Sun has never been seen to suffer an Eclipse from these Planets. But this reasoning seems weak to us. For some Planets can be below the Sun, and yet not be opposed [interposed] to it, because they are not in the same plane passing through them and our sight—just as also, in the conjunctions of the Moon, for the most part no eclipse of the Sun occurs. But since the understanding of this matter cannot be had otherwise—because none of these stars makes a sensible parallax, from which alone the distances are taken—

[...continues on p. 278 (PDF 313): "...the order of the ancients seems to me to proceed more naturally, when, the Sun being placed in the middle, it separates those Planets which can depart from the Sun by however great a distance, from those which cannot..." — Ptolemy's defense against Geber and Copernicus, then ¶VII (Ptolemy's

(printed p. 278 — The account of Ptolemy concludes, vindicating him against Geber and Copernicus on the Venus and Mercury parallax. The page then surveys Ptolemy's followers, especially Regiomontanus, and opens the treatment of Clavius's system and his arguments for the planetary order.)

[Margin: Ptolemy's reasoning vindicated from the objections of Geber and Copernicus.]

...[the distances] are taken; the order of the ancients seems to me, in [its] verisimilitude, to proceed more naturally, when, the Sun being placed in the middle, it separates those Planets which can depart from the Sun by however great a distance, from those which cannot so depart, but are always led around near it [the Sun]: although [the hypothesis] does not move them so [far] from the Sun toward the earth, that a parallax—about which one should be concerned—could occur. By which words, indeed, he sufficiently forestalls the objections to be hurled against him afterward by Geber and Copernicus. For he does not deny all parallax to Venus and Mercury, since by this very [fact]—that he places them below the Sun—he is forced to concede [them] a somewhat greater [parallax] than [to] the Sun, and to Venus at perigee about 3', and to Mercury 7', as Geber gathers (bk. 7, ch. 1 of his *Astronomy*). But he denies that this [parallax] is to be cared about in this business, or that it is so evident from observations, that from it, foreknown beforehand, their distances can be established. Moreover, he does not absolutely deny that some little part of the Sun can be eclipsed by Venus or Mercury—for that this follows from the Ptolemaic hypothesis, Geber shows in the same place; but he says that, if this has not been observed, it has happened because the observations of the conjunctions of the Sun with Venus (■) or Mercury (■) were made at that time when either, on account of [its] latitude from the Ecliptic, appeared on this side of, or beyond, the Sun's disc.

Finally Geber too, above, and Copernicus (bk. 1, ch. 10), thus argue: "That argument too of Ptolemy" (the words are Copernicus's) "—that the Sun ought to be carried in the middle, between those departing in every direction from it and those not departing—how unpersuasive it is, appears from this: that the Moon, itself also departing in every direction, betrays its falsity." But Ptolemy thought this [argument] probable not absolutely, but on the hypothesis that the knowledge of this matter cannot be had otherwise; whereas the place of the Moon below the Sun is manifest from elsewhere—both from Eclipses, and from the Lunar parallaxes, most evidently exceeding the Solar [ones].

[Margin: Regiomontanus's system.]

[VII.] To Ptolemy, as to the order of the Planets, subscribed thereafter all the Arabs (except Geber and Alpetragius); and all the Greeks (except Theon); all the Latins, finally, down to Clavius, before the use of the Telescope had grown strong (except Martianus Capella, Macrobius, Apuleius, Sammerius, Bede, Copernicus, and the Copernicans); but especially John Regiomontanus (in the *Epitome of the Almagest*, bk. 9, prop. 1). Who retained Venus and Mercury below the Sun the more willingly, the more probable he thought it that the space which is between the Sun at perigee and the Moon at perigee—namely [1006] terrestrial semidiameters, as he himself computes—ought not to be empty of every star. He adds—both he himself, and Clavius (on the *Sphere*, p. 71), and the Conimbricam College (2 *On the Heaven*, ch. 7, q. 4, art. 2): (1) the Eclipse which the Sun suffers from Venus passing under the Sun's disc is not sensible, because the disc of Venus, in comparison to the disc of the Sun, is about a hundredth part, as I too computed (bk. 7, sect. 1, ch. 4, num. 4); and much less the Eclipse from tiny Mercury; or, as Copernicus says (bk. 1, ch. 10): "That so small a spot is not easily seen beneath the most excellent light." But these things, as I said in the same place, must be understood of the naked eye, and before (or apart from) the use of the Telescope; otherwise, that Mercury was seen below [against] the Sun by the help of the Telescope, I related (bk. 3, ch. 3, scholium 3), where also (scholium 2) I taught that that blackish [spot] which was seen below the Sun by Averroes, or Aven Rodan [Ibn Ri■w■n], or by others in the time of Charlemagne, was not Mercury, but one or more spots of the Sun.

[Margin: Regiomontanus is vindicated from Copernicus's insults.]

But Copernicus (bk. 1, ch. 10) refutes the former reasoning of Regiomontanus—(whom, however, whether from forgetfulness or from swelling of mind, he passes over unnamed)—from this, that between the Moon and us there are air and fire, and a space of 52 semidiameters empty of every star. But Regiomontanus would answer that the case is unlike, because Air and Fire are not heaven [celestial], nor a place apt for containing a star. Copernicus adds that the semidiameter of the Epicycle of Venus—by which she departs from the Sun on either side about 45 degrees—occupies a greater space than [the distance] from the earth to Mercury at apogee, and yet is empty of a star; but Regiomontanus would answer that the space within that Epicycle is not empty, since through it Venus runs from apogee to perigee.

[Margin: Clavius's system. 1st reason of Clavius, from parallax.]

[VIII.] Lastly, our Clavius tried to confirm the order of the Pythagorean and Ptolemaic System (in ch. 1 of the *Sphere*, from p. 65 in my [copy]), and from him Francesco Barozzi (bk. 1 of the *Cosmography*, p. 9). Which reasons must be weighed. The **first** is from parallax: for the greater it is (other things being equal), the nearer the star having it is to the earth, as is clear from what was said (bk. 1, ch. 35). But the parallax of the Moon is far greater than that of the Sun, as plainly appears from what was said (bk. 3, ch. 8, & bk. 4, ch. 14). Likewise the parallax of Mercury [is] greater than that of Venus, and of Venus than of the Sun, says Clavius—for as to the three superior [planets] he admits that this argument does not avail. But in reality, as Regiomontanus admits (bk. 9 of the *Epitome*, prop. 1), and before him Ptolemy (bk. 9 of the *Almagest*, ch. 1), the motion of Venus and Mercury is not so scrupulously known, that from it—especially using the Ptolemaic or Alfonsine tables—their parallax can be evidently discerned; and rather the distance from the earth must be established from elsewhere, and then from it the parallax is to be gathered by reasoning. Then, since by the Telescope showing [it] it is now established that Venus and Mercury, when they are nearer to apogee, are situated above the Sun, it is false that their parallax is then greater than the Solar; again, because they so go around the Sun that Mercury departs less from the Sun, it follows that Mercury, at its perigee, is higher than Venus at perigee, and therefore undergoes a smaller parallax.

[Margin: 2nd reason, from shadows.]

The **second** reason is drawn from shadow: for the smaller the shadow of the gnomon, the higher (other things being equal) is the star from whose rays, drawn through the top of the gnomon, the shadow is cast—as is clear from the diagram adduced (bk. 4, ch. 10, num. 1). But at an equal elevation from the horizon, the Solar shadow is shorter than the Lunar; nay (says Barozzi), the shadow of the Sun's ray is less than that of Venus's ray, and of Venus's than of Mercury's, and of Mercury's than the Moon's—and he testifies that this is proved by experience. But concerning Venus at perigee with respect to the Sun, we grant [it]; but concerning her with respect to Mercury, we deny [it]; and concerning either planet situated near apogee, we likewise deny [it]: besides that the experiment of the Mercurial shadow is suspect to me, for Mercury near perigee is wont to lie hidden under the brightness of the Sun—nay, in its greatest digression it does not appear, but [rather] the twilight light dilutes [washes out] its shadows.

[Margin: A slip of Clavius.]

This argument could surely be much more brilliantly accommodated to Jupiter, whose shadow is more evident than Mercury's: and so I would not have wished those words to have escaped Clavius (p. 68 of the *Sphere*): "The same which we said of the Moon with respect to the Sun can be accommodated with respect to the other planets; for although the other planets do not shine so [much] as to cast a shadow, yet it can be known how much their rays are cast through the tops of gnomons." For the rays of Venus and Jupiter do cast a manifest shadow. Then, how slippery is that accommodation and supplement of shadow!—say, by placing the eye in a plane and looking at the Planet through the top of the gnomon; and how difficult, in these Planets, to foreknow the moment at which they are at such and so great an altitude above the astronomical

Horizon, independently of their distance from the center of the earth. But it is too easy, from a presupposed hypothesis, to feign experiments, and to reckon [results] that were never produced as [results] that would be, if they were [produced].

[Margin: 3rd reason, from Eclipses.]

The **third** reason is sought from mutual Eclipses: for that star is nearer to the earth and to us observing from the earth, which, by the interposition of its body, occults the other from us; but the Moon occults from us not only the Sun, but all the other planets: therefore the Moon is the lowest of all. By a like reasoning, Mercury will be below Venus, and Venus below Mars, and so on, says Clavius—namely, from the presumption of this system, not from any experiment concerning Mercury; for Mercury has never been seen to have occulted Venus; nay, perhaps it never could nor will be able even to occult her, but rather Venus [occults] Mercury. See what we have handed down about these occultations of the Planets, established from observation (bk. 5, ch. 2, schol. 2, & bk. 7, sect. 6, ch. 14).

[Margin: 4th reason, from the speed of motion.]

The **fourth** reason is taken from the velocity of the proper motion, and the slowness of the common motion: for the more a Planet is distant from the prime Mobile and from the Fixed [stars], the more quickly it completes its period, by tending toward the East; whence it happens that, returning daily later to the same Meridian, it seems slower in the motion of the prime mobile and of the Fixed [stars] toward the West. Since, therefore, the Fixed [stars] cannot complete their period except after many thousands of years, but Saturn completes it in about 30 years, and Jupiter in 12, and Mars in about 2 years, and the Sun in a single year, but the Moon within one month, while Venus too and Mercury complete it more quickly than Mars and more slowly than the Moon—it is established that below the Fixed [stars] are—

[...continues on p. 279 (PDF 314): "...[below the Fixed stars is] Saturn, and below Saturn Jupiter, then Mars, then the Sun, then Venus and Mercury, and lowest of all the Moon" — Clavius's fourth argument concluded, then the remaining reasons for the Ptolemaic order and Riccioli's assessment.]

(printed p. 279 — The treatment of Clavius concludes with his remaining reasons (4–9) for the Ptolemaic planetary order. The page then presents the catalogue of authors who subscribed to that order.)

[Margin: 4th reason continued.]

...it is established that immediately below the Fixed [stars] is Saturn, below it Jupiter, below Jupiter Mars, below Mars the Sun, Venus, and Mercury, and below these finally the Moon. But from this argument Clavius denies that anything certain can be gathered about the order of the Sun, Venus, and Mercury among themselves: for the mean motions of the Sun, Venus, and Mercury are equal, but the apparent motion in the Epicycle is longer for Venus than for the Sun, and for the Sun than for Mercury. By which argument Alpetragius (as we shall relate below) contends that Venus ought to be placed below Mars, above the Sun, but Mercury below the Sun. Further, as we said (bk. 7, sect. 3, ch. 11, at the end), the revolution of Venus, the Sun's motion (which it accompanies) being computed, is 584 days very nearly, and of Mercury about 116; but around the immobile Sun the revolution of Venus is about 225 days, and of Mercury about 88.

[Margin: 5th reason, from the interval between the Moon (■) and the Sun (■) [being] not empty.]

The **fifth** reason is that which I already adduced at number 6, from Regiomontanus—namely, lest the space which is from the Moon to the Sun be empty of a star; which reason avails much more in the hypothesis of Kepler, Ours, and Wendelin, in which between the Moon and the Sun there intervene far more semidiameters of the earth than 1006: for they are, for Kepler, about 3400; for me, 6036; for Wendelin, about 14600. But in the Ptolemaic system the intervals of the Planets are so ordered that nothing superfluous intervenes between heaven and heaven, but the lowest [point] of Saturn, or [its] Perigee, touches the apogee of Jupiter, and so of the rest, as we taught (bk. 7, sect. 6, from ch. 1 to 4). But this reason now ceases in the more recent

hypothesis, in which—if, by the Telescope showing [it], we lead Venus around the Sun in a wider circuit, and Mercury in a narrower, and if we wish to keep safe the magnitude of Venus's Epicycle from [its] greatest digressions from the Sun and from the distance of the Sun from the earth—it is necessary that between the Moon at apogee and Venus at perigee there intervene a great space, empty of every ordinary Planet, as may be seen by [one] comparing the Lunar distances (about which bk. 4, ch. 14) with the least distances of Venus from the earth by the more recent hypotheses (about which bk. 7, sect. 6, ch. 2, in table 2).

[Margin: 6th reason, from the multiplicity of motions.]

The **sixth** reason is taken from the multiplicity and irregularity of the motions: for Mercury has more motions than Venus and the Sun, and therefore the Ptolemaics attribute to Mercury five orbs and an Epicycle, but to Venus three. But this reason is very weak; for thus the Sun would have to be placed above all the Planets, because by the simplicity of [its] motion it is more similar than all the Planets to the motion of the Fixed [stars] and the Prime mobile. Wherefore Aristotle (bk. 2 *On the Heaven*, ch. 10, or text 60) said: "It is no less wonderful, for what cause those [bodies] which are more distant from the first motion are not always moved by more motions, etc. For the Sun and Moon are moved by fewer motions than some of the wandering stars, although they are farther from the middle, and nearer to the first of bodies, than these." Although the latest age has detected far more motions in the Moon, according to what was said (bk. 4, ch. 18). Clavius could, therefore, have neglected this little reason.

[Margin: 7th reason, from the dependence of the Planets on the Sun.]

The **seventh** reason is drawn from the dependence of the Planets on the Sun in light and motion: for the Sun is, as it were, the King and Heart, the rule and moderator of all the Planets—since all the Planets, in their motions, are bound by a certain admirable harmony to the Sun's motion, as is clear concerning the synodic revolutions of the Moon; and concerning the periods of the other Planets, whether in the Eccentric or in the Epicycle, it is clear from what was said (bk. 7, sect. 1, ch. 7). [The Sun] ought, therefore, to go in the middle of them, that it might equably direct their motions and illuminate them—since we see Mars and Venus, on account of [their] nearness to the Sun, more strongly illuminated. Nor did Clavius abstain from a likeness and analogy of those [things] which are customary among human polities, so as to set the Sun in the middle place as King; for he says that Saturn, as being an old man, is the counsellor of the Sun; Jupiter, on account of [his] magnanimity, is the Judge; Mars the leader of the soldiery; Venus the mother of the household; Mercury the scribe or chancellor; the Moon, finally, the swiftest messenger—"As most [people] jest," says Clavius (for he did not wish these [things] to be recounted by himself seriously); "though Stoeffler (on Proclus, p. 44) relates these things seriously." But these [things] are said too much as commonplaces; and by almost the same argument the Copernicans contend that the Sun ought to have been placed in the middle of the whole Universe, but Tycho in the middle of the five smaller Planets surrounding it; nor must a King, or Master, or Leader always be in the middle of his [people], but often he follows after all [of them], or even sometimes goes before them.

[Margin: 8th reason, from the Sun's activity.]

The **eighth** reason, which Albumasar adduces (in his Great Introductory [work], tract. 3, diff. 3), rests on the activity of the Sun: for it ought to be placed in the middle of the Planets, lest, if it were higher, [it should fail in heat]; but if too low, it would act too much upon these lower [things, and scorch them here too]. Clavius thinks Ovid alluded [to this] (*Metamorphoses* 2), when he brings in Phoebus moderating, by [his] counsel, Phaethon [who was] guiding the solar chariot:

"Going too high, you will burn the heavenly signs;

too low, the lands: in the middle you will go most safely."

But this reason, if it held, would require the Sun to be precisely in the middle of the interval which is from the earth to the Fixed [stars], as to quantity; whereas in no hypothesis—much less the Ptolemaic—can this be

true, as is clear from the distances of the Planets from the earth, reduced by us into a table (bk. 7, sect. 6, ch. 2).

[Margin: 9th reason, from the week of days and the dominion of the Planets.]

The **ninth** reason is taken from the order and nomenclature of the days of the week—which order Xiphilinus relates (from bk. 36 of Dio, in [the life of] Pompey) to have been instituted by the Egyptians. For, beginning from Saturn, and attributing to it the dominion over the first hour of the day, and running through the hours according to this order of the Planets—Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon—the dominion falls upon the first hour of the following day to the Sun, and of the [next] following to the Moon, then to Mars, afterward to Mercury, hence to Jupiter, and at last to Venus, according to what was said (bk. 1, ch. 30). But Dio in the same place, and Xiphilinus, indicate also another reason for this order, taken from the harmonic intervals—which [reason], also from Pythagoras, Pliny and Censorinus hinted to us (we adduced [it] at number 3). And that distribution [of the days] presupposes the aforesaid order of the Planets, but does not produce [prove] it; for neither is it true—nay, [it is] a most vain figment—that the dominion of the first hour of the Lord's day [Sunday] is given to the Sun rather than to another Planet, and so of the rest. The other [matters] about the harmonic intervals, which everyone tries to drag over to his own system, must be discussed in section [4] of this book.

For these causes, then—and especially on account of [its] antiquity and authority—this system prevailed over all others, from Pythagoras down to our own century; and so, for about 20 centuries, it had on its side the greater part of the Astronomers, and many of the Theologians and Physicists [Natural Philosophers]; of whom it is fitting to review the chief.

Authors who subscribed to Pythagoras and Ptolemy as to the Order of the Planets

[IX.] I said "as to the order"; for as to the multitude of the total or partial heavens some have dissented, as is clear from what was said here in chapter 1; and as to the hypothesis of Eccentrics, the Homocentrists [dissented], as I already said (sect. 2, ch. 2). But as to the order of the Planets, to this system have given their vote: Archimedes (in Macrobius, bk. 2 on the *Dream of Scipio*, ch. 3); the Chaldeans (in Bede, [the book] *On the Elements of Philosophy*); Cicero (*On the Dream of Scipio*); Pliny (bk. 2, ch. 6 & 7); Cleomedes (bk. 1 of the *Cyclic Theory*, ch. 3); Sosigenes (in Simplicius, on 2 *On the Heaven*); Albategnius [al-Battānī] (*On the science of the stars*, ch. 50); Alfraganus (difference 12, where he says he follows the opinion of the ancients); Albumasar (in his Introductory [work], tract. 3, diff. 3). And these were followed by the greater part of the Arabs, and the Alfonsines in [their] tables; John Fernel (bk. 1 of the *Cosmotheoria*); Peurbach (in the *Theorics of the Planets*) and its expositors, especially Pedro Nunes, Erasmus Reinhold, Erasmus Oswald, and Christian Wursthuis. Besides, John Regiomontanus (in the *Epitome of the Almagest*, bk. 4, prop. 1); John Stoeffler (on Proclus's *Sphere*, p. 44); Julius Firmicus (bk. 3 of the *Mathesis*, from ch. 3 to 9); Giovanni Pontano (bk. 7, *On celestial things*); John of Sacrobosco (on ch. 1 of the *Sphere*, and there his commentators enumerated at the beginning of bk. 1 of our *Almagest*); Orontius [Finé] (on the *Sphere*, bk. 1, ch. [...]); G. B. Amici (opusculum *On the motions of the celestial bodies*); J. A. Delphinus (*On the celestial Globes*); Fracastoro (in the *Homocentrica*, sect. 2 & 3); Egnatio Danti (in [his] tables, from table 12); Peter Apianus (in the *Astronomicum Caesareum*); Gemma Frisius (*On the principles of Cosmography*, bk. 1); Maurolyco (Dialogue 1 & 3 of the *Cosmography*, and at the end of the same); John Anthony Magini (in the *Theorics of the Planets*); Clavius (on the *Sphere*, from p. 64); Barozzi (in the *Cosmography*, bk. 1—

[...the author-catalogue continues on p. 280 (PDF 315): "...p. 8; Rudolph Goelenius, Michael Neander, Cardano, Ascanio Martinengo; and, to add a Father or two, St. John Damascene and Bede" — then the **System I** diagram (the Ptolemaic/Pythagorean order), and ¶X: Clavius's "swan-song," on seeing Galileo's telescopic discoveries.]

(printed p. 280 — The author-catalogue concludes, followed by the System I diagram and Clavius's "swan-song" on the telescope, which ends Chapter II. Chapter III then opens, on the Platonic, Geber, and Theon systems. A large engraved diagram of the Ptolemaic system spans both columns.)

...[Barozzi, in the *Cosmography*, bk. 1,] p. 8; Rudolph Goclenius (in the *Urania*, ch. 4); Michael Neander (in the *Elements of the spherical doctrine*, ch. [...]); Cardano (*On Variety*, bk. 1, ch. 1); Ascanio Martinengo (in the *Great Gloss*, p. 968). Finally, to add one or another Father: St. [John] Damascene (bk. 2 of the *Orthodox Faith*, ch. 7) supposes that in the First circle of heaven—that is, the supreme—is Saturn; in the second, Jupiter; in the third, Mars; in the fourth, the Sun; in the fifth, Venus; in the sixth, Mercury; but in the seventh and lowest, the Moon. And Bede (in the book *On the Nature of Things*, ch. 13, and *On the reckoning of times*, ch. 24), following Pliny, proposed the same order—although (bk. 2 *On the Elements of Philosophy*) he teaches that Venus and Mercury go around the Sun.

If anyone desires a figure—though not a necessary one—of the system of Pythagoras, Ptolemy, etc. (which one may call the common and most ancient [system], and the Chaldean or Babylonian, as we shall learn from Bede, ch. 4, num. 4), behold it [here]—in which, however, Eccentrics and Epicycles are to be understood [as implied], according to the figures handed down in bk. 7, sect. 2 & 3.

System I — The Most Ancient and Common [System] of Pythagoras, Ptolemy, and Very Many

[Translator's note — engraved diagram: A geocentric world-system. At the center sits the *Earth* (drawn as a small globe with lands and seas). Around it run concentric circles, labelled outward in order by their planetary symbols: ■ Moon, ■ Mercury, ■ Venus, ■ Sun, ■ Mars, ■ Jupiter, ■ Saturn. The outermost band is the starry *firmament* / *zodiac* (*Signiferum*), divided into the twelve signs (Gemini ■, Cancer ■, Leo ■, Virgo ■, ... Capricorn ■, etc.) and studded with stars. This is the standard Ptolemaic order; per Riccioli's caption, the eccentrics and epicycles are to be supplied mentally.]

[Margin: Clavius's last word on the system, the Telescope having been seen.]

[X.] Thus far the Astronomers, down to Clavius—as long as the heaven was explored with unarmed eyes. But when the Belgian spyglass [telescope] was first brought [to us], and Venus was seen to be illumined by the Sun in the manner of the Moon, so that it must go around the Sun, and similar [things], the good and candid old man Clavius exclaimed—nay, like a Swan near to death, he sang of the change of the ancient system in these words (which, from the last edition, on chapter 1 of the *Sphere*, Scheiner recites, num. 22 of the *Mathematical Disquisitions*, and Tanner, *On the Heaven*, q. 10): "Yet I do not wish this to be hidden from the Reader: that not long ago there was brought from Belgium a certain instrument, in the manner of a certain oblong tube, in whose ends are fitted two glasses, or lenses, by which objects remote from us appear very near, and indeed far larger than they really are. With this instrument very many stars are discerned in the firmament, which without it can in no way be seen, etc. The Moon too, when it is horned [crescent] or half-full, appears, in a wonderful way, broken and rough—so that one cannot sufficiently wonder that there are such great inequalities in the Lunar body. But on this matter, consult the booklet of Galileo Galilei which he entitled the *Sidereal Messenger*, printed at Venice in the year 1610. Among the other [things] which are seen by this instrument, this holds not the last place—namely, that Venus receives [its] light from the Sun in the manner of the Moon, so that it appears now more, now less, horned, according to its distance from the Sun: which I have observed not once, with others, here at Rome. Saturn too has other stars conjoined [to it], smaller than itself—one toward the East, the other toward the West. Jupiter, finally, has four wandering stars, which vary their position in a wonderful way, both among themselves and with Jupiter, as Galileo diligently and accurately describes. SINCE these things are so, let the Astronomers see in what way the celestial orbs are to be constituted, that these Phenomena may be saved [accounted for]." Thus Clavius. But let us proceed to the other systems.

CHAPTER III

On the System of Plato, of the Platonists, of Geber, and of Theon; on which occasion the System of Cicero is disputed

[Margin: *Plato's system, from Plutarch; and from Macrobius.*]

[I.] Just as, not rarely, discord has begotten concord, so concord [has begotten] discord. For there was between Pythagoras and Plato a wonderful concord in this—that the intervals and order of the Planets were to be constituted from the laws of Music; but straightway from this was born a discord, on account of the diverse opinions about the harmonic interval [*diastēma*] between the Platonists and the Pythagoreans. But neither about the Platonic system itself do all write alike. For Plutarch—most thoroughly versed, certainly, in Greek matters—(bk. 2 *On the Opinions of the Philosophers* [*Placita*], ch. 15), after the related opinions about the order of the stars (about which I [treated] in ch. 2, at the end, num. 2), thus continues: "Plato, after the seat of the fixed [stars], [places] first *Phaenon* (φαινών), which is called Saturn's; second, *Phaethon* (φαιθών), which [is] Jupiter's; third, *Pyroeis* (πυροεις), which [is] Mars's; fourth, *Phosphoros* (φωσφόρος), which [is] Venus's; fifth, *Stilbon* (στύλβων), which [is] Mercury's; the Sun, finally, sixth; and the Moon seventh." Some of the Mathematicians assent to Plato; some [make] the Sun the middle of all. Nor by a dissimilar reasoning does Macrobius teach (in bk. 1 *On the Dream of Scipio*, ch. 19) that, according to Plato, the Sun holds the sixth place, and the Moon the seventh, among the Planets; and (ch. 21): "It must be noted in this place that, in the genesis of the world, either Providence itself, or the genius of antiquity, gave to the stars that order which Plato assigned to their spheres—that the Moon be first, the Sun second, above this Mercury, Venus fourth, hence Mars, thence Jupiter, and Saturn last." And from these two sources, I believe, [they] drew, whoever ascribe this order to the Platonic system—namely Copernicus (bk. 1, ch. 10), Valentin Naibod (bk. 1 of the *Astronomical Institutions*, ch. 16), Clavius (on the *Sphere*, p. 64), Barozzi (bk. 1 of the *Cosmography*, ch. 2), Orontius (bk. 1 of the *Sphere*, ch. 3), and Argoli (in the *Pandosion Sphaericum*, ch. 3)—although only Clavius and Argoli express the position of Venus above Mercury; the rest number both above the Sun, according to the opinion of Plato and the Egyptians.

[Margin: *Another System of the Platonists.*]

[II.] But some Platonists varied this order somewhat, and raised Mercury above Venus; for thus the same Macrobius relates of them (bk. 1 on the *Dream of Scipio*, ch. 3): "Which dimension of Archimedes, however, is repudiated by the Platonists, as not preserving the double and triple intervals. And they established that this must be believed: that as much as is from the earth to the Moon, double [that] is from the earth to the Sun; and as much as is from the earth to the Sun, triple [that] is from the earth to Venus; and as much as is from the earth to Venus, four times as much is from the earth to the star of Mercury; and as much as is from the earth to Mercury, nine times as much is from the earth to Mars; and as much as is from the earth to Mars, eight times as much is from the earth to Jupiter; and as much as is from the earth to Jupiter, twenty-seven times as much is from the earth to the orb of Saturn." This Platonic persuasion Porphyry inserted into the books in which he infused not a little light into the obscurities of the *Timaeus*. The same order is asserted by the author of the book *On the World* [addressed] to Alexander, and by Apuleius (book *On the World*), and by Hamerus (on ch. 1 of Genesis). Therefore not only the author of the booklet *On the World* placed Mercury above Venus, and Venus above the Sun, as Clavius said (*Sphere*, p. 42). The same intervals and the same order, in almost the same words, Marsilio Ficino attributes to Plato (in the *Compendium on the Timaeus*, ch. 34); but he adds: "Here you see the heavier Planets, Jupiter and Saturn, designated by solid numbers; and although elsewhere, from the opinion of some Pythagoreans, I have reviewed other measures of the intervals, yet I esteem the Platonic ones more probable." And by these he thinks can be explained [those things] which—

(printed p. 281 — The discussion of Ficino on the Platonic intervals concludes, followed by the Theon/Geber order. Under the sub-heading on Cicero's System the page treats the Dream of Scipio, and then asks whether Plato followed the Egyptians.)

...[can be explained those things] which are said more obscurely about these spheres and proportions in [Plato's] *Republic*, bks. 8 & 10. But I would believe that occasion was given to these [Platonists] by those words of Plato, in which he introduces Timaeus of Locri, the Pythagorean, speaking thus: "God placed the Moon in the first circuit above the earth; in the second, the Sun; then he fixed the globe of Lucifer [Venus], and the star sacred (as it is said) to Mercury, to circles equal [to the Sun] in velocity, but contrary to it in power, whereby it happens that they overtake one another, and are by turns overtaken by each other—these stars, the Sun, Lucifer, and Mercury."

[Margin: Mercury's motion undiscovered.]

But from the fact that he named Venus before Mercury, it does not follow that Plato, or Timaeus, placed Venus lower than Mercury. Since indeed in the *Epinomis*, after the Sun and Lucifer, he names that one [Mercury]—on account of [its] undiscovered motion, or because among the Egyptians it once had no fixed name; for thus there Plato [speaks] in the person of the Athenian: "I mean [the star] of the Sun, and of Lucifer, and that third one, which, since it is unknown, cannot be named; which has come about because the first observer of these things was a Barbarian: for an ancient region nourished those who, on account of the serenity of the summer season, first inspected these things. Such was Egypt and Syria, where all the stars, so to speak, are always clearly discerned, because neither clouds nor rains impede the view of the sky." Wherefore, on account of [its] undiscovered nature and motion, [Mercury] received its name later than Venus. But he adds: "But indeed they too received names from some: for Lucifer, which is also Vesper, surely has [its] reason; and the star which runs equally with the Sun, and together with it, is called *Stilbon* [στῆλβων, 'the gleaming'], from [its] splendor."

[III.] Now indeed the order of the former system—by which Mercury would be above the Sun, and Venus above this [Mercury]—was upheld by Theon (bk. 9 on the *Almagest*, ch. 7); and Summarus (in Pico, bk. 10 against the Astrologers, ch. 4); and Geber of Seville (bk. 7 of his *Astronomy*, ch. 1), where he reproves Ptolemy, because (bk. 9, ch. 1) he said that the parallaxes of Mercury and Venus are to be neglected, whereas the parallax of the Sun is 2' 51", and of Venus 3', and of Mercury 7', by the Ptolemaic commensurations; then, from the latitudes (likewise Ptolemaic), he shows that the Sun can sometimes be partly occulted by Venus and Mercury. But we, in the preceding chapter (num. 6), have already vindicated Ptolemy from Geber's objections. And Geber concludes [it] more probable that Mercury is situated above the Sun, and Venus above Mercury, with the three other Planets, on account of the similarity in the composition of [their] orbs, in the double anomaly, and in the stations and retrogressions.

On the System of Cicero, and its Disagreement from the Platonic

[IV.] Thus far, then, we would have two forms of the Platonic System: one in which Mercury would be subject [lower] to Venus, and the Sun to Mercury; the other in which the Sun [is subject] to Venus, and Venus to Mercury—were it not that Macrobius insinuates a third form (bk. 1 on the *Dream of Scipio*, ch. 19), where he inquires what order Cicero, [and] what order Plato, assigned to the Sun among the wandering stars. Now Cicero had said, in that Dream, under the person of Scipio the Elder: "All things are connected by nine orbs, or rather globes, of which one is the outermost celestial [one], which embraces all the rest—the supreme God Himself, confining and containing the others; in which are fixed those everlasting courses of the stars which revolve. To it are subject seven, which turn backward by a motion contrary to the heaven. Of

these, one globe possesses that [star] which on earth they call Saturn's. Then [comes] that prosperous and salutary brightness for the human race, which is called Jupiter's. Then the ruddy and horrible-to-the-earth [star], which you call Mars. Then, beneath almost the middle region, the Sun holds [its place], the leader and prince and moderator of the other lights, the mind and tempering of the world, of such magnitude that it surveys and fills all things with its light. Following it as companions are the two courses, the one of Venus, the other of Mercury. And in the lowest orb the Moon, kindled by the rays of the Sun, is turned about. But below [the Moon] there is now nothing except [what is] mortal and perishable, save the souls given to the human race by the gift of the Gods. Above the Moon all things are eternal: for that [globe] which is the middle and ninth, the earth, neither moves, and is the lowest, and into it are borne all weights by their own inclination." This is fully and plainly the Ciceronian System, in nothing at all discrepant from the Pythagorean and the Archimedean.

[Margin: Macrobius's opinion on Cicero's system.]

But because Plato assigns to the Sun the sixth place among the Planets, while Cicero [assigns] the fourth, Macrobius (bk. 1, ch. 19, as I said) investigates the causes of this disagreement; for he says: "Plato followed the Egyptians, the parents of all the disciplines of Philosophy, who will have the Sun so placed between the Moon and Mercury, that nevertheless by reason they have detected and elicited why by some the Sun is believed to be above Mercury and above Venus; for neither do those who think thus stray far from the appearance of truth." And a little after: "Now indeed nearest to Venus is the star of Mercury, and the Sun [is] near to Mercury, so that these three traverse their heaven in an equal interval of time—that is, in a year, more or less. Therefore Cicero too calls these two courses the companions of the Sun, because in an equal space they never recede far from one another"; and, a few [words] about the Moon being interposed, he goes on: "But the nearness of these three nearest to one another—of Venus, Mercury, and the Sun—has confounded the order; but among others [it is otherwise]: for the cleverness of the Egyptians did not escape the reasoning, which is this: The circle through which the Sun runs is encompassed by the circle of Mercury as [by] a higher one; and that too the higher circle of Venus includes: and so it happens that these two stars, when they run through the higher vertices of their circles, are understood to be placed above the Sun; but when they pass through the lower [part of their] circle, the Sun is reckoned higher than they. To those, therefore, who said their spheres are below the Sun, this seemed [so] from that course of the stars which sometimes (as we said) appears lower—which is also truly more notable, because it then appears more freely; for when they hold the higher [positions], they are more hidden by the [Sun's] rays; and therefore that persuasion prevailed, and by almost all this order was received into use." Yet a more perspicacious observation detects a better order. These things being said, and some [remarks] about the light of the Planets being interposed, he concludes: "What order Plato gave to the Sun, or his authors; or whom Cicero followed [in] assigning the fourth place to its globe, or what reasoning introduced the persuasion of this diversity—enough has been said."

Cicero, therefore, followed the more common opinion about Venus and Mercury—which, because they are discerned longer and better when they depart most from the Sun, and are not so hidden by the twilight light (but then they are in the lower semicircle of their Epicycle), are therefore believed to be situated below the Sun; and that very reasoning the Egyptians followed in the distribution of the planetary hours, as we said from Dio and Xiphilinus in the preceding chapter (num. 7, reason 9)—granted [it was] by reasoning about these digressions; or also because, using a clearer air, they sometimes saw Venus and Mercury much diminished in apparent magnitude, [and] reckoned that this happened because they ascended far from the lands, above the Sun, and so described circles around the Sun.

[Margin: Whether Plato followed the System of the Egyptians.]

[V.] Therefore, if Plato followed the Egyptians (as Macrobius says), and the Egyptians taught that Venus and Mercury are situated not only above but also below the Sun, it may seem that Plato transferred this very [doctrine] to the Greeks—although he expressed only the higher position, because in the harmonic intervals

he thought their greatest distance from the lands, and apogean position, should rather be preserved, than their least, and perigean place. Nay, Cicero himself too might seem not to have disagreed from Plato, although he expressed only the vulgar opinion; since Cicero's book *On the Dream of Scipio* is part of bk. 6 of the *Republic*, and in the books *On the Republic* he imitated Plato, who indeed (bks. 8 & 10 of the *Republic*) hands down the account of the harmonic intervals among the seven orbs, attributed to the seven Sirens—yet [an account] sufficiently involved [obscure]. Therefore elsewhere (bk. 7, sect. 1, ch. 4) I judged [it] probable that the Platonic and Ciceronian system was in reality the same as the Egyptian, to which Vitruvius, Macrobius, Capella, and Bede subscribed. But, the matter being better considered, I judge [it] more probable that Cicero thought with Pythagoras, and—the *Epinomis* of Plato being consulted—that Plato disagrees from the Egyptians in this. For Cicero nowhere indicated that order of Plato; and although he admitted a concord of the heavens, he subscribed rather to the Pythagorean intervals, and followed that opinion which Pythagoras had taught in Italy, and which by Numa Pompilius had been transferred in Latium to Varro and Cicero. But Plato thought that all [things] which had been received from the Barbarians (for thus he calls the Egyptians and Syrians and all foreigners) were rendered better by the Greeks; and in this business of the mundane system, he judged it better that Venus and Mercury be always above the Sun, and revolve uniformly in concentric circles, and not run now below, now above, by Epicycles, with changing intervals—

[...continues on p. 282 (PDF 317): Plato's *Epinomis* on the uniform, intelligent motion of the stars; then the System II (Platonic) diagram; then Chapter IV opens — the Egyptian system (Vitruvius, Capella, Macrobius, Bede, Argoli), in which Venus and Mercury circle the Sun.]

(printed p. 282 — The discussion of Plato's *Epinomis* on the uniform motion of the stars concludes, and the System II (Platonic) diagram ends Chapter III. Chapter IV then opens on the Egyptian system, treating the Egyptians' geo-heliocentric insight, Vitruvius, and Martianus Capella. A large engraved diagram of the Platonic system occupies the lower-center of the page.)

[Margin: Plato's opinion on the motion of the Stars.]

...[and not run] now below, now above, by Epicycles with changing intervals. Which I gather from his *Epinomis*, in which he says: "That which proceeds in an orderly manner in the heaven, that it has a mind is demonstrated by this sufficient sign—that it goes always by the same way and in a like manner. But the soul, having intellect, is the greatest necessity of all necessities; for it governs by leading, not by being led. But when the soul, which is the best thing, conducts itself by counsel according to the best intellect, then, without persuasion [i.e., without external compulsion], that which is truly accomplished by the force of the intellect will necessarily come to pass; nor will the adamant be able to hold itself more solid and immobile, etc. It ought, therefore, to be an argument to men that the stars, and that whole circuit, have a mind—because they always do the same things; for in the greatest and most wonderful interval of time, they have already beforehand deliberated what is to be done by them, nor do they approve now this, now that, up and down, by counsel. Wherefore they neither stray, nor are revolved beyond the ancient order." Plato therefore judged that the Planets are driven by a moving Intelligence along the same way by a uniform motion, nor borne up and down—and that this is the work of a mind, choosing once what is best, and immovably preserving it. In a word, he judged that they are carried around in circles concentric to the world.

[Margin: Astronomy [is] more ancient among the Egyptians than among the Greeks.]

And he thought, very probably, that the Greeks understood this more perfectly than the Barbarians; for below, in the same *Epinomis*, speaking of the knowledge of the Stars (which became known to the Greeks later than to the Barbarians, on account of the impediments of a less clear air), he says: "Since indeed we are more distant than the Barbarians (as we said) from summer serenity, we understood the order of these divinities (for thus he calls the stars) more slowly. But whatever the Greeks received from the Barbarians, they rendered better. Which we ought to consider also in these [matters] which we are now treating." It

remains that we represent, in a single diagram, the twin form of the Platonic system—namely of Plato (to whom subscribed Theon, Samerius, and Geber) and of some of the Platonists (namely Porphyry, Apuleius, and Ficino).

System II — The Platonic System

[Translator's note — engraved diagram: A geocentric world-system shown in two labelled halves for comparison, the left marked "Plato" and the right "Porphyrius" (Porphyry). Both share the Earth at the center; immediately around it the ■ Moon, then the ■ Sun (drawn as a radiant face)—so the Sun sits directly above the Moon. Above the Sun come Venus ■ and Mercury ■ (their relative order differing between the two halves—the Platonic vs. the Porphyrian arrangement), then ■ Mars, ■ Jupiter, ■ Saturn, and the outermost starry firmament studded with stars. The defining feature versus System I (Ptolemaic) is that the Sun is placed just above the Moon, with Venus and Mercury above the Sun.]

CHAPTER IV

On the System of the Egyptians—or of Vitruvius, Martianus Capella, Macrobius, Bede, and Argoli

[I.] It might seem [to be] sufficiently demonstrated, the system of the Egyptians, from what was said in the preceding chapter (num. 4). Yet because its form is much diverse from the Pythagorean and Platonic—since it contains in itself the extremes of each—and because what, in our own age, the Telescope at last revealed, this they [the Egyptians] foresaw by the perspicacity of [their] genius, it is fitting in this place, as [its] proper [place], to discuss it again. They, therefore, when they investigated for what cause Venus and Mercury depart from the Sun not by a whole semicircle—nay, Venus scarcely by a semi-quadrant of a circle, Mercury not even by a twelfth part of the Zodiac circle—and why, around [their] greatest digressions, they appear larger, judged that this happened from an Epicycle described around the Sun, in which they sometimes revolve below, sometimes above the Sun, sometimes at equal intervals with it, and depart from the Sun according to the measure of the Epicycle, and appear larger on account of [their] nearness to the earth, and smaller on account of [their] distance. Wherefore they prepared for us, already then, a most beautiful—and, as to this part, most true—system.

Let Macrobius be heard again, if [it] please (bk. 1 on the *Dream of Scipio*, ch. 19), narrating thus: "Neither about the order of the three superior [planets], which an immense distance manifestly and clearly distinguishes, nor about the region of the Moon, which has departed far from all [the rest], was there among the ancients any dissent. But the nearness of these three nearest to one another—of Venus, Mercury, and the Sun—has confounded the order; but among others [it is otherwise]: for the cleverness of the Egyptians did not escape the reasoning, which is this: The circle through which the Sun runs is encompassed by the circle of Mercury as [by] a higher one; and that too the higher circle of Venus includes. And so it happens that these two stars, when they run through the higher vertices of their circles, are understood to be placed above the Sun; but when they pass through the lower [part of their] circle, the Sun is reckoned higher than they. To those, therefore, who said their spheres are below the Sun, this seemed [so] from that course of the stars which sometimes (as we said) appears lower—which is also truly more notable, because it then appears more freely; for when they hold the higher [positions], they are more hidden by the [Sun's] rays; and therefore that persuasion prevailed, and by almost all this order was received into use."

[Margin: Macrobius's System.]

Yet a more perspicacious observation detects a better order—truly more perspicacious [the Egyptians'], which forestalled the use of the Belgian spyglass by so many centuries, by sagacity of genius alone. And from these same words it becomes plain that Macrobius brought his vote to this system, especially since in

the same chapter he confirms from it that these two Planets [Venus and Mercury] too must be carried above the Sun—because, like the rest, they have their own light (for thus he thought), whereas the Moon is always below the Sun, inasmuch as it shines by another's light, and only from the Sun.

[Margin: Vitruvius's [System].]

[II.] Nor is there any doubt to me that Marcus Vitruvius Pollio (bk. 9 *On Architecture*, ch. 4) acknowledged the same order: for although he enumerates the Planets thus—"the Moon, the star of Mercury, of Venus, the Sun itself, and likewise of Mars, and of Jupiter, and of Saturn"—following the vulgar opinion, yet a little after he says: "But the star of Mercury and of Venus, crowning the Sun itself as a center with their journeys around the Sun's rays, make retrogressions backward, and retardations. Also, by [their] stations, on account of that circuit, they tarry in the spaces of the Signs." In which sense Scheiner too interpreted him (in the *Mathematical Disquisitions*, num. 22, toward the end).

[Margin: Martianus Capella's System.]

[III.] Nor less manifestly Martianus Mineus Felix, surnamed Capella (bk. 8 *On the Marriage of Philology and Mercury*, in the chapter whose title is "On the Orbs of the Planets"), says: "But Venus and Mercury do not go around the earth." And in the following chapter, when he had asserted Eccentrics by saying: "Generally it must be known that, for all the orbs of the Planets, the earth is the *Eccentron* [off-center point]—that is, [the earth] does not hold the middle of the circles, [a middle] which there is no doubt is the center of the world," a little after he expounds what is the center of the circles of Mercury and Venus, in these words: "For although Venus and Mercury display daily risings and settings, yet their circles do not go around the earth at all, but circle around the Sun in a wider compass. Indeed, they place the center of their circles in the Sun: so that they are carried sometimes above it, but for the most part below, nearer to the lands. From which [Sun] indeed Venus is separated by one sign and a half [part]. But when they are above the Sun, Mercury is nearer to the lands; when below the Sun, Venus, inasmuch as it is curved in a chaster [narrower] and more diffuse orb." This African writer could not have depicted the Egyptian system in clearer words. But also, below, in a chapter peculiar to Mercury, he says: "Thus far concerning the Sun. Now it is fitting to behold the courses of the Planets, and especially of those which revolve around the Sun. For Stilbon [Mercury], leading [completing] almost the circle of a year, runs through eight parts of latitude, driven by an alternating diversity. That the circles of this [Mercury] and of Venus are Epicycles I noted above—that is, [circles] not within—

[...continues on p. 283 (PDF 318): "...[not] going around [the earth, but around the Sun]..." — Capella's exposition of the Mercury/Venus epicycles around the Sun continued, then the remaining witnesses to the Egyptian system (Bede, Argoli) and its diagram.]

(printed p. 283 — Chapter IV concludes with Capella, Bede, and Argoli, and the System III (Egyptian) diagram closes the chapter. Chapter V then opens, on the homocentric system of Eudoxus, Calippus, and Aristotle. A large engraved diagram of the Egyptian system fills the right column.)

...[that is, circles not] enclosing the roundness of the earth within their own compass.

[Margin: Bede's System.]

[IV.] But we must sail from Africa to England, and the opinion of that most learned and venerable presbyter, namely Bede, must be sought out. He, therefore (in the book *On the Nature of Things*, ch. 13), speaks thus: "The highest is the star of Saturn, by nature gelid, traversing the Zodiac in thirty years. Then [that] of Jupiter, temperate, in twelve years. The third, of Mars, fervid, in two years. In the middle the Sun, in 365 days and a quarter. Below the Sun, Venus—which is also Lucifer and Vesper—in 368 days, never standing off from the Sun farther than 46 parts [degrees]. Nearest to it, the star of Mercury, in a swifter circuit by nine days, shining now before the rising of the Sun, now after [its] setting, never more remote from it than 22 parts.

Last, the Moon, completing the Zodiac in 27 days and a third part of a day." But these things Bede may have said either when he was younger, or indulging the vulgar opinion for a while. Otherwise, in the book *On the constitution of the celestial and terrestrial World* (which is had in the first volume of his works), in the chapter on Epicycles and intersections (p. 383 in my [copy]), he speaks thus of Mercury and Venus: "But that [Venus and Mercury] are carried above and below the Sun is shown in three ways by conjectures: either by the intersection of the circles; or because they are Epicycles—that is, supercircular [circles] which, not having the earth [as] center, make the Sun, as it were, the center of their course; or [because] they measure out the altitude of the Sun by obtuse circles, or by acute windings." This is—as I at least interpret [it]—by Ellipses described around the Sun rather than by circles. But also, in the book *On the Elements of Philosophy*, thinking the Platonic and Egyptian system to be the same, and busying himself to reconcile it with the Chaldean, he says: "Then it must be said why the Chaldeans say the Sun [is] fourth, but the Egyptians and Plato [say] sixth. It is true that the Sun is below Venus and Mercury, next to the Moon"; and he gives the cause—namely, that the cold and humidity of the Moon may be tempered by the hot and dry Sun, and that it [the Moon] may receive light nearer from the Sun. Soon he subjoins: "Yet to the Chaldeans it seemed otherwise: [Bede] refers the cause to the intersection of nearly equal circles, and says: They intersect one another thus, that the circle of Venus, in its lower part, intersects the upper parts of the circles of Mercury and the Sun, comprehending more of the Mercurial [circle] than of the Solar. But the circle of Mercury, in its upper part, intersects the Venereal [circle], in [its] lower [part] the Solar. And the circle of the Sun, in its upper part, intersects the Mercurial and the Venereal—more the Mercurial, less the Venereal." Then, after a few [words], he concludes: "Since, therefore, the circle of the Sun is encompassed in the upper parts of those circles, it is justly said to be lower than they; but because it happens sometimes that the Sun runs through the upper parts of its circle, but those stars [run] through the lower [parts] of theirs, then they appear more freely; for the Sun does not obscure the [things] placed below [it] as much as [those] placed above; [therefore] it is reckoned higher than they." But this hypothesis is very involved; and far neater and readier is that which he had indicated in the former place, through epicycles described around the Sun.

[Margin: Argoli's System.]

[V.] Lastly, Andrea Argoli (in his *Pandosion Sphaericum*, ch. 3) chose this very system, ordering Mercury around the Sun, and Venus around Mercury, in Epicycles, but the orbs of Mars, Jupiter, and Saturn around the Earth. And he adds that what was left unpolished and bare by Vitruvius and Capella, this was fortified by him with Geometrical demonstrations—the quantity of the Eccentricities and Epicycles being added, and, according to these measures, tables of the secondary mobiles published by him, which he affirms to agree to a nail's breadth [exactly] with the Tychonic [tables], except the Moon. And those measures he indicates in the same *Pandosion*, from ch. 50 to 59.

[Margin: Argoli's boldness against Tycho.]

But in that he asserts (ch. 3) that Tycho rests on a most feeble foundation when he makes Mars, at opposition [acronychal], nearer to the lands than the Sun—namely by a greater parallax than the Sun's—and [that] this observation is almost impossible: he speaks too boldly, as will be clear to [one] considering the Tychonic and Keplerian foundations in this matter (about which we [treated] already in bk. 7, sect. 2, ch. 3, scholium 4, and sect. 6, ch. 4, schol. 3 & 4, and ch. 10, scholium 1). But behold the diagram of this Egyptian, Vitruvian, Capellan, Macrobian, etc. system—which, although some of the more recent [writers] ascribe [it] to Martianus Capella, is nevertheless far more ancient; and from its first origin I judge it should rather be called Egyptian.

System III — The Egyptian System

[Translator's note — engraved diagram: A geo-heliocentric world-system. At the center, the **Earth**, with the **Moon** circling it. Beyond the Moon, a large circle on which the **Sun** rides; carried around the Sun itself on a small loop (epicycle) are **Mercury** and **Venus**. Outside the Sun's circle, going outward, are **Mars**, **Jupiter**, and **Saturn**.]

Jupiter, ■ Saturn (each circling the Earth), and the outermost starry firmament studded with stars. Thus Venus and Mercury are heliocentric, while the Moon, Sun, Mars, Jupiter, and Saturn are geocentric—the "Egyptian" (Capellan) arrangement.]

CHAPTER V

On the System of Eudoxus, Calippus, and Aristotle

[Margin: Which System Eudoxus and Calippus followed.]

[I.] The first controversy is about the order of the Planets—namely of Mercury, Venus, and the Sun (for about the three superior [planets], and about the lowest, the Moon, there is no doubt)—as asserted by Eudoxus, Calippus, and Aristotle. And at first, indeed, Eudoxus—as being a Cnidian—seems to have followed the Platonic system, Laërtius attesting this (bk. 8, in the life of Eudoxus); especially since he chose the same opinion about concentric orbs, as we shall presently see. But since Calippus indeed corrected the system of Eudoxus, yet retaining the concentrics, and only adding certain other starless orbs—and the same Aristotle did, adding other revolving [spheres] above the Calippic number, and was moreover a disciple of Plato—it seems consonant that Calippus, equally with Aristotle, retained the Platonic system as to the order of the Planets.

[Margin: The System of the author of the De Mundo ad Alexandrum.]

To this is added that Aristotle, in the book *On the World, to Alexander* (ch. 2), has these [words]: "Next to this [sphere]—that is, to the globe of the non-wandering [stars]—the so-called circle of Phænon [φᾶ■νων] together with Saturn always has [its] position contiguous; nearest to which is [that] of Phaethon [φᾶ■θων], which is also called Jupiter's. After this follows Pyroëis [πυρ■εις], called also Hercules's and Mars's. From this, again, is Stilbon [στ■λβων], which is believed sacred to Mercury, by some also to Apollo; after which is the orb of Lucifer, which some call the orb of Venus, some of Juno. From it is the orb of the Sun; and finally the Moon, nearest to us, extending its bounds even to the earth." But if the author of this booklet be called into doubt, certainly these are the words of Aristotle (bk. 1 of the *Meteorology*, ch. 4), saying: "Moreover, as is shown in the Astrological theorems, the magnitude of the Sun is greater than the earth, and the distance of the stars from the earth much greater than [that] of the Sun—as [the distance] of the Sun from the earth [is greater] than [that of] the Moon; therefore the cone which it [the earth] casts from the Sun's rays is not raised very far from the earth, nor will the shadow of the earth (which is called night) reach to the stars; but it is necessary that the Sun look around upon all the stars, and that the earth obstruct none of them." He supposes, therefore, that no stars can fall into the shadow of the earth, because they are much more remote from the earth than the Sun—granted such a great distance is not necessary, but he supposed it from the hypothesis of certain Astronomers placing all the Planets above the Sun. Finally, that Aristotle supposed Venus and Mercury to be situated above the Sun, affirm Hamerus (ch. 1 on Genesis), Valentin Naibod (bk. 1 of the *Astronomical Institutions*, ch. 16), Clavius (on the *Sphere*, p. 64), Ba—

[...continues on p. 284 (PDF 319): "...rozzi (bk. 1 of the Cosmography, ch. 2), Longomontanus, Argoli..." — then ¶II (whether Eudoxus, Calippus, and Aristotle followed the Egyptian or the Chaldean order), ¶III (Eudoxus's 27 homocentric spheres and the hippopedè), ¶IV (Calippus's added spheres), and ¶V (Aristotle's own counter-revolving spheres — 55 or 47).]

(printed p. 284 — Chapter V continues, completing the list of authors and asking whether Eudoxus, Calippus, and Aristotle followed the Egyptian or the Chaldean order. The page treats Eudoxus's homocentric spheres and Calippus, and opens the account of Aristotle's own counter-revolving spheres.)

...[Ba]rozzi (bk. 1 of the *Cosmography*, ch. 2), Longomontanus (in the *Danish Astronomy*, bk. 1 of the *Theorics*, ch. 1), Argoli (in the *Pandosion Sphaericum*, ch. 3); nor can it be denied that the opinion of these [authors] is probable.

[Margin: Eudoxus's order called into doubt.]

[II.] These [things] notwithstanding, it seems at first that Eudoxus—as being a Cnidian, and pertaining to the Assyrians rather than the Greeks—ought to have followed the opinion of the Barbarians, namely of the Assyrians and Egyptians; the more so because, as Laërtius relates in his life, he heard Plato at Athens for only two months (being both pressed by poverty and cast out by Plato), and was thence compelled to return to [his] fatherland; and afterward, supported by the largess of friends, he set out to Egypt, where, having tarried 16 months, [and] at last having many disciples, he returned to Athens, so as to vex Plato, who from the beginning had dismissed him. Wherefore, although he chose concentrics, it is nevertheless not certain which part of the Egyptian system he chose—that which set Mercury and Venus [above] the Sun, or that which set the Sun above them.

[Margin: And Calippus's [order]; and Aristotle's.]

And I say the same of Calippus, who—as being an Asiatic—is believed to have been addicted to the Chaldean hypotheses, and whose writings were known to Ptolemy (and indeed those of Eudoxus too, it is believed), as is clear from the *Almagest* (bk. 2, ch. 2); and yet (bk. 9, ch. 1) [Ptolemy] places, according to the opinion of the ancients, Venus and Mercury below the Sun, and attributes the opposite only to the younger [moderns]. As regards Aristotle: since he himself says (*On the Heaven*, ch. 10): "But now the contrary happens; for the Sun and Moon are moved by fewer motions than some of the stars, although they are farther from the middle and nearer to the first body than these very [stars]"—he seems to have spoken not of all, but only of some Planets, as being higher than the Sun and Moon and yet having more motions; then, since in the same place he had related that Mars was seen by [him] occulted by the Moon (in order to show that the Moon is the lowest of all, although having fewer motions than certain Planets nearer to the Fixed [stars]), he subjoins: "Similarly also they speak about the other stars—the Egyptians and Babylonians, who long ago observed these things through very many years, to whom we attribute much faith concerning each of the stars." Therefore it is more credible that Aristotle, as to the order of the Planets, followed either the system of the Egyptians; or—because he chose concentrics, and placed no Planets now above, now below the Sun—rather adhered to the Babylonian, or Chaldean, system, which placed Venus and Mercury below the Sun (as we learned from Bede in the preceding chapter, num. 4). For now Alexander the Great, having taken Babylon, had transmitted into Greece the observations made there and recorded for very many years, as may be gathered from Quintus Curtius. And as Pliny relates (bk. 7, ch. 56): "Epigenes teaches that among the Babylonians [there were] observations of the stars of 720 years, inscribed on baked tiles—a weighty author among the first; [those] who [reckon] least, Berosus and Critodemus, [give] 480 years of observations, I understand." Moved, therefore, by these conjectures, and by the authority of certain Peripatetics [commenting] on the books of Aristotle *On the Heaven* and *Metaphysics* 12, I elsewhere opined that Eudoxus and Calippus and Aristotle, retaining concentrics, placed the Sun above Venus and Mercury—though now I confess the opposite to be probable. Now let us come to the other part of this system—namely, to the number and office of the orbs by which the motion of the Planets was set forth by them, the distance of them from the earth being retained always of the same interval [i.e., concentric].

[Margin: Eudoxus's concentrics.]

[III.] Concerning the Orbs of Eudoxus, Aristotle (*Metaphysics* 12, ch. 7, or text 45 & 46) relates thus, with wonderful brevity: "Eudoxus, then, posited that the motion of each—I mean of the Sun and of the Moon—is made by three spheres each: the first being that which would accomplish the motion of the non-wandering [stars]—that is, of the Prime Mobile; the second, for the motion which is made through the circle which is through the middle of the Signs—namely, through the Ecliptic, in longitude; the third, for the motion oblique

to the Zodiac, in latitude—and [that] the [sphere] by which the Moon is carried is made oblique by a greater latitude than that by which the Sun is carried." As if indeed the Sun changed somewhat in latitude. "But the motion of the remaining Wandering stars he posited to be made by four spheres each: the first and second [having] the same motion which those [the Sun and Moon] undergo; for both that [sphere] which [has] a motion similar to the motion of the Fixed stars and common to all, and that which is placed below this (and whose motion is through the circle which is through the middle of the Signs), is common to all; but the third sphere of each has its poles in that circle which passes through the middle of the Signs [the Ecliptic]; while the motion of the fourth cuts this circle obliquely and in two ways. And the poles of the third sphere are proper indeed to the other stars, but for Venus and Mercury [they are] the same." From which it appears that one sphere was attributed by Eudoxus to the Fixed [stars], three to the Sun, three to the Moon, and four to each of the smaller Planets [the five]—that is, in all 27; nor [does it appear] that he thought the lower spheres are carried along by the sphere of the Fixed [stars], but [that] the individual Planets [are moved] by their own sphere with a diurnal motion through the Meridian to the West. Moreover, [it appears] that the variation of the obliquity of the Ecliptic and of the maximum declination of the Sun—asserted by some [to occur] at the Solstices—he attributed to a motion of the Sun in latitude: for he did not think (says Simplicius, 2 *On the Heaven*) that the Sun perpetually proceeds under the Ecliptic. Each Planet, therefore, had one orb for the common motion from East to West; and another for [its] proper motion under the Zodiac toward the East; and a third for the motion of latitude, from South to North—which (as G. B. Amici gathers from Simplicius and Theophrastus, in the opusculum *On the motions of the celestial bodies*, ch. 1) completed its motion in that time in which each Planet accomplishes its *Metabasis* (Μεταβασίς, "transit/passage") through [its] aspects to the Sun: which time, according to Eudoxus, was—for Venus, 18 months; for Mercury, 110 days; for Mars, 8 months and 20 days; for Jupiter and Saturn, 3 months and 10 days. But the fourth orb—as the same [authors], and Delphinus (ch. 5 *On the celestial globes*), expound—carried the body of the Planet, and, by resisting the third orb, prevented [it], lest the Planet should reach to the poles of the Zodiac; and therefore the Planet described, by its center, a certain line called by Eudoxus the *hippode* (ἵπποδη, "horse-fetter" [a figure-eight curve]). And Eudoxus wrote a booklet *On Velocities* (περὶ ταχυτήτων), and several other [things], which have not reached us. Yet otherwise—from mere conjectures—Fracastoro interpreted Eudoxus and Calippus (in the *Homocentrica*, sect. 3, ch. 25), whom let [him] consult who delights to amuse himself [with it].

[Margin: *Calippus's homocentrics.*]

[IV.] But Calippus of Cyzicus, contemporary with Aristotle, added to the homocentrics of Eudoxus some other orbs, likewise concentric to the world. For Aristotle (*Metaphysics* 12, text 47), where he had set forth the orbs of Eudoxus, writes thus about him: "But Calippus posited the same position of the spheres as Eudoxus—that is, the order of the intervals; and also the same number for Saturn and Jupiter. But he judged that two spheres besides should be added to the Sun and the Moon, if one wished to assign the causes of the [things] which appear to the senses; and to each of the remaining wandering [stars], one [more]." Alas, how meagerly Aristotle [speaks]! But now Eudemus (as Simplicius relates) said this was done by Calippus because he wished to safeguard, in the Sun, the "delay" [*dilatatio*, the inequality] of the Equinoxes and Solstices observed by Almeon and Meton; but others devised other causes (says Delphinus, above)—and in the Moon indeed a certain new inequality, but in Mars, Venus, and Mercury, single [spheres] on account of the stations and retrogressions. Further, from what was said by Aristotle, it becomes manifest that Calippus's spheres were 33—and, with [that] of the Fixed [stars], 34: namely one of the fixed [stars]; four each for Saturn and Jupiter; five each for Mars, Venus, and Mercury; and five each, finally, for the Sun and the Moon. Yet Aristotle reckons 8 star-bearing [spheres] and 25 starless, that is 33, as we shall presently see.

[Margin: *Aristotle's counter-revolving [spheres].*]

[V.] But at last Aristotle himself, in the same *Metaphysics* 12, text 47, after the indicated opinion of Calippus about the number of the concentric spheres, involved [enveloped] rather than developed his own opinion too, in these words—and the common translator infused not a little cuttlefish-ink [*loligo*, i.e., obscurity]; but thus we have more clearly rendered that text: "But it is necessary, if the aforesaid spheres, [being] composed together, must restore each Planet to its pristine place, that to each of them there be subjoined just as many other spheres, one being subtracted, which may revolve [back] and constitute, at the same situation, the first sphere of that star which is ordered below [it]. For only in this way will it come about that [the spheres] accomplish all the motion of the Wandering [stars]. Since, therefore, the spheres in which the stars are carried are eight, but the remaining [are] twenty-five, of these the only ones that do not need a [counter-]revolution are those which carry the body of the Planet, or which are lowest in their order. [The spheres] which revolve back the spheres of the first two [planets] will be six; but [those] which [revolve back the spheres] of the four after them, sixteen; and the number of all—both of those which carry [the planets] and of those which revolve them back—[is] fifty-five. But if to the Moon and the Sun one does not add those motions which we mentioned, all the spheres will be forty-seven." Which words still seem similar to an enigma; but we shall solve this enigma, if [we grasp] Aristotle's—

[...continues on p. 285 (PDF 320): "...meaning..." — Riccioli's unravelling of Aristotle's count of 55 (or 47) homocentric and counter-revolving spheres, with its accompanying diagram.]

(printed p. 285 — The account of Aristotle's sphere-count concludes with a table of spheres, followed by others' errors in the count and Sosigenes's critique, ending Chapter V. Chapter VI then opens, on the systems of Averroes, Alpetragius, Delphinus, and Amici, beginning with Averroes and Alpetragius.)

...[we shall solve this enigma, if we have opened up Aristotle's] meaning point by point. First, then, Aristotle, among the partial spheres whose number he inquires, does not number the first—although he supposes it, because, being endowed with a single simple motion, it needs no other orb; and hence it is that he reckons the orbs of Eudoxus endowed with stars [to be] eight indeed, but the *anastrous* (■ναστροι, "starless"), that is, lacking a star, or not carrying the body of a star, he numbers [as] 25—whose sum is 33. Secondly, Aristotle adds no counter-revolving [spheres] to the Moon; for although at the end he seems to say that he has added counter-revolving [spheres] to the Moon and the Sun, he by no means says this, but [says] that, if there be not added to the Moon and the Sun [those] counter-revolving [spheres] such as he had added to the first two Planets and to the four remaining, the number of spheres is 47. But why he did not fear, for the Moon, lest it be snatched along by the higher orbs—and therefore [why] it had no need of counter-revolving [spheres]—was perhaps the wonderful velocity of the Moon in its proper motion; or rather because the Moon does not have orbs below it, to which it might communicate its motion. Thirdly, to all the other spheres of the Planets, but [only the] starless [ones], he thinks single counter-revolving [spheres] must be added, which may prevent or compensate the snatching of the higher [spheres]; but to the spheres carrying the body of the Planet, he adds no counter-revolving [sphere]. Fourthly, reckoning the Calippic number of starless spheres, he counts in just as many counter-revolving [spheres] for them: namely 6 spheres for Saturn and Jupiter together; but four each for Mars, Venus, Mercury, and the Sun—and so 16 together; and none for the Moon. Now the Lunar spheres were 5 in Calippus, and the Sun's 5, and Mercury's 5, and Venus's 5, and Mars's 5, and Jupiter's 4, and Saturn's 4. These, then, being reduced to a sum, the Planetary spheres come to 55. Fifthly: because the stations and retrogradations of Mars, Mercury, and Venus were more evident in that age than those motions on account of which Calippus added two spheres each to the Sun and Moon—if one wished to mix the Eudoxan with the Calippic number, and, as to the Sun and Moon, to follow Eudoxus (who gave three spheres to the Luminaries, six taken together), but, as to the remaining Planets, to follow the Calippic number increased by the counter-revolving [spheres], the Planetary spheres come out [to] 47. That this reckoning may appear more evident, we will append the numbers of the spheres according to these three authors.

THE NUMBER OF SPHERES

Planet	Eudoxus	Calippus	Aristotle: starless	Aristotle: all (with counter-revolving), Calippic	Aristotle: all, Eudoxan-Calippic
Saturn ■	4	4	3	7	7
Jupiter ■	4	4	3	7	7
Mars ■	4	5	4	9	9
Venus ■	4	5	4	9	9
Mercury ■	4	5	4	9	9
Sun ■	3	5	4	9	3
Moon ■	3	5	4	5	3
Sum	26	33	26	55	47
& with the Fixed [stars]	27	34	—	56	48

[Margin: Errors of others in the Aristotelian number of spheres.]

[VI.] Hence you now see how great in reality was the number of spheres for Eudoxus, Calippus, and Aristotle, and how various—according as the sphere of the Fixed [stars] was, or was not, counted in; and according as the Calippic [hypothesis] alone, or [one] mixed from the Calippic and Eudoxan, was employed. Wherefore the numbers of certain [writers] in no way stand, nor can they rest on the Aristotelian text. As when Kepler (in the *Commentary on Mars*, ch. 2) says of Eudoxus, Calippus, and Aristotle: "For since those authors employed 25 orbs to demonstrate the whole inequality of the Planets, Aristotle—believing the heaven filled with solid orbs—judged that 24 other counter-revolving [orbs] must be interposed, namely that each lower orb might be freed from that snatching which, on account of the contiguity of the surfaces, it was going to suffer from the higher [orb]. Therefore, when he had accumulated in all 49 orbs (or, according to Calippus, 53 or 55), he added single movers to the single [orbs]." But neither John Anthony Delphinus (in the book *On the celestial globes and motions*, ch. 8), nor Fracastoro (sect. 3, ch. 25)—where they most diligently expound this Aristotelian passage—nevertheless put the correct number. For Delphinus says that for Aristotle there are 55 [spheres] Calippically, but 49 Eudoxanly; yet he correctly numbers the Calippic [ones as] 34 separately, and the Eudoxan [as] 27 with the Fixed [stars]. But Fracastoro does not number 47—rather he omits the second computation of Aristotle. Hevelius too (ch. 7 of the *Selenography*) badly numbers the Aristotelian orbs [as] 53 or 54. But the Conimbricenses (bk. 2 *On the Heaven*, ch. 3, q. 8, art. 2) put 47 or 50; and Mastrius and Bellutus (disp. 2 *On the Heaven*, q. 1, num. 35) put 55 or 57; but all err in something from the true number: for there are, for Aristotle, 55, and with the sphere of the Fixed [stars], 56; but if he should subscribe to Eudoxus as to the Sun and Moon, and to Calippus in the rest, there are 47, and with the sphere of the Fixed [stars], 48.

[VII.] Furthermore, Sosigenes detected many imperfections of this system (as Simplicius narrates), inasmuch as it did not safeguard many Phenomena of the Planets. But certainly in this it most errs—that it uses homocentrics, since, from the diversity of the Lunar parallaxes and of the apparent magnitude of the Planets, it has now become evident, physically and optically, that they are now higher, now lower. Deservedly, therefore—the homocentrics being rejected—it took refuge in the Pythagorean Eccentrics and Epicycles.

CHAPTER VI

On the System of Averroes, Alpetragius, Delphinus, and Giovanni Battista Amici

[Margin: Averroes's system.]

[I.] How doubtful and inconstant Averroes was in [his] system of the heaven is clear from [his commentary] on 2 *On the Heaven*, comment 35, and on *Metaphysics* 12, comment 45, and in the commentaries on the *Almagest*; for there, as to the order of the Planets, you would not know whether he subscribes to Ptolemy or rather to others—though he inclines to the order of Ptolemy. Yet he contends, with many arguments, to overthrow the Eccentrics and Epicycles, and in their place to substitute the ancient concentrics; and he promises, in that text 35, that—if God should prolong his life—he would treat of that theory of the celestial motions which was cultivated in Aristotle's time, and which he reckons agreeable to Physical principles; but (*Metaphysics* 12, comment 45), recognizing himself worn out by old age, he despairs of this matter, and exhorts posterity to it, and hopes there will not be lacking [one] who may undertake this task. Nor much after did Alpetragius arise, who applied [his] mind to this. And his work is entitled *The Theory of the Planets, Proved by Physical Reasons*—because he otherwise suspected that Ptolemy's hypotheses are indeed not theoretically impossible, but repugnant to Physical principles, and impede themselves; granted that, as to the numbers of the motions and the periods of the times, he follows Ptolemy to a hair's breadth. But he himself too, at the end of this work, confesses that many other particulars regarding the motion of the Planets, which are in Ptolemy's *Almagest*, were passed over by him, because he now saw himself worn out by old age.

[Margin: Alpetragius's system and hypotheses.]

[II.] First, then, Alpetragius teaches that there is given a Ninth sphere, which is moved by the most perfect motion of the prime mobile alone, by one Intelligence, in the space of 24 hours, from East through the Meridian toward the West; and that the same Intelligence impresses on the eight lower spheres its motion, but uniformly-differently more and more remiss [slowed]; and therefore that the sphere of the Fixed [stars] is moved somewhat more slowly toward the West, and is not wholly revolved to the same Meridian in 24 hours, but in a somewhat greater little-appendage of time; and that yet more slowly is moved the sphere of Saturn, and more slowly than this the sphere of Jupiter, and more slowly than this [the sphere] of Mars, and [more slowly] than Mars, Venus, and [more slowly] than Venus, the Sun, and [more slowly] than the Sun, Mercury, and [more slowly] than Mercury, the Moon—because, on account of the imperfect participation of that impetus, they are more sluggish. And hence [he thinks that] the observers, deceived, supposed the Fixed [stars] and Planets to have a proper motion contrary to the motion of the prime mobile; whereas in reality they are not moved by a contrary motion, but by [a motion] the same in kind, yet slower—and slower, the more they are distant from the—

[...continues on p. 286 (PDF 321): "...sphere of the prime mobile." Then ¶III (Alpetragius on Venus above the Sun, Mercury below; the Arabic *laulabina*), ¶IV (Delphinus), ¶V (Amici) — ending Chapter VI; then **Chapter VII** opens, on the homocentric system of Turriano [Della Torre] and Fracastoro.]

(printed p. 286 — Chapter VI concludes with Alpetragius, Delphinus, and Amici; these systems being obsolete, no diagram is given. Chapter VII then opens, on the homocentric system of Turriano [Della Torre] and Fracastoro, recounting Fracastoro's epistle and Turriano's deathbed request and treating the seven orbs of the starry sphere.)

...[are distant from the] sphere of the prime mobile.

[III.] Secondly, he establishes (ch. 8, 9, & 11) that Venus is to be placed above the Sun, but Mercury below, because it [Venus] is revolved more quickly to the same meridian than the Sun, and is therefore nearer to the supreme sphere. And in the same place he affirms that Venus and Mercury have their own light from themselves, and therefore, although Mercury comes between our eye and the Sun, it nevertheless does not obscure any part of the Sun. Further, the slowness and velocity of the motions, all [their] inequality, and the stations and retrogressions, he ascribes to the motion of the poles of each sphere, [the poles] describing various little circles around the poles of the world or of the Ecliptic. But from his Theory it follows that the

Planets always preserve the same distance from the center of the world; nor, however, does he bring a cause why they appear now smaller, now larger than themselves. And the Planets describe a certain sphere—in Arabic *laulabina* [a helix/spiral]—but on the same spherical surface.

[Margin: John Anthony Delphinus's system.]

[IV.] John Anthony Delphinus, of Casale Maggiore, of the Franciscan order, in his book *On the celestial globes and motions* (from ch. 30), besides the Empyrean, posits a ninth sphere, or crystalline heaven, to which he attributes the office of the prime Mobile; but he will have each sphere to have its own Intelligences moving [it] toward the West through spiral lines. As to the order of the Planets, he follows Ptolemy, but uses concentrics; and the cause why the Planets seem to have a diverse magnitude he attributes to a diverse density and opacity of the air—on account of which, by refraction, the apparent disc of the stars is amplified—and to a diverse disposition of the eyes.

[Margin: Giovanni Battista Amici's system.]

[V.] But Giovanni Battista Amici (in the opusculum *On the motions of the celestial bodies*, according to the Peripatetic principles, without Eccentrics and Epicycles) defends the counter-revolving [spheres] of Aristotle, and uses homocentrics; and the cause of the diverse apparent magnitude in the same Planet he refers partly to the sight and the fallacy of instruments, partly to the diverse temperament of the air. But in the eighth sphere he admits a proper motion toward the East, and indeed an unequal one. And therefore he posits ten spheres, of which the tenth is the Prime Mobile, the ninth and eighth for the motion of the Fixed [stars]—equal of itself, but per accidens unequal on account of the "titubation" [wobble] or trepidation—exactly as the Alfonsines posited (whose order, too, in placing the Planets, he follows); nor among the superior Planets does he acknowledge others than Saturn, Jupiter, [and] Mars. But the systems of these [authors] are so obsolete that it is not worthwhile to delineate a peculiar figure for explaining them; but let it suffice to have indicated their hypotheses.

CHAPTER VII

On the System of Giovanni Battista Turriano [Della Torre] and Girolamo Fracastoro

[Margin: Turriano's eulogy, from [the pen of] *Astronomy*.]

[I.] I will begin from the Epistle which Girolamo Fracastoro of Verona—eminent in the ornaments of Astronomy, Medicine, and Poetry—wrote to Pope Paul III, that he might dedicate to him his *Homocentrica*. In which, among other [things], he affirms that Philosophy—nay, nature itself, and the celestial orbs themselves—always cried out against the Eccentrics and Epicycles of Hipparchus and Ptolemy; and that therefore many had striven, but with vain labor, to explain the causes of the celestial motions by another way. Then he thus narrates: "In our age, Giovanni Battista Turriano, our [fellow-]citizen—a man of the greatest and almost divine genius, and a cultivator of a certain more secret Philosophy—discovered two admirable motions in the spheres: those (as I think) which both Albategnius and most other Astronomers prophesied to lie hidden in the stars; through which he seemed to himself to have gained an approach to explaining many things, but especially to demonstrating, without any Eccentrics, those [phenomena] which are seen about the stars. Which matter he had begun to turn over in [his] mind with great hope; when—fortune deciding otherwise (better had he said, God)—at the very beginnings he was forestalled by an immature and unexpected death: a youth most flourishing and admirable in age, genius, studies, virtue, and every discipline. And when he was now about to die (just as they relate that the thrice-great Mercury [Trismegistus], dying, asked the friends standing by to be mindful of that ship which he had taught perpetually to ascend and descend in the midst of the ether), so he, turned to us friends who stood by, when he had said many other things, then, looking at me, said: 'I have something, Fracastoro, which I ask of you as

[my] last [request].’ And when I urged him to speak: ‘I would wish you,’ he said, ‘to be mindful of those circles which Timaeus first cuts into the figure of the letter X, then so twists back that the heads of the lines come together among themselves’ (he meant the motions discovered by him); ‘then, because death now envies me [this], if I might hope that you would accomplish [it], and that the business, grasped by me, would be perfected—it will be a great consolation to me, [now] dying.’ To whom I [answered] that I would be mindful, etc.”

[Margin: *Fracastoro, a reviver of the Homocentrics.*]

[II.] This, then, was the occasion for Fracastoro of thinking out in what way he could explain all the celestial motions by homocentric orbs alone—that is, concentric with the center of the world. But because, to accomplish this, it was necessary to give a reason why the Moon and the other Planets appear sometimes larger, sometimes smaller than themselves—since he could refer this neither to the Eccentrics nor to the Epicycles, as [they were] eliminated from his hypothesis—he tried (sect. 1, ch. 8, & sect. 3, ch. 23, [in chapters] which are entitled "On the diversity of aspect [parallax] in the quadratures, and in the swift and slow motion") to refer the cause to a diversity of the medium: if not of the air, at least of the heaven [which is] somewhere rarer, somewhere denser—the heaven, I say, subject to the Moon, which is so moved that, whenever the Moon is in the quadratures, on account of the refraction of the Solar rays, in the denser but transparent part of that Zone which glides between the Zodiac and the Moon, it exhibits its disc larger than usual as to appearance. But this otherwise so great a man does not seem to have understood what that diversity of aspect [parallax] is, from which Ptolemy shows the diversity of the Lunar distance from the earth; for this is not merely a difference of apparent magnitude, but a difference between the true place and [the place] seen by us from the surface of the earth—[a thing] often set forth by us, but especially [in] bk. 1, ch. 35, and bk. 3, ch. 7, and bk. 4, ch. 13 & 14. Which last places being reread, it will be evident that the difference of the Lunar parallaxes is so great, and such, that its cause cannot be poured back upon the Fracastorian refraction; nor upon the nearness of a greater light, which is the other cause adduced by him. Moreover, Fracastoro supposes the Ptolemaic order of the Planets. Finally, he devises very many Homocentrics, by whose aid the inequality of the proper motion of the Fixed [stars] and Planets may come about—which, briefly, though useless, I shall enumerate.

[Margin: *The orbs of the Aplanes [non-wandering sphere] — 7.*]

[III.] First, then, for the Aplanes, or sphere of the non-wandering [stars] (sect. 2, ch. 17), he employs 7 orbs. The first and supreme is the **Prime Mobile**, carrying with it all the lower [orbs], whose most simple motion of 24 hours is made from Rising to Setting through the Equator. The second is the **Circumducens** [Around-leader], which—carried in latitude through the higher colure from North to South in 3600 years—rolls with it all the lower orbs, except in so far as some counter-carried [orbs] impede it; the circle of whose motion cuts the Equator at right angles and has its Poles in the Equator. The third is the **Circitor** [Circler], whose circle, subaltern to the lower colure of the Equinoxes, is led around in latitude by the higher circle in 3600 years, but of itself moves all [things] in the opposite direction, and completes 4 degrees in that time in which the *Circumducens* completes a quarter of its circle. The fourth orb is called **Contravectus** [Counter-carried] to the *Circitor* and the *Circumducens* in latitude, which, through the higher colure—twice as swift as the *Circumducens*—is carried from South to North. The fifth is the **Anticircitor** [Anti-circler], which is rolled by the fourth in latitude, always in the direction opposite to the *Circitor*, and proportionally; whence it comes about that, by its proper motion, it is always opposed to the *Circitor* in latitude, but agrees [with it] in longitude, and drives [it] into the same [direction]. But lest the Aplanes be moved in latitude—that is, lest the fixed [stars] vary [their] latitude—the *Contravectus* follows the *Anticircitor*, which prevents this motion. Lastly, and in the seventh place, is the **Aplanes**, or the very sphere of the fixed [stars], which of itself, by [its] mean motion, completes one degree in 100 years, but per accidens now more quickly, now more slowly—the period of which inequality is completed in 3600 years.

[Margin: *The orbs of the Planets.*]

[IV.] But to Saturn Fracastoro attributes 10 orbs (sect. 2, ch. 21); and to Jupiter 11 orbs (ch. 24); and to Mars 9 (ch. 27); but in sect. 3, ch. 10, he gives the Sun 6 orbs, or at least 4; and (ch. 15) to Venus 11 orbs; and (ch. 19) to Mercu—

[...continues on p. 287 (PDF 322): "...ry..." — the remaining homocentric orb-counts (Mercury, the Moon), the total, and Riccioli's appraisal of the Fracastorian system before the next world-system.]

(printed p. 287 — Chapter VII concludes with Fracastoro's orb-counts and a table of Fracastorian orbs. Chapter VIII then opens, on the Tychonic system of Tycho, Longomontanus, Blancanus, and many Tychonics, including the System IV diagram, the Ursus plagiarism dispute, and the Tychonic/Copernican concordance. A large engraved diagram of the Tychonic system fills the right column.)

...[and, ch. 19, to] Mercury, 11 orbs; finally (ch. 24) he assigns to the Moon 7 orbs. Which orbs he names *Circitores*, *Circumducentes*, *Contravecti*, *Anticircitores*, etc.; to which he adds 7 orbs carrying the bodies of the Planets. Nor is there need to shake out the superfluous furniture of this farrago of solid orbs—since we have already rejected solid orbs (sect. 1, ch. 7), and have confirmed the variation of the distances from the earth in each Planet by far stronger arguments (bk. 7, sect. 6, ch. 1). Wherefore, only for the sake of a little erudition, it is enough to know that the sum of the Fracastorian homocentric orbs ascends to the number 77 or 79; but if you number the starless orbs, Scheiner rightly said [it] to be 70, or at least 72, as is clear from the following little-table.

THE FRACASTORIAN ORBS

Orb	Number
Aplanes [non-wandering sphere]	6
Saturn	10
Jupiter	11
Mars	9
Sun	4 or 6
Venus	11
Mercury	11
Moon	7
The star-bearing [orbs]	8
Sum	77 or 79

CHAPTER VIII

On the System of Tycho, Longomontanus, Blancanus, and of many Followers of Tycho

[Margin: *Exposition of the Tychonic system.*]

[I.] The Tychonic System is proposed and expounded by Tycho himself (vol. 1 of the *Progymnasmata*, from p. 477, and in the Epistle to Rothmann, given in the year 1589, on the 21st day of February, old style); but more fully [in] vol. 2 of the *Progymnasmata*, ch. 8, from p. 185. Which system—but with the diurnal motion of the Earth adopted—Longomontanus chose (in the *Danish Astronomy*, bk. 1 of the *Theorics*, ch. 1); and Blancanus (in the *Sphere*), with most of our Society [the Jesuits] in [their] writings on the heaven; and

toward it Scheiner inclines (in the *Mathematical Disquisitions*, num. 22). And afterward Giovanni Antonio Magini commended it (in the Epistle to Tycho, given in 1590, on the Ides of September, which is had on p. 52 of Tycho's own *Astronomical Mechanics*); and upon it he constructed the tables of the *Supplement of Ephemerides*. Tycho, therefore—reckoning the assumption of Epicycles with the Ptolemaic Eccentrics [to be] inelegant, nay superfluous, and [reckoning] the Ptolemaic Equants likewise to sin against the first principles of this art (inasmuch as they suppose the Planets to be moved by some physical inequality—that is, not to be moved equally about the center from which they are described, but about an alien center); but, on the other side, offended by the Copernican system—by which the absurdities of the Ptolemaic system are so emended that one falls into a greater absurdity, on account of the diurnal and annual motion of the Earth, against the principles of Physics and the sacred letters [Scripture], and on account of the immense vastness between Saturn and the Fixed [stars]—for these causes, as it were, he turned his mind to another, new system, and set it forth to us in the following diagram.

[II.] In this system the Earth rests by its center in the center of the Universe, wholly immune from the annual motion; and from the same center is described the outermost or supreme sphere of the Fixed [stars], slowly advancing toward the East by an equal proper motion. Moreover, about the center of the Earth are situated the centers of the Orbs of the Sun and Moon, inasmuch as they serve the discrimination of the times; but the centers of the orbs of the five smaller Planets he denies to be situated about the center of the earth, or to regard it *per se*, but rather to be situated about the Sun, and to measure their Eccentricities from it. For all these five Planets, in this hypothesis, have the Sun, as it were, for the center of their revolutions—so that it [the Sun], like Apollo in the midst of the Muses, moderates the whole harmony of the Planetary choir. Accordingly, hence he hopes that there can be rendered the cause not only of the inequalities, stations, and retrogressions, but also of that admirable connection which the other Planets have, in their motions, with the motion of the Sun; and he promises that he will render [it] in the work *On the Restoration of Astronomy*. But what is most worthy of note appears in this diagram: that Mars at opposition [acronychal]—namely, when it appears at either extreme of the night, being opposite to the Sun—descends so far toward the earth that it becomes nearer to the earth than the Sun itself; which must happen, both from the hypothesis and observations of Copernicus, and from Tycho's own observations (according to what was said in bk. 7, sect. 2, ch. 3, schol. 4, and sect. 6, ch. 10, schol. 1). Whence it comes about that the circle through which Mars is carried intersects that orb or circle in which the Sun itself is carried; but no physical absurdity arises hence, since for Tycho the whole heaven is liquid and permeable, as I taught (sect. 1, ch. 7).

System IV — The System of Tycho and Blancanus, and (as to some points) of Longomontanus

[Translator's note — engraved diagram: The Tychonic geo-heliocentric system. At the center sits the immobile Earth (a dark disc), girt by the ■ Moon; about the Earth runs also the orbit of the ■ Sun. The Sun in turn is the common center of the five planets: ■ Mercury and ■ Venus on small circles tight about the Sun, then ■ Mars, ■ Jupiter, and ■ Saturn on larger Sun-centered circles. Mars's circle is drawn crossing the Sun's circle (the feature noted in ¶II — Mars at opposition coming nearer than the Sun). The outermost band is the starry firmament of the fixed stars.]

[Margin: The theft and error of Nicolaus Dithmarsus [Ursus] concerning the Tychonic system.]

[III.] Now indeed, in the epistle to Rothmann numbered 1 (cited above), he [Tycho] complains that this his system was vended [passed off] by Nicolaus Reimarus Ursus the Dithmarsian as his own; and he convicts him of theft, or plagiarism, from this—that Nicolaus had earlier been a servant of Tycho, and had fled from him, and had copied this system for himself from a certain imperfect diagram, in which, however, through carelessness, the orb of Mars encircled the whole orb of the Sun without any intersection; wherefore, since he could not emend that error, he boasted, as his own, the Tychonic system—but stained by this second [error]—before William, Landgrave of Hesse. And so, by this single indication, Tycho there affirms his imposture to be manifest, and Longomontanus [too] (in the preface to bk. 1 of the *Theorics*). But he [Tycho] adds that he did not, by these his hypotheses, give occasion to the inverted Copernican hypothesis—for he

saw no such inversion by himself, but judged [his system established] both by the approach of Mars at opposition [acronychal] toward the earth, and by the Phenomena of the Comets, which (the annual motion of the Earth being excluded) he judged could not otherwise be explained. Granted Rothmann objected this to him—namely, that his hypothesis is Copernican, but inverted—as appears from the Tychonic Epistles, p. 128.

[Margin: *The concordance and discordance of the Tychonic and Copernican systems.*]

[IV.] But that Scheiner affirms (in the *Mathematical Disquisitions*, num. 22) that the Tychonic system shares nothing with the Copernican, must be taken with a grain of salt; for that is true as to the annual motion of the Earth, and the rest [quiet] of the Fixed [stars] and their interval, and the other [things] which depend on these; otherwise many [things] are common to both systems: namely, the Sun [is] the center of the Planetary system, the Earth the center of the Lunar motion; Mars, in opposition with the Sun, [becomes nearer to the—]

[...continues on p. 288 (PDF 323): "...lands than the Sun." Then ¶IV closes (whether Tycho admitted the Earth's diurnal motion — Tycho's Epistles to Rothmann, the falling-lead-globe and cannonball arguments); ¶V (Rothmann's critique of the "confusion of the spheres"); ¶VI (Longomontanus's Semi-Tychonic variant with a rotating Earth); then Chapter IX opens — Riccioli's own system.]

(printed p. 288 — Chapter VIII concludes, asking whether Tycho admitted the Earth's diurnal motion in his Epistles to Rothmann, then treating Rothmann's "confusion of the spheres" objection with Tycho's reply and Longomontanus's Semi-Tychonic system. Chapter IX then opens, on Riccioli's own system.)

...[Mars, in opposition with the Sun, becomes nearer to the] lands than the Sun.

[Margin: *Tycho admits neither a diurnal nor an annual motion of the earth.*]

But whether Tycho admitted the diurnal motion of the Earth is wont to be doubted. For nowhere did he teach by what reasoning the Fixed [stars] and Planets are moved by the diurnal motion; and (vol. 2, p. 187) he seemed to repudiate only the annual motion of the earth, in these words: "That the Earth which we inhabit occupies the center of the universe, and is not rolled by any annual motion (as Copernicus would have it), I judge must be established beyond all doubt—with the ancient Astronomers and the received opinions of the Physicists, the sacred letters moreover attesting the same." And Kepler thought that he did not shrink from this [diurnal] motion. But if those [things] be attentively read which he himself, in the Epistles to Rothmann, contrives against the hypothesis of Copernicus, it will doubtless be judged that all motion was denied to the Earth by Tycho—nay, that he brought a peculiar argument against the diurnal motion, both from the opinion of St. Augustine, and from the perpendicular fall of a leaden globe. For in the epistle of the year 1589, Nov. 24, old style, p. 156, he says: "A question was being moved, whether the mobility of the terrestrial globe—and that threefold [mobility] asserted by Copernicus—can really stand, and whether it ought to be preferred to our [own] invention, and whether the sacred letters are contrary to that imagination, or not. If, therefore, you have anything from the sacred oracles, or from their interpreters—say Augustine or other Fathers—making for this Copernican assertion and your agreement, cite it from their writings. Provided the reasons be just, I will not gainsay [it]. This I know well enough: that Augustine—whom alone you name—never granted the motion of the earth, neither annual nor diurnal; from which [it follows] that, as [being] less of a mathematician, by denying the Antipodes, he detracted from its roundness—which, however, must be pardoned him. Wherefore, since he did not perceive [the earth] to be round, far less could he admit a motion befitting [its] roundness." And at the end of the same epistle he adds: "But since I see that the Copernican opinion about the threefold motion of the Earth quite pleases you, I will propose at least one of any of these [arguments]—although several can be given, [and] the doubt [is] not so laborious. First, as regards the diurnal motion about its axis, by which the Earth is feigned to be revolved in 24 hours, and so the universal course from East to West is excused: Tell me how it can come about that a leaden globe, let down

in due manner from a very high tower, should perpendicularly touch exactly the point of the earth placed beneath it; for that this can by no means happen—the earth being meanwhile carried around, since its course is most swift—a Geometrical computation will teach you: since, in a single second of time, the Earth must be revolved—even in these Northern regions—by very nearly 150 paces and a half. Hence reason out the rest. For the fall of the lead does not accompany the air, but violently passes through it." To whom, when Rothmann had replied (epistle of the year 1589, April 18) that, according to Copernicus's opinion, heavy and light [bodies] are endowed with two motions—one by which they follow the motion of the whole into a gyre, the other by which they tend up or down—Tycho again pressed against [him], bringing the other argument concerning the globes [cannonballs] fired from a bombard, one toward the East, the other toward the West, as may be seen in his epistles (from p. 190). Again, in vol. 1 of the *Progymnasmata*, when he had confirmed that the New Star of the year 1572 was celestial from its diurnal motion (by which it complied with the motion of the prime mobile), he says: "Unless perhaps I should wish to assent that that universal motion takes place in the Earth (as it pleased Copernicus and some of the ancients)—which, however, in the truth of the matter, must by no means be conceded, [otherwise] we shall render [it] abundantly manifest."

[Margin: *The Tychonic system [is] defective as to the diurnal motion.*]

It must be concluded, therefore, that neither the annual nor the diurnal motion of the Earth ever pleased Tycho. Yet hence it is gathered that his hypothesis is defective, since he never taught how, in a liquid heaven, the stars could accomplish both motions which appear to us, without physical repugnance; which imperfection Galileo too noted (in his *Assayer* [*Trutinator*], p. 25); nor did Kepler sufficiently wash away this stain (in the *Hyperaspistes*, p. 190).

[Margin: *The censure of Rothmann and others on the Tychonic system.*]

[V.] Rothmann also detected another imperfection in Tycho's system, as he himself relates (in the Epistle of the year 1588, on the 13th of the Kalends of October [Sept. 19])—namely, the confusion of the spheres, especially because Venus, Mercury, and Mars are posited to wander up and down through the heaven of the Sun; for he says: "Moreover, this inverted reasoning of Copernicus introduces confusion into the spheres of the Planets. For although no collision of the celestial bodies can follow from it (as you strive to excuse [it]), nevertheless no true or determinate distinction of the spheres remains, but all are confounded among themselves. But the Copernican hypothesis attributes to each Planet its own and determinate space, out of which it cannot depart by its motion. And you know that God is the author not of confusion but of order, and that He so founded Nature that it abhors confusion." The same is objected against it by Malapertius, Tanner, and Amici (in the places cited, bk. 7, sect. 6, ch. 4, schol. 4), and by Hérigone (vol. 5, p. 548); and moreover [they object] that it is not probable that the larger circles of the 5 Planets are carried around by the smaller circle of the Sun. But to the first objection it is answered by Tycho (p. 149, in the epistle of the year 1589, Feb. 21), in these words: "Nor is any confusion committed in my hypotheses, for the heaven is single and similar to itself from the Moon to the eighth sphere, in which the Planets freely ascend and descend, according as they go around the Sun walking in the middle with a most beautiful harmony. For I do not believe that you wish, again, to introduce some real distinction of the celestial orbs—contrary to which it was long since agreed between us." The second objection too ceases; because the circle of the Sun does not carry the other circles effectively, but objectively, and is the center which the motions of those [planets] regard. Therefore Longomontanus (bk. 1 of the *Theorics*, ch. 1) extols Tycho's system and hypotheses with wonderful praises—because, in the three superior Planets, the orbs described around the Sun perform the function of the Ptolemaic Epicycles (namely, because the single annual orb of the Sun serves them for a single and great epicycle); but, on the contrary, the Epicycles of Venus and Mercury, described around the Sun, serve them for orbs [deferents]; and so all and each of the smaller Planets have their orbs Eccentric to the Sun.

[Margin: *Longomontanus's system, in what it differs from the Tychonic.*]

[VI.] But Longomontanus himself judged that the diurnal motion of the Earth should be introduced into the Tychonic system (as Origanus had done): both that, by this single and uniform motion, the apparent motion of the stars toward the West may be represented—while in reality their motion toward the East is single and simple; and that the incredible swiftness of the diurnal motion may be removed from the Fixed [stars]. Nay, he attributes no real proper motion at all to the Fixed [stars] toward the East—for he fears lest hence follow a pulling-apart of them from one another, and a variation of distance, which, however, has never been found to vary; which fear would be vain, and would wholly vanish, if he posited the heaven of the Fixed [stars] solid, and the stars fixed in it. But he himself posits that heaven—not to mention [that] of the Planets—[as] flowing and most limpid, and the individual globes of the stars hanging by libration in the free ether, in that manner in which the earth, balanced, hangs in the air. Accordingly, he attributes the apparent motion of the Fixed [stars] to the precession of the Equinoxes, made [taking place] in the earth. Thus has Longomontanus (bk. 1 of the *Theorics*, partly ch. 1, p. 161 in my [copy], partly ch. 4, p. 220 in my [copy]). Moreover, since on the same p. 161 he says that the center of the Earth is the center of the Sun and Moon—nay, that their orbs are homocentric to the earth—he alludes to his [own] hypothesis of the Sun and Moon; for he explains the motions not by Eccentric orbs (as Tycho did, at least in [the case of] the Sun), but by a single Epicycle of the Sun carried by a Concentric, and the Moon's motions by twin Epicycles—yet so that the center of the Lunar orb is carried around the earth by a little-circle concentric to the earth, as we have sufficiently set forth (bk. 3 *On the Sun*, ch. 19, & bk. 4, ch. 26, num. 8, *On the Moon*). Although, therefore, Longomontanus follows Tycho in the fluidity of the heaven, and in carrying the five smaller Planets around the Sun, but the Sun and Moon around the Earth, and in the very order of the Planets—he nevertheless differs from him, both because he attributes a diurnal motion to the Earth, and transfers to it the apparent motion of the Fixed [stars] toward the East, and because, in [the case of] the Sun, he uses an Epicycle rather than an Eccentric. And therefore it is manifest that Longomontanus's system ought to be called **Semi-Tychonic**, and not Tychonic.

CHAPTER IX

On Our [Own] System

[Margin: A summary of our system.]

[I.] After the various systems of the ancients and of the more recent [authors], resting on the immobility of the Earth, two at last seem to me—after the Tychonic—more probable: one **semi-Ptolemaic**, the other **semi-Tychonic**, as to the center from which the Eccentrici—

[...continues on p. 289 (PDF 324): "...ties [are measured]..." — Riccioli's exposition of his own two preferred world-systems (the semi-Ptolemaic and the semi-Tychonic), no doubt with their diagram(s).]

(printed p. 289 — Chapter IX concludes with the common frame of Riccioli's system, its two forms — Semi-Ptolemaic and Semi-Tychonic — supported by five reasons, the System V ("Our System") diagram, and the intervals and thicknesses of the heavens. This is the last page of Section III.)

...[the center from which the] Eccentricities of the orbs are to be measured. For as to the order of the Planets, it is plainly Egyptian; and as to the number of the heavens, it differs from each [form]. For in it we place the Earth in the center of the world, immune from all motion; and around it the orb of the Moon, above which the circulation of the Sun is so situated that nevertheless around the Sun Mercury, and around Mercury Venus, is carried—and they are found sometimes above the Sun, sometimes below; then Mars so encircles Venus that, in opposition with the Sun, it comes nearer to the earth than the Sun. Above Mars rises Jupiter, carrying around four satellites, which describe their epicycles around it; and above Jupiter, Saturn, itself also girded with two companions, or side-attendants. All of which, in reality in a single fluid heaven, are freely carried

around—through helicoid spirals, or screw-wise, by the Intelligences—by a single motion obliquely toward the West. Above Saturn is the solid sphere of the fixed [stars], by a single spiral motion likewise, [moved] by one Intelligence or by several, exhibiting apparently a threefold motion—namely, in longitude toward the West, in longitude toward the East, and in latitude on account of the variation of declination—which, however, in reality is single, toward the West. Above the sphere of the Fixed [stars] is the aqueous, or crystalline, heaven, for that use which is known to God; and above this, the immobile Empyrean, coruscating with admirable splendor, and the most happy and everlasting dwelling-place of the Blessed.

The arguments for the immobility of the earth we shall adduce in the following section; but for the solidity of the heaven containing the Fixed stars, and for the fluidity of the planetary heaven, I have already adduced [them] (sect. 1, ch. 3 & 7); for the fivefold number of the heavens (the aerial included), see what was said (sect. 3, ch. 1); for the Intelligences moving the heaven, (sect. 2, ch. 1). Further, for the order of the Planets, see what I said (bk. 7, sect. 1, ch. 4); and for the ascent and descent of the Planets, (bk. 7, sect. 6, ch. 1). Now for the exclusion of the diverse orbs or circles, and for the single spiral motion, see what we said (this book, sect. 2, ch. 3, schol. 4, & bk. 6, ch. 18). Finally, for the approach of Mars to the lands, see what was said (bk. 7, sect. 2, ch. 3, schol. 4, & sect. 6, ch. 4, scholium 3, 4, & 5, & ch. 10, scholium 1). But if, with the new stars [satellites]—as some would prefer—a distinct heaven is to be given between the Planetary [heaven] and [that] of the Fixed [stars]; and to the Planets having their Companions [moons], their own heaven is to be assigned separately; and the Aqueous be reduced to the Empyrean—there will be 6 heavens, and 7 great bodies of the world, according to the economy handed down (bk. 7, sect. 6, ch. 4, schol. 5).

[Margin: *The first form of the new System.*]

[II.] These [things] being supposed, as it were, as the general elements of the mundane system: the **first form is the Semi-Ptolemaic**, which, namely, employs the center of the Earth as the terminus from which it measures the Eccentricities of the orbs—but in such a way that it describes the Epicycles of Venus and Mercury around the Sun, and supposes the Eccentricities of five (or at least four) Planets, nay also Epicycles not always of the same magnitude, according to the hypotheses already explained (bk. 7, sect. 2, ch. 6, & sect. 3, ch. 6). To which form, indeed, the figure of the Egyptian system set forth in ch. 4 could serve—if Mars, at opposition to the Sun, came nearer to the earth than the Sun.

[Margin: *The latter form of the System.*]

The **second form is the Semi-Tychonic**—namely that which, long ago, while I was dictating the treatise *On the Heaven* at Parma (where I professed Philosophy), I devised: namely, that the Sun should be the center of the motions of Mercury, Venus, and Mars; but the Earth [the center] of the Lunar motion and of the Fixed [stars], and also of the motions of Saturn and Jupiter. To which the following reasons impelled me. **First**, because I saw that Saturn has its own [planets], and Jupiter its own planets, around themselves, but Mars, Venus, and Mercury [have] none; therefore I esteemed it probable that Saturn and Jupiter exercise their [own] monarchy in the heaven, and are not satellites of the Sun; but that Mars is the greatest satellite of the Sun, inasmuch as it embraces the Earth by its circuit; and that Venus and Mercury are the interior and nearer attendants of the Sun. **Secondly**, because I saw, in the variation of Eccentricity, a greater connection of Mars, Venus, and Mercury with the Sun, than of Saturn and Jupiter. **Thirdly**, because I judged that Saturn and Jupiter—slower and more ponderous Planets—have a greater affinity with the most slow sphere of the Fixed [stars], and accordingly with the center of the Earth—since the Fixed [stars] too regard the Earth rather than the Sun in their motion. **Fourth**, because, since Mars (like Venus and Mercury) enters the heaven of the Sun as to [their] designation [mapping], it seemed far more probable that these three have the Sun as the center of their motion, and that distinct regions of the ether are not to be distributed to them, but a single [one]; but that to Jupiter and Saturn distinct realms are to be ascribed, and so the confusion of the heavens is avoided—[heavens] distinct even by designation alone. Which inclusion of Mars, Venus, and Mercury in the single heaven of the Sun, I see pleased Amici (*On the Heaven*, p. 285), and Oviedo (the single controversy

On the Heaven, p. 468). Wherefore, if we should wish to divide the visible heaven into several regions, we could distribute the first to the Fixed [stars], the second to Saturn, the third to Jupiter, the fourth to the Sun together with Mars, Venus, and Mercury, the fifth to the Moon. **Fifth**, it is very probable that there is found one among the Planets which is the middle between the superior and the inferior, and which in its motions has many [things] in common with Saturn and Jupiter, [and] many also with Venus and Mercury—namely, Mars. All which [things], when more observations shall have been collected and weighed in vol. 3, will be subjected to examination, that it may be established whether this form satisfies the Phenomena. Meanwhile, let no one of the Astronomers take it ill that it is reviewed by us in this place among the other systems. And the figure of this system is [drawn] below, as to the visible heavens; for around it must be understood the Aqueous, or Crystalline, heaven, and around this the Empyrean.

System V — Our System

[Translator's note — engraved diagram: Riccioli's own geo-heliocentric system. At the center, the immobile Earth (a dark disc), encircled by the ■ Moon. About the Earth runs the orbit of the ■ Sun (a radiant face); tight about the Sun ride ■ Mercury and ■ Venus, and on a larger Sun-centered circle ■ Mars (its orbit "embracing the Earth," coming nearer than the Sun at opposition). Higher up, circling the Earth, are ■ Jupiter (girt by its four satellites on little epicycles) and ■ Saturn (with its two companions / "ansae"). The outermost band is the starry firmament. Thus Mercury, Venus, and Mars are heliocentric, while the Sun, Moon, Jupiter, and Saturn are geocentric — the three Sun-attendants being "satellites," Jupiter and Saturn "monarchs" with their own moons.]

[Margin: On the interval and thickness of the primary heavens.]

[III.] It must be noted, further, in this our System, that the intervals are not so constructed that the lowest [point] of the concave of Saturn's heaven touches the highest [point] of the convex of Jupiter's, or the lowest of Jupiter the highest of Mars, etc.—as happens in the Ptolemaic hypothesis—but [that] some interval, empty of stars, is left between the Fixed [stars] and the highest [point] of Saturn, namely of at least 9824 semidiameters of the Earth; and between the lowest of Saturn and the highest of Jupiter, an interval of 10045 terrestrial semidiameters. But between the lowest of Jupiter and the highest of Mars the interval is 5310 terr. semid.; and between the lowest of Venus and the highest of the Moon, 1850. Moreover, the thickness of the whole heaven of Saturn, the Satellites being computed, is 32454 semidiameters of the earth; of Jupiter, the satellites computed, [it] is 21361; of the Sun, Mars, Venus, and Mercury, as of a single heaven, [it] is 19091 terrestrial semidiameters. Wherefore the thicknesses of the heavens of these three Monarchs with their satellites stand thus—that, as it were, 32 such [units] befit Saturn, 21 Jupiter, and 19 the Sun with [its] three satellites. But for the interval between Saturn (■) and Jupiter (■), and between Jupiter (■) and Mars (■), etc. [...] But about these measures you have more, digested into their tables, at the end of bk. 7.

[End of Section III. The page closes with the page-signature "O o" and the catchword "SECTIO" — Section IV (Sectio Quarta) begins on the next printed page. Section III ("De Systemate Mundi circa Terram Immobilem") has run from printed p. 271 through p. 289, presenting the world-systems from the most ancient down to Riccioli's own (the "Ricciolan" semi-Tychonic system). The promised arguments for the Earth's immobility are reserved for Section IV.]