Book I

1. Introduction.

Those who genuinely engaged in philosophy, Syrus, seem to me quite rightly to have distinguished the theoretical part from the practical part of philosophy.[1] If in fact it turns out that the practical also is at first theoretical, one would nevertheless find a great difference between them. Not only is it the case that many people can possess some of the moral virtues[2] without instruction, but it is impossible to succeed in the study of the heavens[3] without learning: in addition, in practical philosophy the greatest advantage accrues from continuous activity in actual affairs, while in theoretical philosophy

from progress in theorems. Hence we thought it proper for ourselves to order our actions amid the presentations of appearances themselves such that even in chance matters we not lose sight of our inquiry into beautiful, well-ordered structure; and to devote our research for the most part towards teaching many beautiful theorems, and especially those properly called mathematical.

In fact, Aristotle quite suitably distinguishes theoretical philosophy itself again into three kinds: the natural, the mathematical, and the theological.[4] Now, all things that are derive their existence from matter, form, and motion. Each of these cannot be observed distinctly and without the others

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[1] Ptolemy has adopted Aristotle's division of philosophy into "theoretical" philosophy and "practical" philosophy. According to Aristotle's scheme (see, for example, *Metaphysics* 1025b3–1026a32), theoretical philosophy, as the name (from Greek θεωρέω, to look at, view as a spectator) suggests, concerns knowledge for its own sake, without an immediate view either to acting or making; practical philosophy concerns knowledge for the sake of doing, making or acting (cf. πράττω, to act or do). "Practical philosophy" includes the arts (medicine, for example), political science and ethics. Aristotle subdivides theoretical philosophy into three types: natural philosophy, mathematics and metaphysics.

[2] The moral virtues are within the purview of ethics, a part of practical philosophy.

[3] "The study of the heavens" is, according to Aristotle's scheme, a part of mathematics, and thus of theoretical philosophy.

[4] Aristotle (*Metaphysics* 1025b3–1026a32) subdivided theoretical philosophy into these three types according to the way the objects each considers are related to matter and motion:
   (1) Natural philosophy or "physics" (from φύω, to grow) is concerned with the ever-changing, visible, material world.
   (2) Mathematics concerns entities (points, lines, geometric figures, numbers, et al.) that do not exist apart from matter, but may be understood without reference to matter. In Aristotle's view, optics, harmonics and astronomy (as well as arithmetic and geometry) are branches of mathematics.
   (3) Metaphysics ("after physics") is concerned with "first causes," with being as such and the properties of being, and with God in so far as the divine nature can be understood by reason alone (natural theology).

in a substance, but can only be conceived of. If anyone should grasp in its pure simplicity the first cause of the first motion of the heavens,[1] he would consider it a god, invisible and unmoved.[2] And he would consider the kind of theoretical philosophy that seeks this out to be theological; such an activity (ἐνέργεια) somewhere on high that concerns what is highest in the heavens could only be conceived of and is absolutely distinct from perceptible substances. The kind of theoretical philosophy that tracks down material and ever-changing quality, concerning white, warm, sweet, soft, and the like,[3] one would call natural (φυσικόν). A nature (οὐσία) of this sort resides among perishable things, for the most part, and below the sphere of the moon.[4] The kind of theoretical philosophy that reveals quality in terms of forms and motions inquires into figure, quantity, and size, and furthermore, place, time, and the like. One would define this as mathematical. A nature (οὐσία) of this sort falls, as it were, between those two.[5] For it not only can be conceived of both with and without perception, but also is a property of all existent things simply, both mortal and immortal. It changes along with things that are always changing relative to their inseparable form, while it preserves unchanged what is unchangeable in form for things that are eternal and of the nature of ether.[6]

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    In light of these considerations, we thought that one might call the other two kinds of theoretical philosophy *conjecture* (εἰκασία)[7] rather than scientific knowledge: the theological because it is utterly suprasensible and unobtainable, and the natural because of what is unstable and obscure in

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[1] See Aristotle, *Physics*, Book VIII.5–10 (256a4–267b26) for the argument that the prime mover is an unmoved mover.

[2] See, for example, *Metaphysics* 1071b3–1073a13 for Aristotle's argument that the first unmoved mover must be pure actuality, without any potentiality, and thus pure "activity."

[3] Compare Plato, *Theaetetus* 171e1–3.

[4] According to Aristotle (for example, *On Generation and Corruption* 392b7–331a5) the sublunary world, as contrasted to the the heavens, is the realm of change. It is the world of tangible things composed of the four elements, earth, air, fire and water.

[5] The objects of natural philosophy are said by Aristotle to be "inseparable" from matter and motion, either in thought or in being—they can neither exist apart from matter and motion nor be understood without reference to matter and motion, because these are essential to their definitions. On the other hand, the eternal, unchanging objects of metaphysics are understood to be "separable" from matter and motion both in thought and in being. The objects that mathematics studies lie between these two in that they are "inseparable" from matter in form and being but are "separable" in thought.

[6] See, for example, *De Caelo* 269b16–270b30 for Aristotle's account of the fifth element, ether, which is eternal, ungenerated and indestructible, and exempt from increase or alteration. According to Aristotle, ether is found only in the supralunary realm and is the material basis of the heavenly bodies.

[7] *Republic* VI (509d–511e).

matter. For this reason, those who pursue philosophy would never hope to come to agreement about them. But the mathematical kind alone, should anyone attend to it carefully, would provide certain and steadfast knowledge to those who practice it, as its mode of proof arises through indisputable paths, arithmetic and geometry. And we were induced to cultivate as far as possible the whole of this theoretical discipline and especially the part that contemplates the divine and the heavenly. For this alone is concerned with the inquiry into things that are "always such,"[1] and is thereby itself capable of being "always such" concerning the comprehension it properly produces, which is neither obscure nor irregular (this is a distinctive feature of scientific knowledge). And the mathematical kind contributes to the other kinds of theoretical philosophy no less than they themselves do. For it would most pave the way for the theological kind; it alone is capable of making sound conjectures about the unmoved and separable activity[2] (ἐνέργεια) using the close agreement between the properties (in terms of motions and regularities of motions) of perceptible substances (which produce motion and are in motion) and of substances that are suprasensible and unchangeable.

It would make no trifling contribution to the natural kind of theoretical philosophy. For, roughly speaking, what is in general distinctive of material substance becomes manifest from the specific form of its motion.[3] Thus the perishable itself and the imperishable become manifest from their rectilinear and circular motions, and the heavy and the light, or the passive and the active, from motion towards the center and motion away from the center.[4] And surely it would render men clear-sighted in the nobility of their actions and character because of the uniformity, orderliness, proportion, and modesty it contemplates in the divine. It makes those who pursue it lovers of this divine beauty, and it habituates and, as it were, naturally disposes them to a like structure of soul.

Now we ourselves are striving unremittingly to increase this love for the study of the "always such." We study what was already grasped in such disciplines by those who pursued them in a genuine spirit of inquiry. And we also propose ourselves to contribute roughly as much as the time between them and us might have produced. And everything that at present we believe to have been discovered we will note down as briefly as possible and in such a

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[1] Compare Plato, *Parmenides* 28 b 8.29–30.

[2] See *Physics* VIII.5–10 (256a4–267b26) and *Metaphysics* XII.6–8 (1071b3–1074b14) on the prime mover.

[3] See, e.g., *De Caelo* 268b11–270b30 on the characteristic natural motion of each of the five elements.

[4] See *De Caelo* I.2–3 (268b11–270b31).

way that those who have already made some progress might be able to follow. In order to make our treatise complete, we will set forth all that is useful for the study of the heavens in its proper order. But so as not to make the account too long, we will merely recount what the ancients precisely determined; what they did not grasp, either at all or in the most useful way possible, we will, as far as possible, elaborate.

2. On the Order of the Theorems.

Now, in the work before us, the first task is to see the general relation of the earth as a whole to the heavens as a whole {I.3–7}. Directly thereafter come the particulars; of these, the first task would be to provide a detailed account of the position of the oblique circle[1] {I.8}, the regions of the earth we inhabit {II.1}, and furthermore the ordered difference[2] among these regions for each horizon according to their latitudes {II.2–13}. For the prior study of these matters makes the investigation into the rest easier. The second task is to provide a detailed account of the motions of the sun {III} and moon {IV–VI}, and what these motions entail. For unless these matters are understood first, it would not be possible to inquire in detail into the stars.[3] Since the account of the stars comes last in terms of the method itself, what relates to the sphere of the so-called fixed stars would reasonably be set forth here first {VII–VIII} and what relates to the five stars called planets[4] would follow {IX–XIII}.

We will attempt to demonstrate each of these matters. We will use manifest appearances and indisputable observations of antiquity and our own time as principles and foundations, as it were, for discovery. And we will apply the ensuing concepts using demonstrations based on geometrical methods.

A preliminary treatment, then, of the general features would be as follows. The heavens are spherical and move as a sphere {I.3}. The earth itself also is sensibly spherical in shape, taken as a whole {I.4}. In terms of position, it is

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[1] *the oblique circle*: The circle traditionally called the *ecliptic*. It will be identified and discussed in Chapter 5 below.

[2] *the ordered difference*: Ptolemy does not state in respect of *what* the difference consists; a phrase like "of appearances" is to be understood.

[3] *stars*: Here, and frequently in Ptolemy's usage, the term refers not only to the "fixed stars" that constitute the constellations, but also to Mercury, Venus, Mars, Jupiter and Saturn.

[4] *planets*: Literally, "wanderers." For Ptolemy, the term refers not only to Mercury, Venus, Mars, Jupiter and Saturn but also to the sun and the moon. It does not refer to comets and meteors, which Ptolemy probably followed Aristotle in regarding as atmospheric phenomena.