Lecture 16
Ptolemy on the Shape of Heaven and Earth

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Introduction

- The man: Claudius Ptolemy
  - Lived about 100–170 CE.
  - In Alexandria, Egypt.
- The book: *Almagest*
  - This is the earliest astronomy book that has survived. It's a systematic presentation of all the astronomy known at the time.
  - "Almagest" comes from Arabic meaning "the great book." Ptolemy's title was "Mathematical Treatise" (in Greek).
  - We'll discuss the first part of Book I, which sets out Ptolemy's general conception of the universe.

The branches of philosophy (Ch. 1)

Three kinds of theoretical philosophy

The true philosophers . . . were, I think, quite right to distinguish the theoretical part of philosophy from the practical . . . Aristotle divides theoretical philosophy too, very fittingly, into three primary categories, physics, mathematics, and theology. [35]

Theology

The first cause of the first motion of the universe, if one considers it simply, can be thought of as an invisible and motionless deity; the division [of theoretical philosophy] concerned with investigating this [can be called] 'theology', since this kind of activity, somewhere up in the highest reaches of the universe, can only be imagined, and is completely separated from perceptible reality. [35]

Physics

The division [of theoretical philosophy] which investigates material and ever-moving nature, and which concerns itself with 'white', 'hot', 'sweet', 'soft' and suchlike qualities one may call 'physics'; such an order of being is situated (for the most part) amongst corruptible bodies and below the lunar sphere. [36]

Mathematics

That division [of theoretical philosophy] which determines the nature involved in forms and motion from place to place, and which serves to investigate shape, number, size, and place, time and suchlike, one may define as 'mathematics.' [36]

Possibility of knowledge

The first two divisions of theoretical philosophy should rather be called guesswork than knowledge, theology because of its completely invisible and ungraspable nature, physics because of the unstable and unclear nature of matter; hence there is no hope that philosophers will ever be agreed about them . . . Only mathematics can provide sure and unshakeable knowledge to its devotees, provided one approaches it rigorously. For its kind of proof proceeds by indisputable methods, namely arithmetic and geometry. Hence we were drawn to the investigation of that part of theoretical philosophy, as far as we were able the whole of it, but especially to the theory concerning divine and heavenly things. [36]

The heaven is spherical (ch. 3)

The heaven is spherical in shape, and moves as a sphere. [38]

Argument from circular motion of stars

What chiefly led [the ancients] to the concept of a sphere was the revolution of the ever-visible stars, which was observed to be circular, and always taking place about one center, the same [for all]. [animation] For by necessity that point became [for them] the pole of the heavenly sphere: those stars which were closer to it revolved on smaller circles, those that were farther away described circles ever greater in proportion to their distance, until one reaches the distance of the stars which become invisible. In the case of these, too, they saw that those near the ever-visible stars remained invisible for a short time, while those farther away remained invisible for a long time, again in proportion [to their distance]. [38]

Argument from constant sizes

If one assumes any motion whatever, except spherical, for the heavenly bodies, it necessarily follows that their distances, measured from the earth upwards, must vary, wherever and however one supposes the earth itself to be situated. Hence the sizes and mutual distances of the stars must appear to vary for the same observers during the course of each revolution, since at one time they must be at a greater distance, at another at a lesser. Yet we see that no such variation occurs. [39]

Ptolemy has other arguments that sound more like Aristotle.

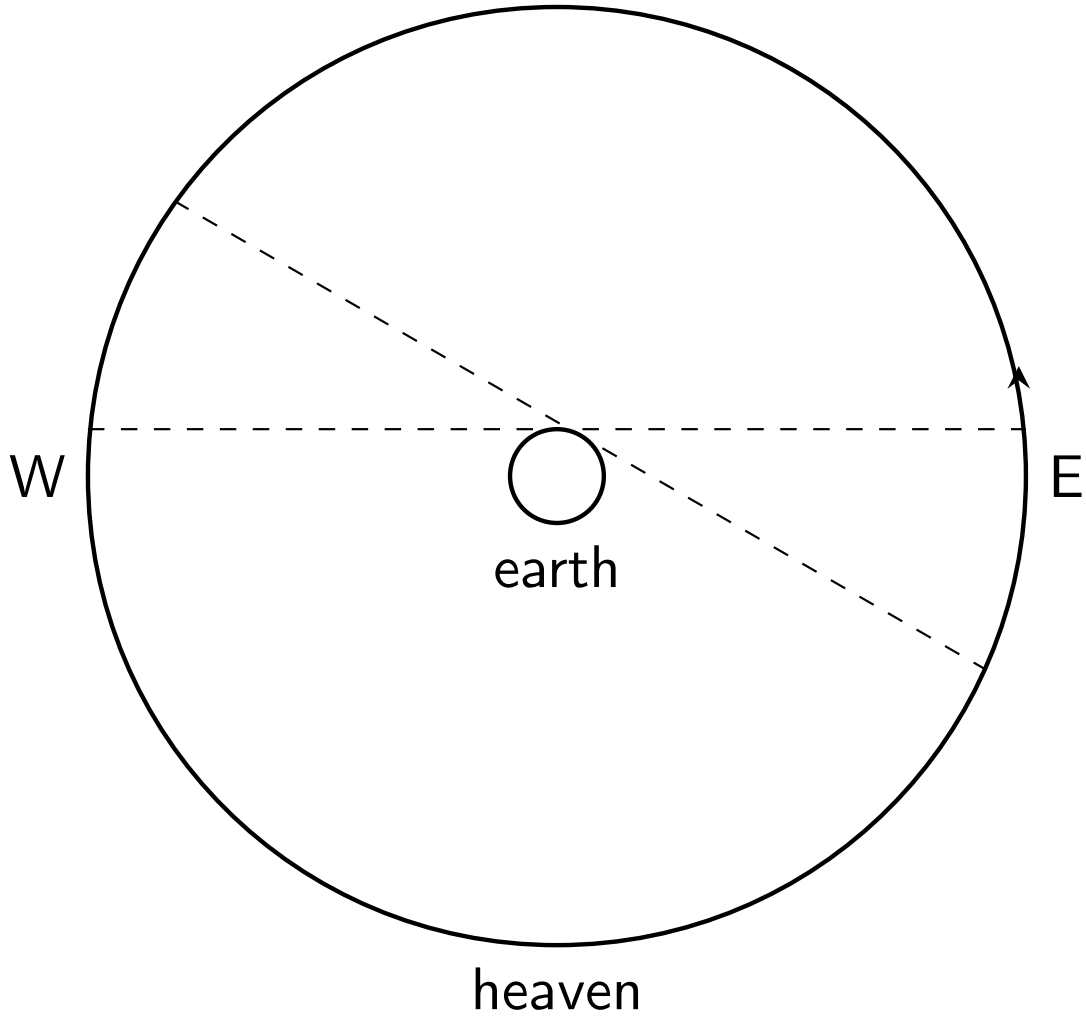
The earth is spherical [ch. 4]

The earth, too, taken as a whole, is sensibly spherical. [40]

The earth curves uniformly east-west

We find that the phenomena at eclipses, especially lunar eclipses, which take place at the same time [for all observers], are nevertheless not recorded as occurring at the same hour (that is at an equal distance from noon) by all observers. Rather, the hour recorded by the more easterly observers is always later than that recorded by the more westerly. We find that the differences in the hour are proportional to the distances between the places. [40]

- The hour at each place is determined by the position of the sun or stars. So this phenomenon shows that the sun and stars rise at an earlier hour for those in the east, in proportion to the distance east.
- This must happen if the earth curves uniformly east-west.
- It wouldn't happen if the earth didn't curve uniformly east-west.


W
E
earth
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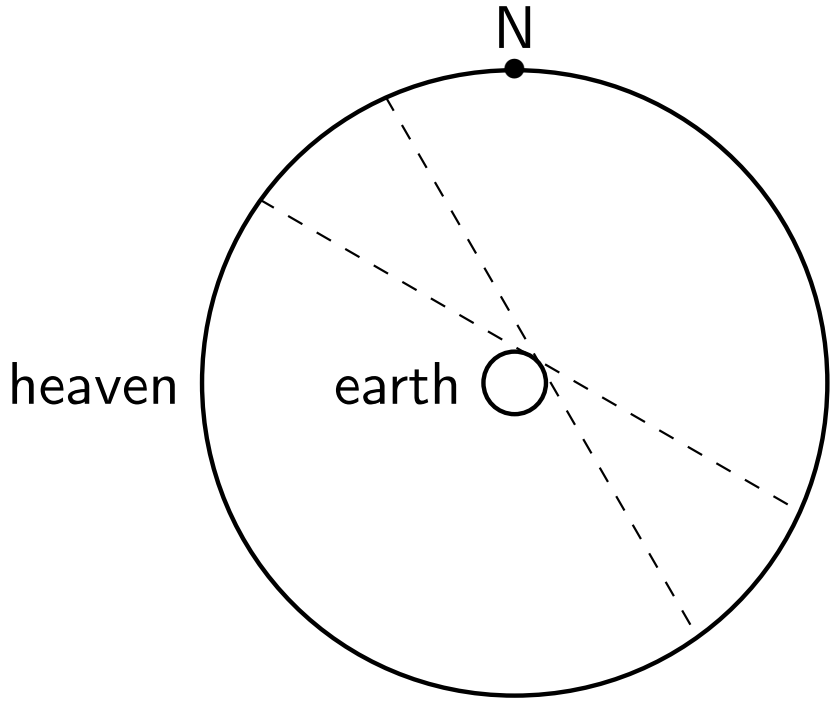
The earth curves uniformly north-south

The further we travel toward the north, the more of the southern stars disappear and the more of the northern stars appear. Hence it is clear that here too the curvature of the earth cuts off [the heavenly bodies] in a regular fashion in the north-south direction, and proves the sphericity [of the earth] in all directions. [41]



Questions

1. According to Ptolemy, what are the branches of theoretical philosophy? In which of these did he believe "sure and unshakeable knowledge" is possible? What reasons did he give for this belief?
2. State two of Ptolemy's arguments for the view that the heavens are spherical.
3. Explain how Ptolemy used astronomical phenomena to argue that the earth is spherical.

Reference


G. J. Toomer.
Ptolemy's Almagest.
Princeton University Press, 1998.
(Originally published by Duckworth, 1984.)
Numbers in brackets refer to pages of this edition.