

# PTOLEMY

## DAY 1

### INTRODUCTION TO PTOLEMY AND HIS *ALMAGEST* AND FIRST BACK YARD EXERCISES

#### INTRODUCTION.

Little is known about Claudius Ptolemaeus. He was probably born at Ptolemais Hermii, and lived from around 100 A.D. to around 178, which means that all his astronomy was obviously “naked eye” astronomy, unassisted by binoculars or telescopes. He did use and in some cases develop certain instruments (e.g. the astrolabe) for accurately measuring angular “distances” between celestial objects—for example, the angle formed by any two stars with the observer’s eye at the vertex. Even that simple type of observation goes a long way, as we shall see. He also had no precise, accurate, and universal means of telling the time of or measuring the durations of events (such as eclipses). Water clocks and hour glasses and sun dials are plainly of very limited value in this regard. Doing astronomy with Ptolemy can therefore feel like fighting with our hands tied! But while we will try to understand how he got so far with so little, we will also sometimes “cheat” in order to see for ourselves how right he was about many of the basic facts on which he will base his theories. We should not deny ourselves the use of binoculars and watches when these prove useful, for instance.

Besides the *Almagest*, the book which is the focus of this course on Ptolemy, he wrote other books on astronomy and also on geography. His book *Guide to Geography* was largely a table of latitudes and longitudes of various places in the “inhabited world” (or in the world known to be inhabited in his time), and because of it he was almost as famous for his geography as for his astronomy.

The original title of his monumental astronomy book was rather uninspiring. It was called “The Mathematical Composition.” But it came to be called “The Great Astronomer,” and then the Arabs called it “The Greatest,” combining the Arabic prefix *al* to the Greek *megiste*, and ever since it has been called “The Almagest.”

Like Euclid’s *Elements*, it consists of 13 books. Chapter One of Book 1 is a preface in which Ptolemy places astronomy among the other sciences in accord with his understanding of their classification, and a word or two about the great dignity of the study of the stars.

THE ORDER OF *THE ALMAGEST*. In Chapter Two of the Book 1 Ptolemy explains the overall order in the parts of his book, which is roughly as follows:

(1) First, in Books 1 and 2, he determines the ratio and situation of the earth to the whole of the heavens (or universe). This is like a general understanding of how we fit into the whole universe.

(2) After that, in Books 2 and 3, he takes up the position of the “ecliptic”—don’t worry about that just yet, we’ll get to it. He will also explain how to determine where you are on the earth and how certain celestial appearances vary according to your location on the earth (i.e. your latitude and longitude). You can’t really get very far without this information. It amounts to understanding your own point of view, your location as an observer and the properties of your place of observation.

(3) In Books 3 through 6 he develops the theory of the solar and lunar movements and their eclipses. The prediction of lunar and solar eclipses was of central importance to ancient astronomers.

(4) Books 7 through 13 were devoted to the stars. Books 7 and 8 were about the so-called “fixed stars”, which we would simply call “the stars” today. He catalogued constellations and the like. Books 9 through 13 were about “the wandering stars”, that is, the planets (the word “planet” comes from the Greek word for “wanderer”). These five “wandering stars”, namely Venus, Mercury, Mars, Jupiter, and Saturn, don’t keep their positions among the other stars, the “fixed” ones, which all stay still relative to each other (so far as naked eye astronomy is concerned!).

Note the order in which Ptolemy proceeds in his astronomy generally respects the following principles:

- He goes from what is at rest to what is in motion, and from what has fewer motions to what has more motions. So he considers the Earth first, and the heavens only generally by contrast, before coming to the particular motions of things in the heavens. And he considers the “fixed” stars first, since the “wandering” stars have all the motions that the “fixed” stars have and more motions in addition.
- He goes from what is close to us to what is further away (e.g. he takes up the sun and moon before the fixed stars, our own location on earth before the sun and moon). He does talk about the sun before the moon, but that is because the moon is less regular in its motion. Similarly, although he talks about the fixed stars before the planets, that is because there is less for him to say about the “fixed” stars, since their motions appeared much more regular than those of the “wandering” stars.
- He also goes from what is easier to observe to what is harder to observe. Hence he takes up the Earth first, the Sun next, the Moon next, then the fixed stars, then the wandering ones. The wandering stars or planets are in some ways easier to observe than the fixed ones, insofar as they are generally brighter. But it takes many more observations to acquire any power of predicting where they will be in your sky at 6pm on some particular evening two years from now than would be required to make similar predictions about a “fixed” star. We will see this soon enough.

Ptolemy next subdivides the first part of his *Almagest*, concerning the ratio and situation and condition of the earth in relation to the whole of “the heavens”, i.e. in relation to that whole world of stars out there. Here is what he intends to show, in order:

- (i) That the heavens are spherical and move spherically.

- (ii) That the earth, in shape, is “sensibly” spherical.
- (iii) That the earth, in position, lies at the center of the universe.
- (iv) That the earth, in size, has the ratio of a point to the universe.
- (v) That the earth has no local motion at all.

In short, he is arguing for a round earth and for a geocentric view of the universe. Notice he is *not* arguing for a *flat* earth! It is a myth that everyone believed the Earth was flat until Christopher Columbus proved the opposite. Christopher Columbus proved no such thing, and many before him did prove it, including Ptolemy.

We will return to these first five Ptolemaic Propositions in Day 2. But for the remainder of today, we will consider some basic back yard astronomy exercises in order to orient ourselves under the sky, and become familiar with what it means to be an observer of the heavens. Ptolemy assumes we have this basic understanding, but most people don’t—not today any more than in his day. Not all of these exercises can be accomplished in a single night, or even in a single week or month. If possible, you should continue those which require more time throughout your reading of this course. What you should find is explained in the notes following the exercises.

**WARNING:** The exercises are extremely INCONVENIENT! For that reason, I will not assume that you are willing to go through with them. If you have the will, then by all means, make the observations for yourself. But if you do not, read through what they ask of you, and see if you can guess what it is you should observe—and then read the subsequent explanations (included below the exercises as lists of “Phenomena”) of what you in fact would observe, if only you took the trouble. But do not skip the exercises altogether, at least not if you are a beginner. Little of what follows after will make much sense to you if you do.