Lecture notes: Aristotle and Ptolemy

Aristotle

Biography. Born in 384 BC. His father (Nichomachus) was court physician to Amyntas II, the father of King Philip II of Macedon (who conquered the Greek city-states in 338, and who was Alexander the Great's father). In 368 he was sent to Athens to study at Plato's Academy. We do not know how much contact he had with Plato himself. He stayed there for 20 years, until the death of Plato in 348. (The Academy continued under Plato's nephew, Speusippus.) Aristotle left Athens and engaged in biological research at Mitylene in Lesbos. In 343, Philip II invites Aristotle back to the capital of Macedon (Pella) to tutor Alexander the Great, from age 13 to 15. Aristotle later returned to Athens in 335 (a year after Philip's death). In Athens he developed his school, the Lyceum, for 12 years. He had to carry out this work in a public gym, the Lyceum, because resident aliens like Aristotle were not allowed to own property in Athens. When Alexander died in 323 and his empire began to crumble, the Athenians lashed out at anything Macedonian; thus Aristotle fled to an old friend (Antipater) "lest the Athenians sin twice against philosophy." Theophrastus continued the Lyceum. He died the next year, in 322; the Classical period ended and the Hellenistic phase began.

Texts. No one knows exactly what our Aristotelian texts are. We know that Aristotle composed eloquent dialogues, but these are now lost, save a few scattered fragments. These works were called "golden and flowing" by the Roman Cicero, who saw them. This fact, combined with the fact that the texts we have are dense and choppy, lead most scholars to the conclusion that the texts we have were not intended for public consumption. Some conjecture that the texts are Aristotle's lecture notes, or private books of research to be kept as a reference in the Lyceum (similar to Wikipedias today). Some say the texts are works in progress, so insertions and deletions were performed in the texts as years went by and Aristotle learned or discovered new ideas. In short: we do not know exactly what the circumstances of production were, and we do not know what purpose they were intended to serve.

A far-reaching project. Aristotle thinks there are 3 kinds of science/ study: theoretical, practical, and productive (which correspond to knowing, acting, creating). Within theoretical science, there are three further studies: metaphysics, mathematics, and physics. Also under the "physics" subset of the theoretical sciences fall what we would now call biological works. Hundreds of pages of the Aristotelian corpus are devoted both to the careful description of various animals and their parts, but also to answering why particular animals have the parts that they do. Aristotle also wrote influential treatises on ethics, political science, and literary criticism.

Physics, Book II

Translation. The title is misleading. It is a transliteration, not a translation. The Greek word "Physis" means *nature* and it is translated as "nature" in the body of the text. So the English title of the book

should be "On Nature," not "Physics."

Definition of nature. The word "physis" is a noun derived from the verb "phyein," which means "to grow." This helps explain why Aristotle defines "nature" as "an internal principle of change or rest." If something can grow, there must be some internal principle of change that causes it to grow. (See 193b15 for a particularly telling example of this close association between growth and nature.) Thus perhaps we see Aristotle's ontology recapitulate Greek philology here. A *nature* is this internal principle; a particular thing is a *natural thing* if it contains within itself such a principle of change. However, Aristotle does not confine the word "natural" only to things that can grow; lots of inorganic things, like rocks, are natural. Why? If you drop a rock, it will change place by moving downward, and then come to rest when it meets the rest of the earth. Nature is an "active principle," and is responsible for the changes we witness in the world.

Chapter 1: natural vs. artificial; matter and form

Aristotle is concerned to draw the difference between natural and artificial (not natural and supernatural). And his definition of nature aims to capture this difference. Then Aristotle goes on to assert that the natural is the "really real," the ontologically basic stuff in the physical universe (192b33). The artificial is secondary, subsidiary, or dependent on the natural for its existence. Thus, with this additional assumption, the question "What is nature?" becomes "What is the fundamental reality of our world?"

What does Aristotle mean by "matter" and "form"? Aristotle considers two candidates for the title of nature (and hence for the title of fundamental reality): matter and form. How should one think about these? Well, one and the same hunk of bronze can be put into many different shapes (statutes, sphere, brass knuckles). This bronze is matter. Similarly, one and the same shape can exist in many different materials: a sphere can be made of wood, or bronze, or iron. This thing, which is the same in all these situations, is the form of sphere. Both matter and form are things that stay the same through different situations: this hunk of gold remains this hunk of gold no matter what shape it is in, and a sphere is a sphere no matter what material it is made out of.

Might matter constitute the fundamental reality in nature? One argument for the view that matter is the fundamentally real in nature is Antipho's wooden bed. A bed with a wooden frame, when planted, sends up tree shoots, not more beds. The underlying stuff that persists throughout the changes of shape and form is what is really real. Aristotle identifies this view with several of the Presocratics (193a22): they make one or all of the four elements (earth air fire and water) into the ontologically basic stuff in the universe.

Aristotle's choice: form. Aristotle asserts that form has a better claim than matter to be called "nature." Why?
1. What is <u>actually</u> x has more of a right to be called x than what is only <u>potentially</u> x.
For example, the matter of a bed (lumber, cloth, metal springs, etc.) is only potentially a bed. We call

something a *bed* only when it is actually a bed, i.e., when the materials have been given a definite form or shape. This example in the man-made case can carry over to the natural case. Suppose we think flesh is composed of some combination of earth, air, fire, and water. We can imagine four lumps of these elements which, if arranged and combined properly, would constitute the skin of my arm. Thus they are potentially flesh. But the four piles of stuff, by themselves, are not skin.
2. Antipho's example can help Aristotle too, if we take the implicit premise of Antipho's argument to be "Whatever is preserved through generations/ passed on is natural." For just as wood gives birth to wood, a human gives birth to a human: the materials of a human, muscle, bone, skin etc., cannot by themselves give birth to a human or the material parts of a human.

Chapter 2. The student of nature should study enmattered forms; that is, not just the forms, but also the materials used to realize the forms. So the student of nature must know more than just mathematics. This is a clear difference from both Plato and the Presocratics.

Chapter 3: The Four Causes.

Translation. "Cause" is not the best translation. "Explanation" would probably be better. For explanations are answers to why-questions, and at the start of chapter 7, Aristotle says that the 4 causes are answers to the question "On account of what?", or put more simply, "why?". *Aition* is drawn from legal terminology: if the jury thought that someone had in fact committed the crime they were accused of, that person was said to be *aition* for that crime; the person was responsible for the crime. Similarly, an explanation of why the lights are turned on is given by citing what factor is responsible for the lights being on.

More than one kind of explanation of a thing are possible. Many different kinds of explanations can be given for the question "Why are the porch lights on?" One answer: in order that my dinner guests don't trip on the way up the porch stairs, or in order to deter burglars. Another kind of answer: because there is a complete electrical circuit now made between the bulb on the porch, and a functioning light bulb supplied with electricity always gives off light. A third kind of answer: because my father, who was downstairs, flipped the switch into the on position. In short, the question "why?" does not admit of only one kind of answer.

Aristotle's classification of "causes"/ explanations. Aristotle thought that there are 4 kinds of answer to why-questions. (Example in parens: a drinking glass)
1. Material: stuff x is made of (glass)
2. Formal: the form of x; sometimes the essence of x (roughly cylindrical, with an open top)
3. Final: the purpose of x, what x is for (for holding liquid to be drunk)
4. Efficient: the maker or creator of x (the factory or person that produced it)
Furthermore, the last 3 often coincide: human begets human.

On the Heavens (= Latin *De Caelo*), Book I: ch. 2-3

Motion. As we have seen, for Aristotle, all natural things have "an internal principle of change." One kind of change is change of place/ location, i.e., motion. Aristotle says there are two kinds of motion: *simple and compound*. The simple motions are those that we can build all the other motions (the compound ones) out of. Aristotle says there are two kinds of simple motions: *straight and circular*.

Bodies in straight-line motion. Aristotle says that bodies that naturally move with one of the simple motions are "simple bodies." Thus, for Aristotle, earth, air, fire and water are all simple bodies, because earth and water naturally move straight down (= toward the center of the universe) and fire and air naturally move straight up (= away from the center of the universe). Of course, under certain conditions, earthy bodies move upwards as well: for example, I can throw a rock up into the air. But Aristotle calls such motion *unnatural motion* -- for the rock has no "internal principle" of upward motion.

Bodies in circular motion. What about the other simple motion -- movement in a circle? Aristotle points out that the *stars* (and planets) have a circular motion. Aristotle infers that they must not be made up of the same materials as the stuff in our immediate surroundings, since earth, air, fire, and water all move in straight lines. This inference is supported by additional major differences between stars' behavior and the behavior of our immediate surroundings:
1. Everything around us comes into being and passes away, but no one has seen a star or planet come into existence or pass away.
2. The stars (and to a lesser extent, the planets) move uniformly (i.e., with exactly the same speed, in the same direction), but things around us do not, for they start, stop, speed up, etc. Aristotle calls the material that makes up the stars "aither," which means 'always running.'
Lastly, Aristotle concludes from this that the stars are *divine*, for they are immortal (for they never disappear) and unchanging (for their motion is always exactly the same).

Ptolemy

We do not know much about Ptolemy. He lived in Alexandria, in Egypt, around the time of Christ (so more than 3 centuries after Aristotle and Plato). We believe his work collected and presented systematically all the astronomical knowledge of his time. (We think this in part because we have virtually no other astronomical treatises from the ancient world -- Ptolemy's was so complete, and covered all the important discoveries of previous times, that nobody bothered keeping the older astronomical works.) Besides the astronomical and astrological works that we read, Ptolemy also wrote a very widely-read geography.

Almagest: Book I

What's so great about astronomy? Ptolemy takes over Aristotle's classification of theoretical sciences into physics, mathematics, and theology/ metaphysics. Ptolemy says that physics and theology should be called "guesswork rather than knowledge." The problem with physics is that (i) material things are always subject to change, and (ii) people can't agree on what exactly matter is. Theology is guesswork because we have no observable evidence about the first cause of the universe. Astronomy is a branch of

mathematics, because the motions of the stars and planets can be described purely geometrically. Why can it be described purely mathematically? Because of the point we just saw Aristotle make: the extra-terrestrial bodies' movements are eternal and unchanging -- just like mathematical objects. (The number 5 is eternal and unchaging.)

The stars' motion is spherical. The stars' motion appears to be spherical (where the Earth is at the center of the sphere), because all stars complete a circle around a single spot in the sky (the pole star) over a 24 hour period. Furthermore, we can rule out any other motion, because the stars always look to be the same size: the only way they could look the same size is if they are not moving any closer or farther away from us. (If they drew closer towards us, they'd look bigger; if they moved farther away, they'd look smaller.) So they must be staying at the same distance from us -- which means they must be moving circularly.

The Earth is a sphere. If the earth were flat, then the sun, moon, and stars would rise at the same time for everyone. But the Sun, moon and stars rise first for people living in the East, later in the West. Also, sailors see the tops of mountains first.

The Earth is at the center of the universe. The arguments here are technical and complex, so we will only consider one example. The ecliptic is the apparent circle along which the planets move (from the point of view of the earth. There are 12 evenly-spaced-out constellations around this circle; these 12 are known collectively as the Zodiac. It is always the case that 6 are visible in the night-time sky and 6 are not. If the Earth were not at the center of the heavenly sphere, then some people on the Earth would see more, and others would see fewer. [Need to see a picture]

The diameter of the Earth is infinitely small compared to the distance from the Earth to the stars. 1. The sizes (and thus distances) of the stars appear the same from everywhere on Earth. If the Earth were bigger (or the celestial sphere smaller) this would not be the case. 2. An observer's alawys sees a full half of the celestial sphere -- she would see less if the earth were bigger (or the celestial sphere smaller).

The Earth does not move. That the Earth does not change its location follows from the previous claim that the Earth is at the center. For if it moved away from the center, previous arguments would apply. Ptolemy then considers the claim that the Earth may rotate, instead of the celestial sphere. Ptolemy admits that "although there is perhaps nothing in the celestial phenomena which would count against that hypothesis... nevertheless, from what would occur here on Earth and in the air, one can see that such a notion is quite ridiculous." Nothing could ever be thrown eastward, because the earth's motion would overtake it. If you say that everything is carried around with the earth, then nothing will be able to move, since it's stuck to the Earth and sharing its motion.

Tetrabiblos, Book I

Astrology's place in the classification of sciences. As we saw above, Ptolemy thinks there are 3 kinds

of theoretical science: physics, mathematics, and theology/ metaphysics. Astronomy was mathematics, whereas astrology, the subject of the *Tetrabiblos*, is part of physics.
(a) Why is it physics? Because it studies the effects of the planets and stars on what happens here on Earth.
(b) Ptolemy does admit that astrology is not as great a science as astronomy: because it involves material happenings here on Earth, the phenomena it studies are not absolutely uniform and regular, and thus exact predictions cannot always be made. (c) In the second chapter, Ptolemy explicitly says that the astological causes can be extremely complicated, with different stars and planets working towards different effects simultaneously.

Why astrological knowledge is possible. Ptolemy offers a series of reasons why astrology can and should be a science.
(a) The Sun clearly has effects on what happens here on Earth. There is the daily motion of the Sun, which brings heat and dryness. There is also the seasonal motion of the Sun (the sun is up in the sky longer during the summer, shorter during the winter) -- and the seasons are responsible for the cycles of birth among plants and animals here on Earth. (b) The moon appears to have effects on what happens here on Earth: the oceans' tides rise and fall with the moon (so Ptolemy says the moon has a 'moistening' power, working counter to the Sun's drying power). Also, several animals and plants change according to the moon's motion (e.g. menstrual cycles).
(c) The positions of planets are used to predict the weather (on a large scale).
Ptolemy thinks that, since the stars and planets have these effects on what happens here on Earth, the position of the stars and planets at the time of a person's birth can tell us what kind of person she or he is likely to become. (It is only "likely" because, as said above, what happens here on Earth is not perfectly uniform and regular, and hence cannot be perfectly predictable.)

Criticisms of astrology are not compelling. Ptolemy then addresses various arguments against astrology.
(a) Many people who claim to be astrologers are either simply bad at it, or are in it merely for attention. We don't say there's a problem with arithmetic if someone says 10+10=30 -- the problem is with the person, not the discipline. Similarly with astrology.
(b) And even if someone is intelligent and sincere, that does not mean that every prediction she or he makes will be exactly right: for we do not know all the various influences of each planet (and how each interacts with the others).
(c) The planets never return exactly to a previous configuration. They might return to a similar arrangement, but not an identical one.
(d) And for predicting a person's character, there are other causal factors at work: the mother and the father, and the social environment in which a child is raised, play a decisive role in determining a person's character.