NS 280: Week #4 Handout, 2002.02.18
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Announcements

● Just a note on the optional readings that are recommended each week: If you are having any difficulty understanding the material presented in class, the optional readings can be very useful for you. They are specifically chosen for their coverage of the material discussed in class, as well as their clarity of presentation. They also can be more expansive on certain topics, so you will gain a broader perspective than, perhaps, is achieved through class alone. All recommended books are on reserve at the Library Center.

Assignment for Wed., Feb. 20

There is no specific assignment for this Wednesday; just come to class ready to listen and learn!

Assignment for Monday, Feb. 25

● Reader: p. 31 - 33. Plato, from The Republic.
Here Plato tackles art and poetry, and we see that they don’t fare too well when it comes to mirroring reality: the productions both of the painter and the poet are imitations of a life which has itself only secondary reality, and neither painter nor poet have any knowledge of what they imitate. Pictures and poems are secondhand, unreal, and tell us little or nothing about life. The dialog continues beyond the excerpt where we find out, that of the 3 possible beds that can be made: the one of forms, the one of the carpenter, and the one of the painter, the one of the painter comes farthest from the true reality of a bed.

● Reader: p. 90 - 93 Abell, from Copernicus and the heliocentric Hypothesis.
This, the first reading from a classic astronomy text, describes what we covered in Wednesday’s class. Pay particular attention to the definitions and concepts illustrated by Figures 2.3 and 2.4. And don’t let the mathematics used here scare you: It is nothing more (or less) than high school geometry (which I hope was not too frightening for you). Note that we need one definition that is not explicitly stated in this reading: Astronomical Unit (AU): The distance from the Earth to the Sun.

● Reader: p. 34 - 36 Aristotle, from Physics.
Reading Aristotle’s writings is tricky. The writings of Aristotle that have been handed down to us probably don’t represent anything which he would have considered to be a “book”, or even a “work”. Though during his lifetime he wrote many dialogues and books on zoology, natural history, and physics, these have been lost. What has survived (and it is a lot) are believed to have been either lecture notes, or possibly even notes taken by a student in the Lyceum. Thus, it may be unfair to criticize Aristotle’s writings as difficult to follow, contradictory, or too verbose: lord knows, if someone took my lecture notes and published them, future generations would have thought I couldn’t put a sentence together. So, you may find his writings difficult to understand – but that’s part of the point of having you try to read them, actually! Many later interpreters had similarly difficult times trying to figure out just what he meant. Don’t struggle too long on anything, though; do read the introduction that I give below, and then do your best with the readings, and take comfort in knowing that these are some of the hardest readings of the course.

The fact remains that Aristotle’s extant writings, which occupy over a foot of a bookshelf, make very tough reading. Choosing what bits and pieces to include in the Reader was difficult, but I wanted you to have some flavor of what it’s like to read Aristotle directly.

Before embarking on Aristotle, here’s a brief overview of his views, which I think will help make reading his works a bit easier. Essentially, the thing to look for with Aristotle is the “why” to every question; just describing how something works does not satisfy him. He always goes further and delivers an ultimate cause for everything, be it motion, change, or the movement of the stars. Prior to Aristotle, it is often said that there were basically two ways of looking at Nature: Either through the use of the senses or through use of pure logic, with the senses playing a secondary role (of course we also know that with the Ionian
philosophers we do seem to get an elegant mixture of these two ways to understand nature). Further, there were those who believed in the reality of change and those who felt that all observed change was merely the result of seeing the imperfect shadows of the World of Forms, where everything exists a pure, essential, and unchanging state.

Aristotle took ideas from both camps, elevating the role of the senses and empirical observation but not totally rejecting the use of logic to arrive at truth. He refused to accept Plato’s world of forms: the traits that give an individual object its character do not have a prior and separate existence in a world of forms, but belong to the object itself. In his cosmology he also found a happy medium between the two rival ideas. He claimed that the Universe consisted of two distinct places: a perfect, unchanging part that exists above the lunar sphere (i.e., the sphere that contains the Moon and rotates around the Earth once per month), and an area below the lunar sphere, surrounding and containing the Earth, which is the scene of change, corruption, decay, birth, death, etc. Aristotle thus believed that change was genuine, but confined to the sublunary sphere.

The first reading selection is from the first pages of Physics, and opens with Aristotle’s method of scientific inquiry. Note particularly at lines 24 and 25 where he espouses that “we must advance from generalities to particulars”: this method of logic, known as deductive reasoning, is a dominant theme throughout Aristotle’s writings. (This approach is also the one taken by Euclid in his geometric proofs.) After discussing more about his theory of knowledge, we pick up Aristotle, in a significant statement, saying that “men do not think they know a thing till they have grasped the ‘why’ of it”. Remember, Aristotle has an answer for everything.

In book IV, Aristotle continues the theme of how all the elements have a natural place of existence. For Aristotle, place was a fundamental thing; it has properties. Heavy bodies move toward their place at the center of the universe not because of a tendency to unite with other heavy bodies located there, but simply because it is their nature to seek that central point. All places are not equal in Aristotle’s cosmology! Notice also how Aristotle refers back to Hesiod in this excerpt.

The last tiny excerpt from Book VII of Physics is very important: it says, like Plato had before him, that there must be a cause for all non-natural (violent) motion. There is no Lucretian “Doctrine of the Swerve” for Aristotle.

**Reader: p. 37 - 38 Aristotle, from On the Heavens.**

Aristotle believed in two kinds of motion: natural and violent. In Aristotle’s universe, there were 5 elements – four (air, earth, water, fire) belonging to the sublunary sphere, and one (the “quintessence”, or “ether”, which is sometimes spelled “aether”) belonging to the region beyond the moon. If left to their own devices, earth and water would descend toward the center; because of its greater heaviness, earth would collect at the center, with water in a concentric spherical shell outside it. Air and fire ascend, but fire, owing to its greater levity, occupies the outermost sphere, with air as a concentric sphere just inside it (see Reader, p. 251). In the real sublunar world, though, things are composed largely of mixed bodies, one always interfering with another, and this ideal state (of having all the elements separated) is never attained. However, objects, depending on the proportions they possess of each element, will strive towards their natural place: a rock will fall, fire will race upwards. This is called natural motion. Violent motion occurs when motion is caused by an external force, which compels the body to violate its natural tendency and move in some direction other than toward its natural place. Lifting up a rock is an example of violent motion.

In this excerpt, we read about the “natural” and “violent” motions of objects, and the natural tendencies of the four basic elements to move in straight lines, either towards or away from the center of Earth. The observed, circular motion of objects in the heavens leads Aristotle to propose that things up there beyond the lunar sphere are composed of a completely different substance, which he calls “Aither”, or “Ether”. This divorce between things in the heavens and things on Earth remains entrenched in Western thought for nearly 2000 years.

*Optional Reading: Lindberg, The Beginnings of Western Science, p. 35 - 68. Good coverage of Plato’s and Aristotle’s thinking, including most of the major ideas discussed in class, as well as a few that we didn’t talk about.*
• *Optional Reading*: Koestler, The Sleepwalkers. Chapters 4 and 5. Wonderful reading about Plato, Aristotle, and wheels within wheels (epicycles). Gives a bit more detail about how epicycles worked than we did in class.

**Weekly Thought Question**

The two questions which make up this week’s assignment are both somewhat mathematical in nature, and refer specifically to the reading from the Abell text, on pages 90 - 93 of the Reader. In particular, they probe your understanding of Figures 2.3 and 2.4 of this reading.

Question 1: We ended class last Wednesday by looking at Jupiter in the night sky, remarking that it is about the brightest star in the sky. Find Jupiter again on a clear night this week, and carefully note its position in the sky relative to the sun (it will help to note when the sun sets below the horizon as well). From this observation, estimate the present elongation of Jupiter in degrees, and construct a diagram similar to Figure 2.3(a) on p. 92 of the Reader, in which you indicate Jupiter’s approximate current position relative to Earth, based on your observations.

Question 2: Answer Problem 8, on Page 103 of the Reader. Remember, 1 Astronomical Unit is *defined* to be the distance from Earth to the sun.