Lecture 2
Anaximander, Anaximenes, Pythagoras, Philolaus

Patrick Maher

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Anaximander

From Miletus. Said to be a student of Thales. 64 years old in 547/6 BC.

Anaximander's theory of matter

- He would say to Thales: Water can change into wood, as you say, but after having done so it isn't water any more. So water isn't conserved.
- Something is conserved, but it is something that can have first the form of water, then the form of wood.
- *Anaximander . . . said that the principle and element of existing things was the indefinite, being the first to introduce this name for the material principle. He says that it is neither water nor any of the other so-called elements, but some other indefinite nature, from which come into being all the heavens and the worlds in them.* (Theophrastus quoted by Simplicius) [107]

Examples

- Water is the indefinite that has been made clear and liquid at room temperature.
- Wood is the indefinite that has been made solid, flammable, etc.

Similarities with our concept of matter

- Matter doesn't necessarily have any particular color or shape or hardness.
- Matter can be transformed from one form to another, but the matter itself is not created or destroyed.

Anaximander's cosmology

- What holds the earth up:
  - Nothing. It is at the center so there is no reason for it to move one way rather than another.
  - A bold idea and a step towards modern views.
- Shape of the earth:
  - It is a cylinder; we live on one of the flat surfaces.
  - Halfway towards our view of the earth as a sphere.
- Heavenly bodies:
  - There are circles (or spheres) turning around the earth. These have vents in them through which we see fire; those are the heavenly bodies.
  - Eclipses occur when the vents are blocked.
  - The phases of the moon are due to the blocking and opening of its vent.
  - Agrees with modern cosmology that heavenly bodies orbit under the earth.

Anaximenes

Said to be a younger associate or student of Anaximander.

Theory of matter

- *Anaximenes . . . a companion of Anaximander, also says, like him, that the underlying nature is one and infinite, but not undefined as Anaximander said but definite, for he identifies it as air; and it differs in its substantial nature by rarity and density. Being made finer it becomes fire, being made thicker it becomes wind, then cloud, then (when thickened still more) water, then earth, then stones; and the rest come into being from these.* (Theophrastus quoted by Simplicius) [145]
- This is Thales' theory with air substituted for water.
- Anaximander probably would have said: Stone isn't air!

Anaximenes' cosmology

- *The earth is flat, being borne upon air, and similarly the sun, moon and the other heavenly bodies, which are all fiery, ride upon the air through their flatness.* (Hippolytus) [154]
- *Anaximenes says that the heavenly bodies make their turnings through being pushed out by condensed and opposing air.* (Aetius) [154]
- *He says that the heavenly bodies do not move under the earth, as others have supposed, but round it, just as if a felt cap turns round our head; and that the sun is hidden not by being under the earth, but through being covered by the higher parts of the earth and through its increased distance from us.* (Hippolytus) [154]
- This is retrograde from Anaximander.

Pythagoras

Introduction

- Pythagoras lived from about 570 to 490 BC.
- He was born on Samos in the eastern Aegean. See map.
- At about age 40 he emigrated to Croton, in southern Italy.
- He set up a secret society there. Members were not allowed to tell the doctrines to outsiders, so we don't know much about what Pythagoras believed.
- The first Pythagorean to publish a book was Philolaus; he was born 20 years after Pythagoras died.
- However, we know Pythagoreans believed the world is essentially mathematical.

The tetractys

- Pythagoras is said to have found that:
  - Strings in the ratio 1:2 make sounds an octave (8 notes) apart.
  - Strings in the ratio 2:3 make sounds a fifth (5 notes) apart.
  - Strings in the ratio 3:4 make sounds a fourth (4 notes) apart.

  These combinations are all harmonious and the ratios are represented by the first four integers.
- The first four integers, taken together, were called the *tetractys* (tetra=four).
- *By "the tetractys" [the Pythagoreans mean] a number which, being composed of the first four numbers, produces the most perfect number, ten (for one and two and three and four make ten). This number is the first tetractys, and it is called "fount of ever-flowing nature" since the whole universe is arranged according to harmony, and harmony is a system of three concords, the fourth, the fifth, and the octave, and the proportions of these three concords are found in the four numbers just mentioned.* (Sextus Empiricus) [233 modified]

What this adds to the Milesians

- Modern science looks for quantitative laws governing nature.
- We didn't see that in the Milesians, but we do see it in Pythagoras.

Philolaus

Nature is made of unlimiteds and limiters

- *Nature in the universe was harmonized from both unlimiteds and limiters—both the universe as a whole and everything in it.* (Diogenes Laertius, who said this was how Philolaus's book began) [325]
- Unlimiteds are substances like wood, earth, water, iron.
- Limiters are shapes.
- Objects are formed by combining these. E.g., a table is wood with a certain shape.
- *What this adds:* The Milesians only talked about substances. Philolaus adds that there is also shape or form.

Nature and harmony

- *It was not possible for any of the things that exist and are known by us to have come into being, without there existing the being of those things from which the universe was composed, the limiters and the unlimiteds. And since these principles existed being neither alike nor of the same kind, it would have been impossible for them to be ordered into a universe if harmony had not supervened—in whatever manner this came into being. Things that were alike and of the same kind had no need of harmony, but those that were unlike and not of the same kind and of unequal order—it was necessary for such things to have been locked together by harmony, if they are to be held together in an ordered universe.* (Stobaeus) [327]
- Probably, the limiters and unlimiteds are represented by numbers and they go together when those numbers are in a ratio that is harmonious, e.g., 2:3.

Questions

1. What is everything made of according to Thales? Anaximander? Anaximenes? Which of these is closest to modern theory of matter? Justify your answer to the latter question.
2. For each of the following, describe what Anaximander and Anaximenes said about it, say which was closest to modern cosmology, and justify that judgment.
   (a) The shape of the earth.
   (b) What holds the earth up.
   (c) The orbits of the heavenly bodies.
3. What is the tetractys? How is it related to harmony, according to Pythagoras?
4. What are unlimiteds and limiters? What holds them together, according to Philolaus? How might he have thought that this works?

References

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Chapters I and II are relevant to this lecture.