The Presocratics

Leucippus and Democritus

Atomism

- Atomism developed by Leucippus and his student Democritus.
- Democritus was born about 460 BCE so he was 40 years younger than Anaxagoras and 10 years younger than Socrates.

Overview

Each atom is a Parmenidean unit.

- indivisible
- no differentiation within the atom
- No empty space within an atom.

Compared to other phusikoi

– Same as Parmenides except the **number** of real beings.

Compared to other phusikoi

- Anaxagoras and Empedocles: have a **qualitative** pluralism: each entity is qualitatively different.

Compared to other phusikoi

- The atomists have **quantitative** pluralism: each entity is identical, but there's just more of them.

Influence of Parmenides

- Impetus for atomism came from **logical** and **metaphysical** positions of Parmenides and Zeno.
- “the first atoms came from Elea.” (Jonathan Barnes' *Presocratics*, p. 346):
- Atoms were postulated in response to the Eleatic view that what is real is one and indivisible.

Properties of atoms

- Uniform
- Homogeneous
- Colorless
- Tasteless
- Indivisible
- They move, have size, shape, and (perhaps) weight

Properties of atoms

- Atoms have "primary qualities":
  - solidity, extension, figure, motion or rest, and number
- Atoms do not have secondary qualities (e.g., color, taste, sound). An atom cannot be purple or sugary or loud.

Properties of atoms

- Atoms move around in the void (empty space), collide, attach to others to form compounds.

- The compounds can have secondary qualities, but these are analyzable as the primary qualities of their component atoms.

- *He makes sweet that which is round and good-sized; astringent that which is large, rough, polygonal, and not rounded; sharp tasting, as its name indicates, that which is sharp in body, and angular, bent and not rounded; pungent that which is round and small and angular and bent; salty that which is angular and good-sized and crooked and equal sided; bitter that which is round and smooth, crooked and small sized; oily that which is fine and round and small.*

Atomism: So what's real?

- No actual generation only formation of compounds.
- Arrangements and clusters of atoms are not real nor are their "properties"
- While a compound may appear to be purple or gold, it isn't. Nothing is actually purple or gold.

Atomism: So what's real?

Two things only:

Atoms and the empty space they're in

Atomism: So what's real?

- Cf. **26**=B 9:

  By convention, sweet; by convention, bitter; by convention, hot; by convention, cold; by convention, color; but in reality, atoms and void.

Mechanistic

- The movement of atoms is explained without recourse to reasons, motives, Mind, the Good, Love, Strife

BUMMER!

Atomism

- Our only fragment from Leucippus supports (**1**=B2):

- *Nothing happens at random but all things as a result of a reason and by necessity*.

- Causal determinism

Determinism

- An individual atom has no choice concerning its movements. If pushed, it moves. Its “motivational forces” are all external.

Determinism

- The compounds of atoms are determined also.
- Movements are a function of the movements of their component atoms.

Atomism

The movement of an entire system of atoms is just the sum of the movements of all of its individual component atoms.

Atomism

- Explanations are **bottom up**, not **top down**.
- The behavior of the compound of atoms is explained with respect to the individual atoms making up the compound.

Atomism

- Similar to Locke is some ways
- world-view is mechanistic, deterministic
- Very contemporary?
- (Note: quantum mechanics has considerably weakened the support for this point of view.)

Atomism

In what sense are Democritus' atoms indivisible?

Indivisability

Either (a) it is **physically** impossible to divide an atom or (b) it is **logically** or **conceptually** impossible to divide an atom.

Indivisability

If (a) physically impossible?

- The we can have parts of an atom even if it isn't physically possible to separate the parts.

Indivisability

If (b) conceptually or logically impossible?

- Then talk of "splitting an atom” wouldn’t just be technologically impossible, but would be a conceptual absurdity.

Indivisability

- Democritus thought that atoms had **size** and **shape**:

5=A37: *For some of them are rough, some are hooked, others concave and others convex, while yet others have innumerable other differences.*

10=A14: *These atoms, which are separate from one another in the unlimited void, and differ in **shape** and **size** and position, and arrangement, move in the void*

Indivisability

- But if atoms have size and shape, why refuse to think they are theoretically indivisible?
- We can always think of dividing that by half.

Possible solution to objections to theoretical indivisibility

- Matter and space are atomistic
- Size of an atom = a unit of **atomic space**
- Fundamental unit of **measurement** is an atom.

Possible solution to objections to theoretical indivisibility

- If each atom represents atomic space, then it makes no sense to think of half that space.
- An atom may then have size even though an atom is theoretically indivisible.

Atomism

- Zeno's argument that an (apparently) moving arrow is really at rest throughout its flight seems easy to evade if one insists that space is continuous (and hence infinitely divisible). But an atomist who insists on theoretically indivisible atoms seems bound to deny that space is infinitely divisible.

Atomism

- Zeno’s Arrow Paradox poses an especially troubling problem for such an atomist.

Atomism

- How will the arrow (or any object, in fact) move through an atomic space? Since the space cannot be divided, the tip of the arrow must advance from one end of the space to the other without ever having occupied any of the intervening space.

Atomism

- At one moment, *t*1, it's in one place, *p*1; at some later moment, *t*2, it's in another place, *p*2. But if you pick any time *ti* that falls between *t*1 and *t*2, the arrow is either still at *p*1 or already at *p*2.
- It **never moves** from *p*1 to *p*2, because the space from *p*1 to *p*2 is atomic and therefore cannot be divided.

Atoms and shape

- Democritus did not just think that atoms had magnitude. He thought that they had **different** sizes and **shapes**.
- Difficulty: atomic sizes
- An atom could be larger than another only if one of them were either larger than (or smaller than) the atomic size.

Atoms and shape

- Perhaps there's a smallest size atom, and the size of that atom is the atomic unit of measurement.
- But atomic "shapes" brings further difficulties.

Atoms and shape

- Furley has argued that if atoms have different shapes we ought to be able to distinguish a feature of the atom that distinguishes it from the other atom. We can think of that distinguishing feature as a "part" of the atom.
- That we can do this suggests that the theoretical indivisability won't work.