

## Aristotle on Space

### Physics, Book IV

“The existence of place is held to be obvious from the fact of mutual replacement. Where water now is, there in turn, when the water has gone out as from a vessel, air is present; and at another time another body occupies this same place.” [208<sup>b</sup>, p. 54.  
*Physics, IV, 1*]

- Question: How do we know that the air occupies at a later time the same place that the water occupied at an earlier time?
- The answer is manifest, if space/place is defined in relation to the containing vessel.
- If it were defined more abstractly, there would have to be a tacit invocation of the “stable” earth.

If place exists, then it has influence, since “each [thing, kind?] is carried to its own place.” [208<sup>b</sup>]

One might even suppose that place can exist without bodies and so is “first”. [Independent existence as mark of substantiality]

**Book I** consists of preliminary puzzles about space. At one point, Aristotle seems to reject the existence of void or empty space. “Again, just as every body is in its place, so, too, every place has a body in it.” [Aristotle *does* reject empty space or void. He

believes that the world is a *plenum*.] “What then,” he asks, “shall we say about *growing* things.”

**Chapter 2** is supposed to prove that space/place “is something,” i.e., that it exists. Since place is “what primarily contains each body,” [209<sup>b</sup>] perhaps it is taken to be obvious that it exists.

Aristotle says this: “Plato in the *Timaeus* says that matter and space are the same.” It would be nice to know what Aristotle is thinking of here.

Space is not to be identified with matter or form. These latter are not separable from the given object, but its place is.

**Chapter 4.** Aristotle lists what we would call *criteria of adequacy* for a solution to the problem of the nature of space/place. [210<sup>b</sup> – 211<sup>a</sup>]

- a) Place must contain that of which it is the place and be no part of that (contained) thing.
- b) The primary place of a thing must be neither less nor greater than the thing.
- c) Place must be separable from the thing (and can be “left behind”).
- d) Place must admit of the distinction of up and down (in line with the way that bodies behave).

Then Aristotle notes that a good theory of place/space should do the following:

- i. Satisfy the criteria of adequacy.
- ii. Resolve the initial puzzles.
- iii. Explain why the initial puzzles arose; explain why they were puzzling.

Then he proposes four possible solutions:

space/place is either

1. shape
2. matter
3. some sort of extension between the extremities,
4. the extremities.

Options (1) and (2) are rejected as non-starters. His argument for the rejection of (3) is obscure.

So Aristotle opts for (4). Let us consider what he says:

**“Place... the boundary of the containing body at which it is in contact with the contained body.”**  
[212<sup>a</sup>]

And he continues:

Place is thought to be something important and hard to grasp, both because the matter and the shape

present themselves along with it [but they are separable, so they have been eliminated as being *place*], and because the displacement of the body that is moved takes place in a stationary container, for it seems possible that there should be an interval which is other than the bodies which are moved.... [But what actually is the place if the container is moved?] Just, in fact, as the vessel is transportable place, so place is a non-portable vessel. So when what is within a thing which is moved, is moved and changes, as a boat on a river, what contains plays the part of a vessel rather than that of place. Place on the other hand is rather what is motionless: so it is rather the whole river that is place, because as a whole it is motionless.

Hence the **place** of a thing is the innermost motionless boundary of what contains it. [But what, in fact, is motionless?]

This explains why the middle [that is, the centre] of the world and the surface which faces us of the rotating system [of the fixed stars] are held to be up and down in the strict and fullest sense for all men: for the one is always at rest, while the inner side of the rotating body remains always coincident with itself."

Julian Barbour comments: "He has found and defined the universal and ultimate frame of reference." (*The Discovery of Dynamics*, p. 87)

This reference frame is defined in terms of matter. It's a projection of the stability of the earth. Barbour thinks this "stability" has a profound (and unjustified) influence on our way of thinking about space.

**Chapter 5.** Aristotle wrestles with the question of whether the world can move. It has no place, since there is nothing outside it. [Of course, this idea struck many as unintelligible. What happens, they asked, if I go to the edge of the world and throw a spear?] But all its parts are in place and so can change place.

So, he says, *in this sense* the whole (universe) can move as well. Thus for something that moves in a circle [like the outer sphere] "this place is the place of its parts."

**Barbour** claims that Aristotle's view captures our basic or fundamental *topological* views regarding space [say, our intuitive views about next-ness.] What it leaves out, he says, is the (Euclidean) *metrical* [or distance] view of space, as captured by the atomists with their void, that eventually was to emerge in the 17<sup>th</sup> century. The tension for Aristotle is felt by the question asked above: What is beyond the outer sphere? The tension for the atomists is: If it's nothing but void out there, then how is *anything* located?

Barbour writes:

Kuchař has pointed out to me that the coexistence for around two millennia of these two concepts, represented respectively by the finite Aristotelian cosmos and infinite Euclidean space, which were both developed with great precision and detail long before the end of Greek antiquity and then lived on cheek by jowl until almost the middle of the seventeenth century, when the Euclidean concept finally triumphed, is a most remarkable and almost inexplicable phenomenon. How were people able to live so long with such contradictory notions? (90)

## On the Heavens

### Book I

**Chapter 1.** There are (and must be) exactly three dimensions to space.

**Chapter 2.** Simple bodies (the elements) and simple motions (to/from the center in a straight line) naturally go together.

But motion in a circle is even simpler than motion in a straight line (since it is finite, bounded). Indeed we find something moving *naturally* in a circle, and it must be different from the elements we experience, since it's motion is neither the same nor contrary to their motion. In fact, it must be prior to these elements (since its motion is simpler) and in a way divine.

Note the distinction between natural motion (to or from the centre, in a circle) and forced motion. This distinguishes kinematics from dynamics. [Newtonian kinematics is quite different, according to the law of inertia.]

### **Chapter 8.** There cannot be many worlds.

Aristotle takes as a **premise** that “all the worlds [if there are other worlds] must be formed from the same types of body.” [267<sup>a</sup>31] But since earth moves down towards the centre, the existence of two centres would induce contradictory motions. That is, earth moving towards the centre in another world would be moving away from the centre in this world. Fire moving away from the centre in this world would be moving towards the centre of another world.

All this constituted a *reductio* of the existence of other worlds as far as Aristotle was concerned, but I have never noticed that he gives any justification for the premise I note above.

## Book II

**Chapter 4.** “The world” [the heavenly sphere, presumably] must be spherical, else in rotation its parts would be forced to move outside it—but there is no outside.

The earth must be spherical too, “for bodies bounded by what is spherical and wholly in contact with it must be spherical.” [287<sup>a</sup>]

**Chapter 13.** Where lies the earth? Some thinkers, like the Pythagoreans, deny that it’s at the centre. According to Aristotle, these thinkers value their theories more than the “apparent facts”. [Empiricism vs Rationalism]

**Chapter 14.** The earth is at rest at the centre (of the universe). This is the natural place for earth (the element), and there appears to be nothing forcing it from its natural place.

Also there is supporting evidence. A weight thrown straight upwards returns to the same place it was thrown from, which it would not do if the earth moved

The earth is a sphere of no great size (as the astronomers tell us). The convex shadow of the earth on the moon in an eclipse is evidence that the earth is spherical. That different stars appear as we move north or south testifies to its small size—about 400,000 stades in circumference.

[It’s not clear how long a Greek stade was. *If* Aristotle was thinking of Attic stadion, this is about 185m, giving a circumference for the earth of about 46,620 km, about 16% large--not a bad estimate really. Eratosthenes did the estimate.]