

Notes – the old science

Old science dates back to Aristotle, was developed in important ways by Ptolemy

Three parts of the old science:

1. the science of macro objects
2. the metaphysics underlying that science
3. the epistemology explaining how we know about the metaphysics and the science

These views were combined with the theology of the Catholic Christian church by Thomas Aquinas (1225-1274) to form the Church-sanctioned way of understanding the world, leading to widespread acceptance by educated Europeans in the Catholic sphere.

The metaphysics:

What is the nature of everyday physical objects? What does it mean for an object to undergo a change? What causes change and motion?

Form and matter

Aristotle's Hylomorphism: physical objects – substances - are combinations of *matter* and *form*.

A form is basically a property, and matter is the thing that instantiates the property.

'form' doesn't necessarily refer to a shape (though shapes too can be forms, e.g. a statue). It can be any kind of property: being red, being Socrates, being a horse, etc.

Linguistic analogue: subject and predicate

Substances can be composed of other substances:

- A person's body is composed of matter (organs, bones, etc.) and the form of a person
- Each organ – e.g. a heart – is itself composed of matter (flesh) and the form of a heart
- Ultimately everything is composed of some combination of the four elements: earth, air, fire, water
- [there's controversy about whether 'prime matter' exists: the matter that combines with elemental forms to make the elements. This is required by A's account of change, but it's hard to understand what it could be (something I know not what?)]

Essences and Forms and Purposes

Substances – combinations of form and matter – have essences or definitions, and those essences are determined by their forms.

Essences make us the sorts of things that we are. I have the form of being a human, and the essence of being human to be a rational animal, which means to be an animal that can think, perceive, desire, etc.

Forms explain changes

Change is explained in terms of gaining or losing forms:

- There's a thing that persists throughout the change – matter or substance.
- *Accidental changes* involve a substance gaining a form that's inessential to that thing.
 - E.g., being a good cook is inessential to being human – some humans are good cooks, some are not – so it's possible to a substance like me to gain the form of *being a good cook*
- Substantial changes: substances come into or pass out of existence
 - E.g., when I die I cease to have the essential human properties of being capable of rationality; I no longer have the form of a human. What persists through this change is the more basic matter that makes up my body

Forms partially explain causation - Teleology

Aristotle thinks there are four types of causes:

- Material causes: what type of matter the thing is made of
- Formal cause: what type of thing it is; how it is defined
- Efficient cause: what made the thing come into existence
- Final cause: the purpose of the thing

For our purposes, final causes are most important.

People often act to achieve their goals, and we often explain a person's behavior by citing the goals that she was trying to meet:

Sue studied hard for the exam. Why? Because she wanted an A, i.e. it was her purpose to get an A. Here the purpose of a substance is cited as an explanation.

Forms define substances

- they determine the purpose of things of that kind
- those purposes explain/ cause the substances to do what they do, on the model of people acting to achieve their goals
 - Example: When matter has the form of an acorn, the essence/ purpose of that acorn is to grow into an oak tree
 - For Aristotle, this partially explains *why* the acorn grew into an oak tree, and the goal or end state – being an oak tree – is part of what caused it to do so.

- Second example: why does the rock fall when you drop it? Because it's made of the element *earth*, and the goal of earth is to seek the center of the universe, i.e. the center of the earth
- Importantly, these goals or functions of objects are *really in the objects*, they're not just convenient explanatory devices for us. The universe is essentially goal-directed
- This phenomena of goal oriented, backwards causation is called *teleology*

Epistemology

Aristotle's inductive-deductive method

Scientific knowledge is acquired according to the following process:

1. Start out with observation(s) of substance of a particular type
2. Inductively infer general principles about substance of that type (with that form):
 - a. this can proceed either via enumerative induction, or by 'intuitive induction', in which the scientist makes an observation about what is essential in the thing observed; this is a skill possessed by the experienced scientist (taxonomist)
 - b. Example: Observe a lunar eclipse, induce some general principles: that light travels in straight lines, that opaque bodies cast shadows, that the particular configuration of light source and opaque bodies casts just this sort of shadow. (example from Losee 2010)
 - c. The generalizations that are inductively inferred are the essential, defining properties of the substances under observation. So if you can inductively infer that all giraffes have four-chambered stomachs, then having a four-chambered stomach is an essential property of being a giraffe; it's a necessary truth
3. Once you have the general principle, deduce propositions about what has been observed
 - a. continuing the above example, deduce that: all lunar eclipses are the result of light from the sun being blocked by the opaque body of the moon
 - b. Deduction is necessarily truth-preserving
 - c. Since the premise is necessary, and deduction is necessarily truth-preserving, all deduced conclusions are necessary

All scientific knowledge is acquired in this way, so all scientific knowledge is knowledge of necessary truths

The Astronomy of Aristotle/ Ptolemy

Aristotelian astronomy held that:

- The earth doesn't move and is at the center of the universe, with the moon, planets and Sun orbiting the Earth, and the stars fixed to the inside of a giant sphere with Earth at its center and that sphere rotating every 24 hours. There are no other heavenly bodies
- All orbits were in perfect circles, and all heavenly bodies traveled at constant speeds.
- All heavenly bodies are the shape of perfect spheres, and they are eternally unchanging
 - These general properties of planets are 'known' by Aristotle's process of induction. Same
- Stars and planets are made of the fifth element *ether*, which is fundamentally different matter from the stuff on earth, which is all made of the elements earth, air, fire, and water. Earth (for example) is matter with the form of earth, and stuff with that form seeks the center of the earth as part of its function or purpose. Fire moves away from the center of the earth. But heavenly bodies don't do either of those things: they go around in circles endlessly. So heavenly bodies must not be made of the same four elements as earthly things.
 - (Interestingly, this was given as a reason to reject Galileo's observations with his telescope: heavenly bodies are made of fundamentally different stuff from terrestrial objects, so why think that the telescope works the same way on both of them? Who knows what's happening when you point that telescope 'up'!)
- Sphericity, constant speed, circular orbits, and eternal unchangingness are all essential properties of bodies made of ether and are known by Aristotelian induction upon observations of those bodies

New problems for the old science:

- All heavenly bodies are supposed to revolve around the earth, so what about Galileo's observations of:
 - the moons of Jupiter
 - The rings of Saturn
- Sunspots (Galileo): but the Sun was supposed to be eternally unchanging and a perfect sphere
- Through a telescope the Moon looks like a big rock. But big rocks are made of earth, and the essence of earth is to seek the center of the universe, i.e. the center of the Earth. So why doesn't the moon fall to Earth? What keeps it up there?
- Kepler's model of a heliocentric universe, which is much simpler than Ptolemy's geocentric model and enables more accurate predictions of astronomical observations
 - Consequence: if the Earth moves as much as Kepler thinks, then the lack of stellar parallax implies that the universe is ENORMOUS, much bigger than Aristotle and Ptolemy thought
 - Consequence: Science and Catholic theology were nearly inseparable at this point, and many Catholics thought that Heaven is a place beyond the sphere of fixed stars. But Kepler's model doesn't include a sphere of fixed stars, so where's heaven?

NB: Galileo published his discoveries in 1610 and 1613. Descartes's Meditations were published in 1641. Descartes was familiar with Galileo's work.

Big problem for the old epistemology:

According to Aristotle's epistemology, the old science was well supported.

How could it have lead us so far astray?

Big problem for the old metaphysics:

We'll get into this later, but here's an initial problem:

Forms are supposed to explain change. But do they?

When I learn to play piano I undergo a change: I become musically competent.

In Aristotelian language, I gain the form of a musically competent substance.

In essence, the analysis is: becoming musically competent is gaining the form of musical competence.

But how illuminating is that?