

Humanities 4: Lecture 2

The Scientific Revolution

Outline of Lecture

- I. Pre-modern Science
- II. The Scientific Revolution
- III. Newton's Crowning Achievement
 - A. Project
 - B. Argument
 - C. Significance
 - D. Limitations

Pre-Modern Science

1. Aristotelian Science

- a) paradigm: biology and (astronomy and theology)
- b) qualitative explanations
- c) four causes: material, formal, efficient, final
- d) geocentric astronomy
- e) scientific method: syllogism

2. The Language of God:

- a) Biblical narrative is crucial to decipher God's intentions
- b) man at the center of the universe
- c) made in the image of a perfect God, but imperfect

Scientific Revolution

1. Galileo (1564-1642)

a) paradigm: physics and astronomy (not theology)

i) Galileo's law of free fall (against Aristotle)

b) rejection of geocentric astronomy on basis of telescopic observations, caused theological controversy

c) observations also confirmed imperfections of sun

2. Bacon (1561-1626)

a) Scientific method: pro-induction, anti-syllogism

Scientific Revol., cont.

3. Descartes (1596-1650)

- a) discovered Cartesian coordinate system
- b) matter in motion, quantifiable properties
- c) rejection of formal, material, and final causation
- d) full-scale epistemology and metaphysics for new science
- e) laws of motion

4. Boyle (1627-1691)

- a) Boyle's law, $p \cdot V = k$, mathematical formula for behavior of (ideal) gases

Isaac Newton

- ♦ The Project
- ♦ The Argument
 - ♦ Definitions
 - ♦ Scholium
 - ♦ Axioms
 - ♦ Rules of Reasoning
 - ♦ The Argument of Books I-II and III
- ♦ The Significance
- ♦ The Limitations

Newton's Project

Philosophiæ Naturalis Principia Mathematica (1687)

1. Mathematical principles of natural philosophy
 - a) priority of mathematics over physics & theol.
2. prove that
 - a) there are laws of motion that can account for the motions of bodies examined in rational mechanics.
 - b) there is a single mathematical law, the law of universal gravitation, that holds for both terrestrial and celestial bodies.

N's Argument, I

1. Euclidian Form

a) start with definitions and axioms, then prove propositions

i) oddly, calculus, which N discovered, is not used

2. Definitions are of the relevant properties of bodies

a) quantity of matter (mass)

b) quantity of motion (momentum)

c) the quantity of (different kinds of centripetal) forces

3. Scholium to Def. VIII explains space, time, place, and motion

a) absolute vs. relative,

b) true vs. apparent,

c) mathematical vs. common (sensible)

N's Argument, II

d) How can we distinguish between true & apparent motion?

i) bucket experiment and two globes example

ii) “But how we are to obtain the true motions from their causes, effects, and apparent differences, and *vice versa*, how from their motions either true or apparent, we may come to the knowledge of their causes and effects, shall be explained more at large in the following treatise. For to this end it was that I composed it.” (160)

4. The axioms are three Newton's three laws of motion

a) law of inertia

b) $F=ma$ (almost)

c) equality of action & reaction

N's Argument, III

5. Rules of Reasoning in Philosophy

A. for determining causes and effects

i) admit causes only if necessary

ii) assign same causes to same effects

B. for judging the universal qualities of bodies

i) extended, hard, impenetrable, movable, inertia

a) properties of whole derived from properties of parts

ii) gravity (if it can be shown by universal experience)

N's Argument, IV

6. The Actual Argument !

A. In Books I-II, N proves that these definitions, axioms, and rules provide powerful means for explaining motions of terrestrial bodies.

B. In Book III, N shows that his principles of rational mechanics can also account for celestial motions, specifically, for Kepler's three laws.

i) But this account only works if one attributes gravity to all bodies, i.e., universally, and according to the inverse square law.

Principia's Significance

1. Culmination of Scientific Revolution
 - a) physics, not biology or theology, is paradigm science
 - b) explanations are quantitative, not qualitative
 - c) only efficient causes remain
 - d) heliocentric astronomy
 - e) induction rather than syllogism
2. Mathematics is the language of nature (and God)
3. Importance of Laws of Nature

Principia's Limitations

1. Problems in Physics

- a) atoms (Query 31)
- b) loss of motion (Query 31)

2. Larger problems

- a) cause of attraction, action at a distance
 - i) ether (Query 21 and 28)
 - ii) “impulse, or some other means” (Query 31)
- b) only mathematical principles
- c) only natural philosophy, not “moral”, i.e., man