A Brief History of Scientific Thoughts
Lecture 1

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Science

Definitions.

Online Oxford Dictionaries.

- The intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment.
- A systematically organized body of knowledge on a particular subject.
- Origin: Middle English (denoting knowledge): from Old French, from Latin scientia, from scire ‘know’.

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Rise of Modern Science

1633

Galileo Galilei faced the Inquisition.

What had he done?

- He advocated the heliocentric theory.

Why was it considered dangerous?

- The answer involves a discussion of the prevalent socio-religio-political structure.

We will only briefly look at the serpentine course of the heliocentric theory.



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Astronomy in the Ancient World: Why?

Practical: years of painstaking observations.

- Seasons determine agriculture and migration of animals.
- The Moon controls the tides and the life cycles of many animals.
- Prediction: accurate information about the position of the Sun and the Moon leads to reliable timings for organising hunts, determining sowing and reaping.

Speculative:

- Up above the sky appears immortal; down below things are mortal.
- Do the planets have influence on human life?
- By predicting the behaviour of the heavenly bodies can we predict our own future?

Curiosity:

- Consciousness comes with an in-built curiosity.
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- Hipparchus (161–126 B.C.)
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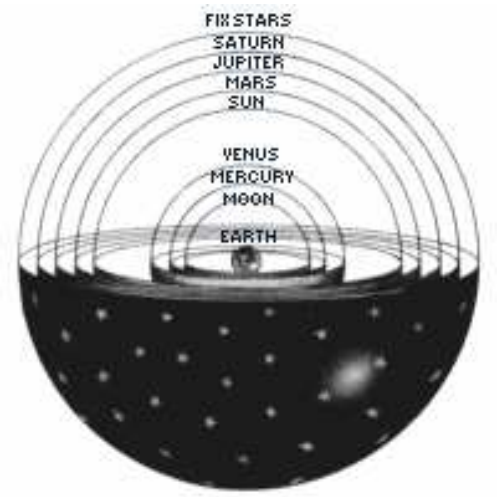


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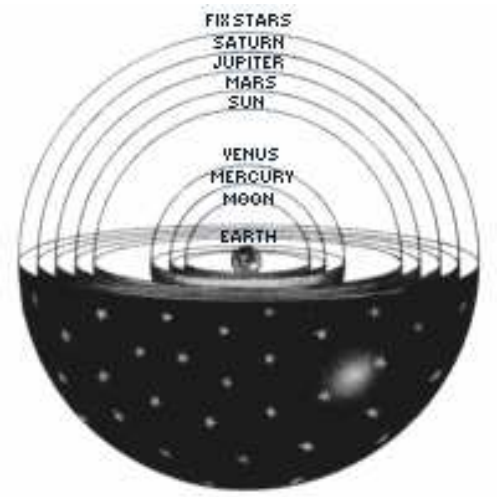
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Source:
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  - The scriptures did not provide a cosmology.
  - Geocentric universe was consistent with Christian theology.

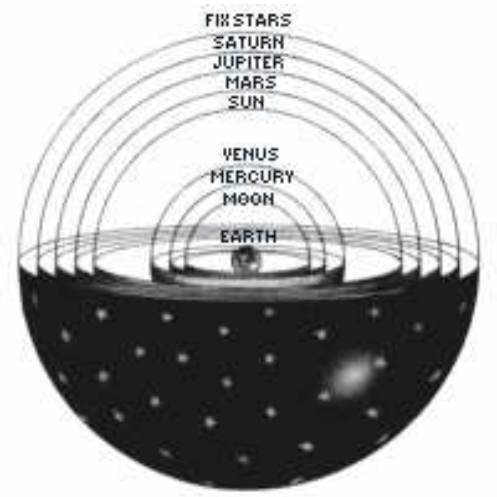
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Heliocentric Model

- Copernicus (1473–1543): was a Polish ecclesistic.
  - Sun at the centre of the universe.
  - Earth has two-fold motion.
  - Put forward as a tentative hypothesis.
- Tyco Brahe (1546–1601):
  - Made a star catalogue and noted positions of the planets for many years.
  - Intermediate position: Sun and Moon go around the Earth; planets go around the Sun.
  - Raised objections to Aristotle's view:
    discovery of a new star in 1572 without daily parallax and hence is more distant than the Moon;
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Heliocentric Model (contd.)

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  - Three laws of planetary motion (1609 and 1619):
    Elliptical orbits with Sun at one of the foci;
    Line joining a planet to the Sun sweeps out equal areas in equal times;
    Period of revolution is proportional to the cube of its average distance from the Sun.
- Galileo Galilei (1564–1642):
  - Motion: law of intertia, law of falling bodies, projectiles.
  - Improvements to the telescope to obtain about 30x magnification.
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- Modelling, abstraction and simplification:
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- Invention of calculus.
- Optics: decomposition of white light.

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Evidence and Inference

Data is fundamental and cannot be ignored (or fabricated).

- After 3 years, Kepler believed that he had found the correct values for a Martian *circular* orbit which matched ten of Brahe's observations.
- However, two further observations deviated by 8 minutes.
- Kepler writes
  'If I had believed that we could ignore these eight minutes, I would have patched up my hypothesis accordingly. But since it was *not permissible to ignore*, those eight minutes pointed the road to a complete reformation in astronomy.'
- This later led to the development of the elliptical orbit.

– from "Cosmos" by Carl Sagan.



Founders of Modern Science

Copernicus, (Brahe), Kepler, Galileo, Newton

> *'The men who founded modern science had two merits which are not necessarily found together: immense patience in observation, and great boldness in framing hypotheses.'*

– from "History of Western Philosophy" by Bertrand Russell



Development of Theories About Science

Two subsequent themes in scientific thought.

- A scientific theory is a model.
- Every scientific theory is tentative.

- The word ‘science’ as used above has a narrow-sense interpretation.
  The first listing in the Oxford definitions:
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Epicycles Versus the Heliocentric Universe

- Both could explain the known observations.
- Use of more and more epicycles.
- In the modern notion, all motion is relative.
- The heliocentric model is *simpler*.



Principle of Simplification

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- Contributions to politics, logic, metaphysics, epistemology.
- Best known for a maxim called ‘Occam’s razor’:

  ‘It is vain to do with more what can be done with fewer’.

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    ‘Simpler theories are, other things being equal, generally better than more complex ones.’

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  - A simple theory is better testable; a simple theory applies to more cases than a more complex one, and is thus more easily falsifiable. – Karl Popper.
- Arguments against the principle:
  - Extra-evidential consideration: there is little empirical evidence that the world is actually simple.
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