Scientific Revolution & The Enlightenment – Lecture Notes

Aristotle –
In early 1500’s Europeans still using his model of universe
Slightly modified in Mid Ages – combined w/ Christian ideas

Motionless Earth – at center
10 separate transparent crystal spheres: 1st 8 embedded: sun, moon, 5 known planets, & fixed stars….then 2 spheres added in Mid Ages to account for slight changes in stars over the centuries.
Beyond the 10th, throne of God and all saved souls.

Ptolemy (2nd Century A.D.) – believed the sun rotated around the earth.

Since ancient times it has been known that five of the "stars" moved across the sky: Mercury, Venus, Mars, Jupiter and Saturn. They were termed "planets" which simply means wanderers.

Nicolaus Copernicus (1473-1543)
Studied church law and astronomy. Other objections were based on the Aristotelian point of view---it was difficult to believe that all the other planets were composed of ether, and the earth of the other four elements, if they were all behaving in so similar a fashion. A further objection, which had long ago been raised by Aristotle to the idea of a rotating earth, was that the stresses would cause it to fly apart, and furthermore, anything thrown in the air would land far to the west.
Despite these problems, Pope Clement VII approved of a summary of Copernicus’ work in 1530, and asked for a copy of the full work when it was available. This was not until 1543, the year Copernicus died.
As Copernicus’ new picture of the universe became more widely known, misgivings arose. The universe had after all been created for mankind, so why wasn’t mankind at the center?

An intellectual revolutionary called Giordano Bruno accepted Copernicus’ view, and went further, claiming that the stars were spread through an infinite space, not just on an outer sphere, and there were infinitely many inhabited worlds. Bruno was burned at the stake in 1600.
Luther and Calvin condemned Copernicus’ ideas.

Johannes Kepler (1571-1630) – from a minor German noble family. Trained for Lutheran ministry. Looked for THE mathematical formula of universe... also looked for musical harmony in heavenly bodies. Developed three formulas: 1. orbits are elliptical rather than circular, 2. planets do not move at uniform speed in orbit, 3. overall completion of planet’s orbit is directly correlated to distance from sun.

Galileo Galilei (1564-1642)
From Florence. Was headed for ministry… Father also wanted him to pursue a career in medicine… Galileo, once in school, will switch to mathematics.
Publishes Dialogue on the Two Chief Systems of the World, in 1632…
Examines Aristotle/Ptolemy views –vs- Copernicus (with the Pope Urban VIII’s blessing in 1624). But, he couldn’t presume to judge which one actually exists. He did…and he was brought to trial for heresy.
The real breakthrough that ultimately led to the acceptance of Copernicus’ theory was due to Galileo, but was actually a technological rather than a conceptual breakthrough. It was Galileo’s refinement and clever use of the telescope that persuaded people that the moon was a lot like the earth, and in some ways, so were the planets.
GRAVITY - Galileo proved to be an extremely talented mathematician, and in his early twenties he wrote some tracts extending results of Archimedes on centers of gravity of shapes. At age 25, he was appointed to the Chair of Mathematics at Pisa.
At age 28, in 1592, Galileo moved to a better position at Padua, in the Venetian Republic, where he stayed until the age of 46.
After his trial in 1633 – under house arrest… started to go blind… yet, he continued to observe, experiment, write and even publish his texts in Holland… in 1638 went blind and Pope refused to allow him to go to Florence to see a doctor.

Tycho Brahe (1546-1601) – all planets revolve around sun, and entire group revolves around earth-moon system. (from a noble Danish family)
Isaac Newton (1642-1727)
Wrote *Principia* or *Mathematical Principals of Natural Philosophy*, published in Latin in 1687.
The Law of Universal Gravitation
Calculated the average density of earth to be 5 and a half times that of water.
Suggested electrical messages activate nervous system
Postulated some ideas of thermodynamics and quantum theory
All colors are composed of mixture of primary colors of the spectrum
Explained phenomenon of the rainbow
Calculated sound waves
Invented calculus
Proposed that light could be mathematically described (1671)
Became wealthy, a hero, knighted, and buried in Westminster Abbey… elected to Parliament in 1689 representing Cambridge University
He was ungenerous to those who may have helped him… only published discoveries when he heard that others might publish their findings… he scoffed at them and claimed they copied his work.
Alexander Pope (a poet) went so far as to compare him with God and wrote his proposed epitaph:
“Nature and Nature’s laws lay hid in night; God said, Let Newton be! And all was light!”

The University System & the Causes of the Scientific Revolution
1. medieval intellectual life and universities more contributory than originally thought to be…
   By 1300 Philosophy took its place next to Law, Medicine, Theology.
   Science was able to emerge as a small but distinct branch of philosophy.
   14th and 15th centuries, universities developed professors of math, astronomy, and physics (natural philosophy) within their faculties.

2. Renaissance generated great progress in science/math as well as humanities and art. Patrons (e.g., Medicis) left sums for scientific pursuits.
   Sir Thomas Gresham leaves a huge amount of money to start Gresham College in London. Wanted 3 of the college’s 7 profs to work exclusively on science.

3. Navigational problems of long sea voyages, overseas expansion, trade, etc. provides motivation for more knowledge.
The problem of longitude
Development of instruments

4. the role of religion
   Catholics, Protestants and Jewish all rejected Copernicus ideas at first.
   Catholic church a little more supportive of science through Galileo’s trial in 1633.
   Thereafter, the Counter-Reformation limits science in Italy and Catholic nations.
   Protestant nations hostile until after the 1630’s… then, in nations without strong religious leadership, science is pursued… i.e., France, Netherlands, and England.

Francis Bacon (1561-1626)
Develops formal method of inductive reasoning: empiricism. Dump the old Aristotelian and Medieval methods of science.
The empirical method is the same as the scientific method… hypothesis, observation, conclusion, etc.
At the height of his career and power, he was 60 and Lord Chancellor, he was accused of accepting bribes… tried, found guilty, and dismisseed in disgrace from all offices of the crown. He married Alice Barnham, no children, and widely rumored to be bisexual.

He carried out a few experiments… none of significance… he died after catching a bad cold while carrying out an experiment of marginal value: stuffing snow into a dead chicken.

Rene Descartes (1596-1650)
*as young 23-year-old soldier in Thirty Years’ War in 1619 he discovered that geometric figures could be expressed by algebraic equations and vice-versa = Analytic Geometry
Completely rejected old science systems.
Begin by doubting EVERYTHING… and then use deductive reasoning from self-evident principles to ascertain scientific laws.
Reduce all substances to “matter” and “mind”… that is, physical and the spiritual.
This is known as Cartesian dualism. (or Cartesianism)
Wrote *Discourse on Method*, famous quote: “Cogito, ergo, sum”
“I think, therefore I am”