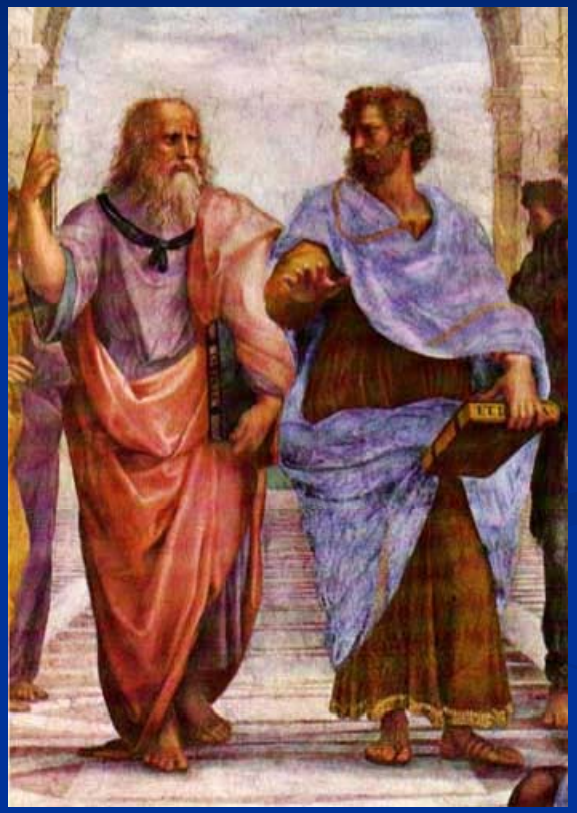
announcements

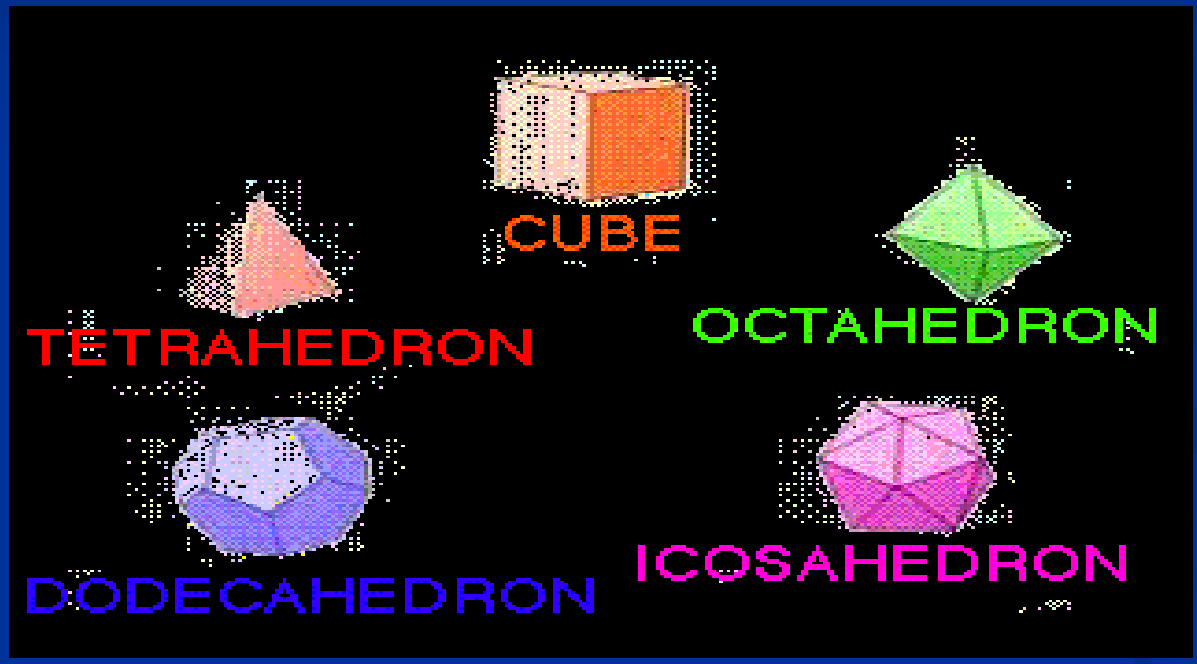
- http://scienceandreligion.blogspot.com/
- Exam will be moved, probably one week later than shown on syllabus

The Heavens of the Ancients

- 428 B. C.

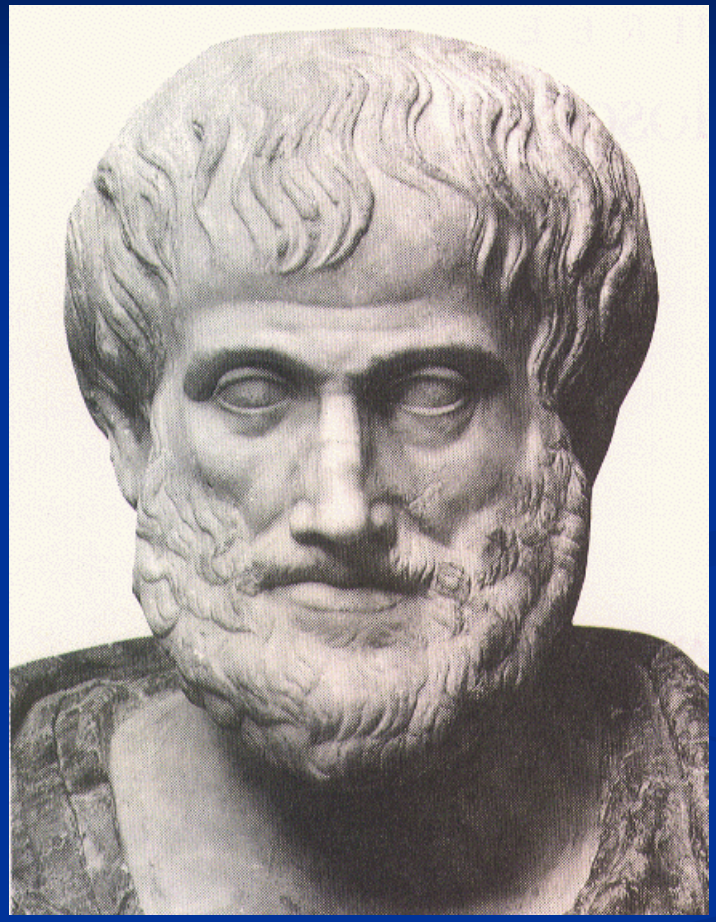


Plato's Perfect Solids



Aristotle

- 384 B. C.

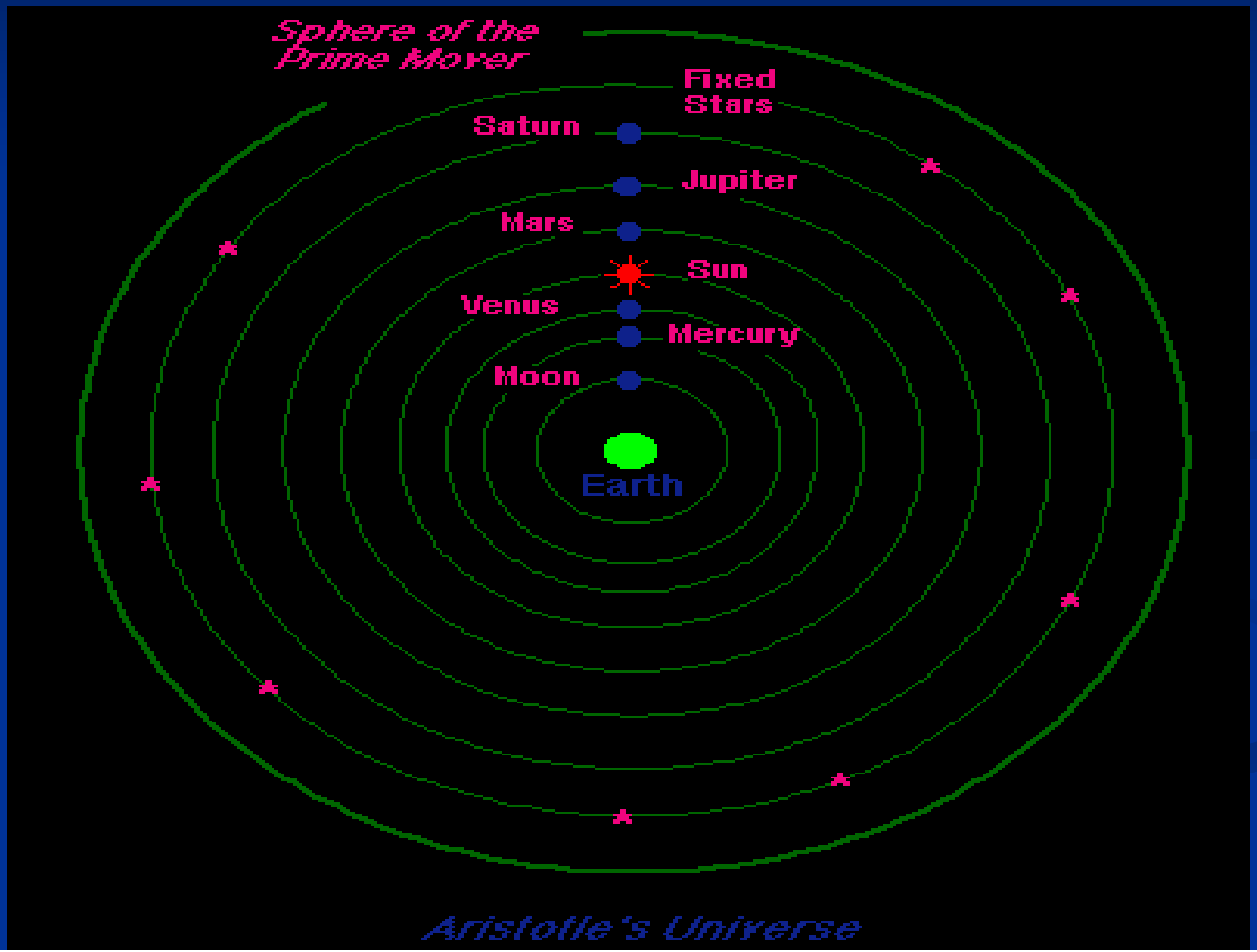


Aristotle, cont.

- Was a student of Plato's Academy
- Started his own school, the Lyceum

- Alexander the Great – who conquered the known world was one of Plato's students

Aristotle's cosmology



Aristotle's heavens

- The Earth was at the center of the cosmos
- Everything beyond the Earth was in God's territory and therefore must be perfect
- So, he believed the planets were held in place by being attached to a set of perfect crystalline spheres
- Formulated the inductive and deductive methods of investigation, but
- He didn't use experiments to test propositions

The Earth is not flat!

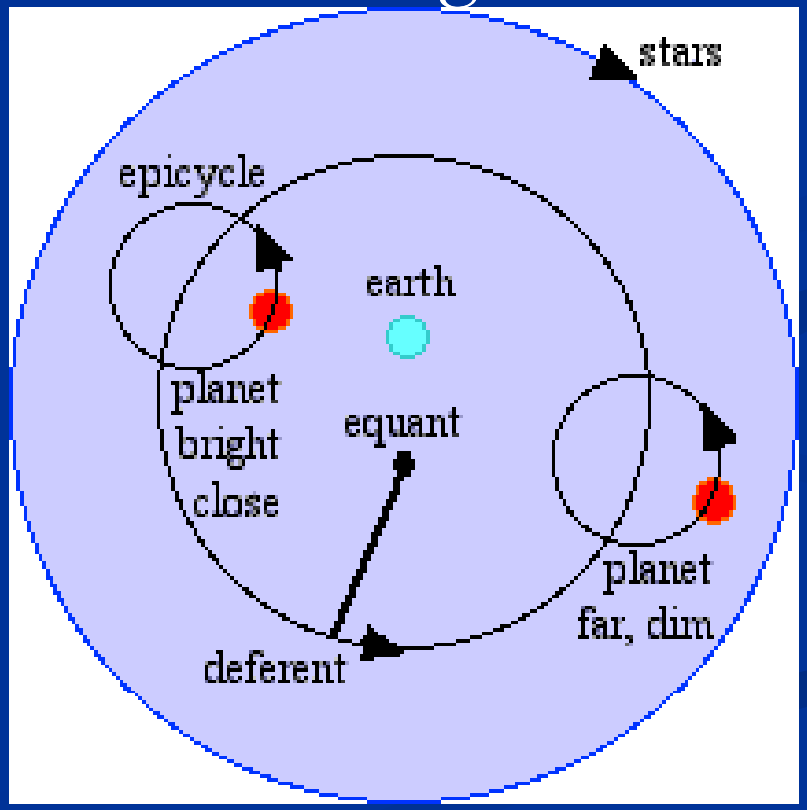
- But he did argue that the Earth was a sphere because lunar eclipses showed a curved edge
- There were four basic elements: earth, air, fire, and water – the basis of alchemy
- The sublunar world was one of change, but everything above the Earth was the unchanging and perfect heavens.
- So Aristotle's universe was "geocentric"

Ptolemy

- Greek, born around 90 C. E.
- (imaginary image):

Ptolemy's Universe

- Ptolemy's (an astronmer) name became synonymous with the idea of a geocentric universe.



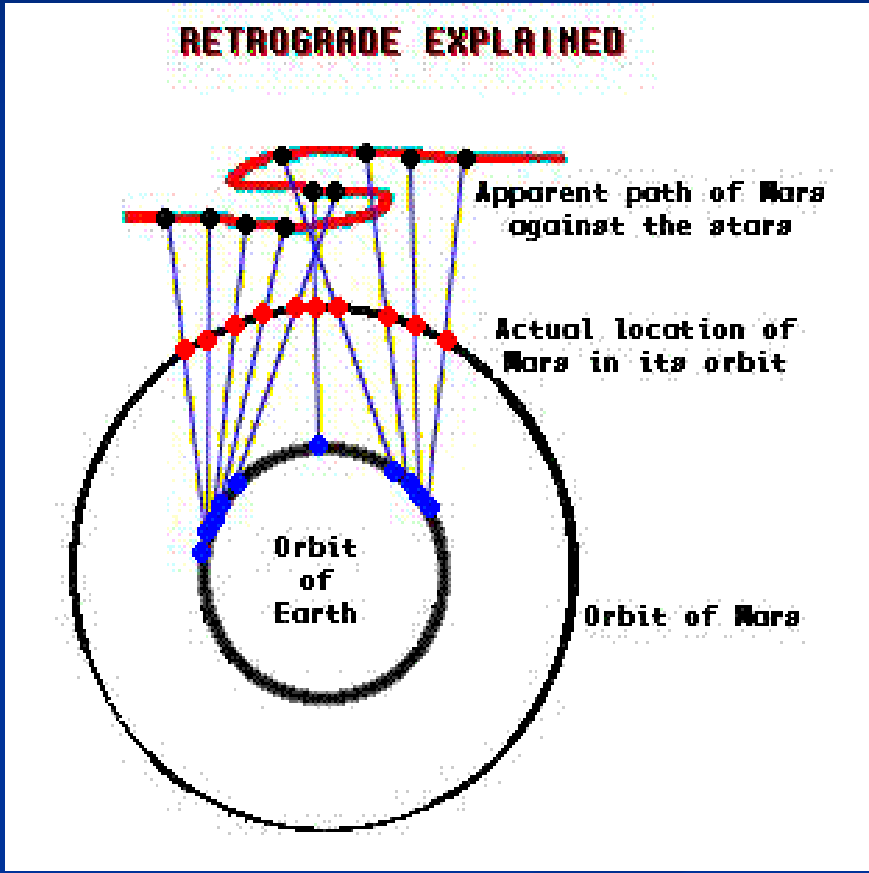
Epicycles

- But to make his model of the heavens work, Ptolemy had to introduce the idea of epicycles.
- This was because of the problem of "retrograde motion" – which refers to the fact that at times some of the planets (such as Mars) appear to back up against the starts in the heavens.
- See course website, or

  http://www.flex.com/~jai/astrology/retrograde.html

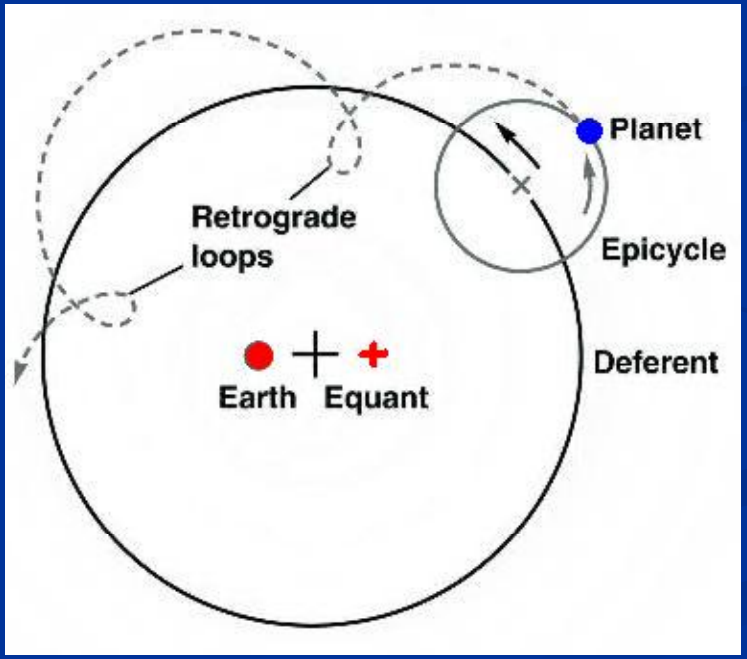
  for example of retrograde motion

Retrograde motion



Retrograde motion and epicycles

- So early astronomers first assumed planets had personalities and could move themselves, later they tried epicycles to account for the reversals



Tycho Brahe

- B. 1546

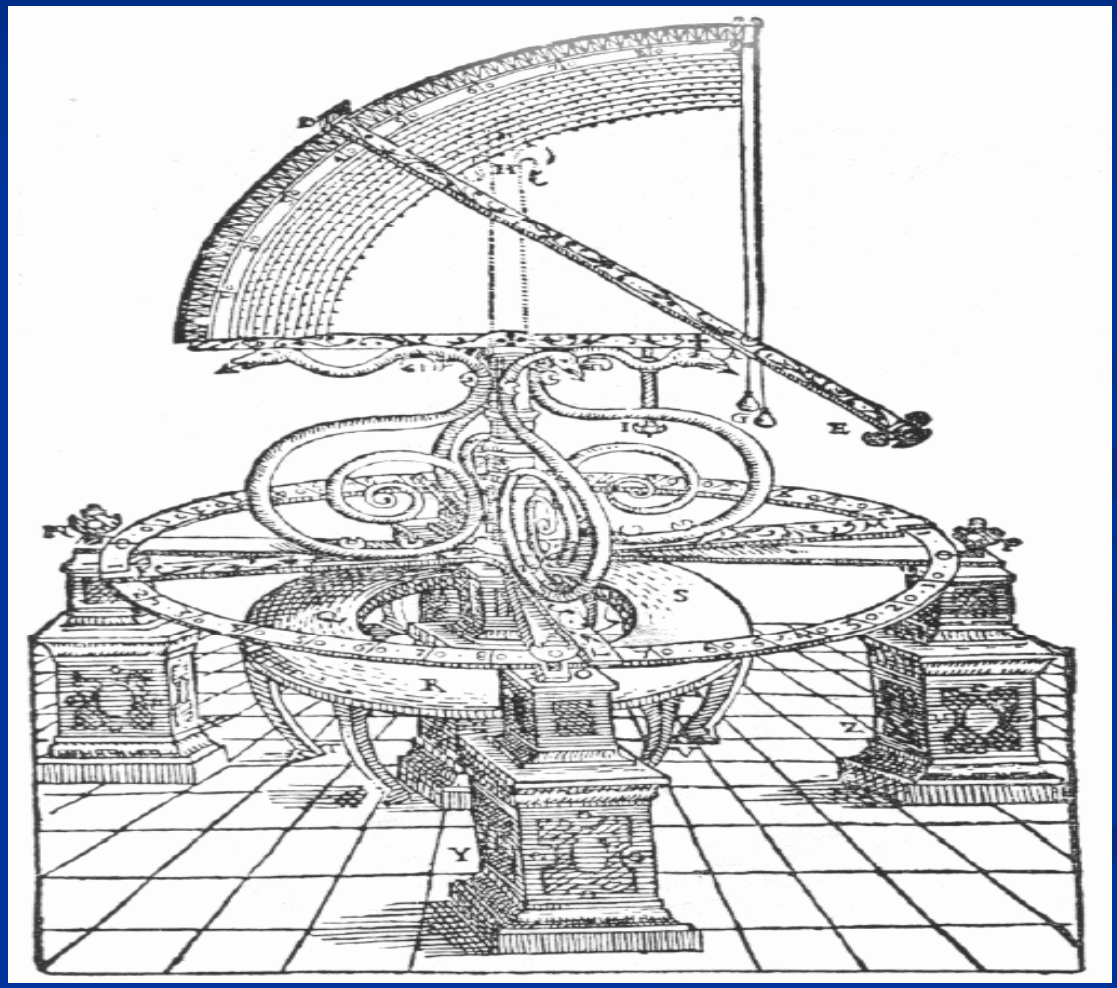
Strange guy

- He had lost his nose in a sword duel
- So he had silver ones made that he could stick on his face with glue!
- He apparently won lots of arguments this way – because in heated discussion he'd sweat – and his nose would start to slide across his face
- Kept a "pet" dwarf named Jepp around to amuse himself and guests at huge feasts

Tycho's observations

- The king of Denmark admonished him for mistreating his peasants, but gave him an island off of the coast to conduct observations.
- Tycho built his castle solid black so refections wouldn't interfere with observations.
- He didn't use telescopes, but did use "quadrants."

Quadrant or azimuthal

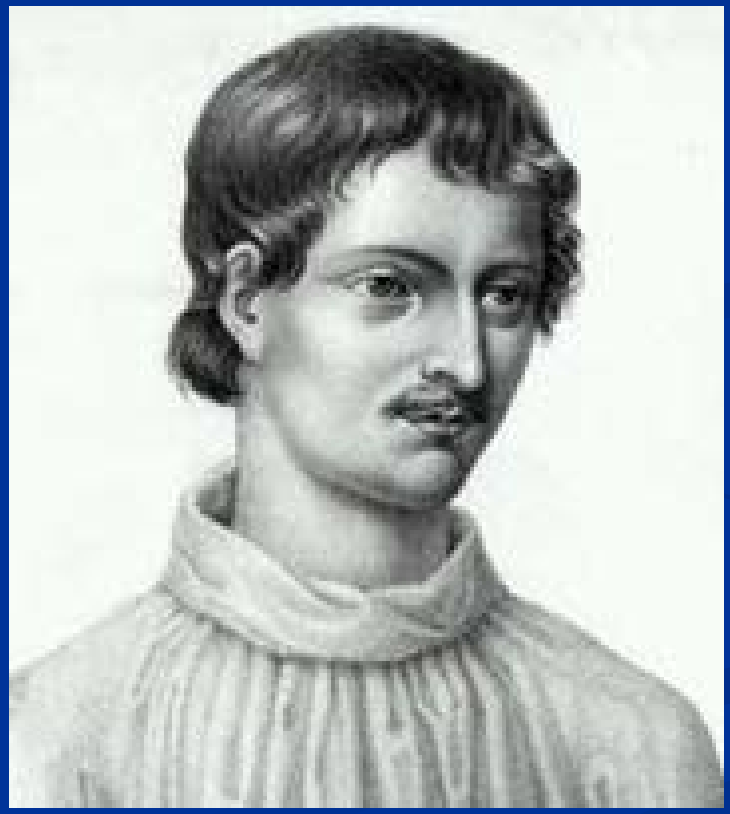


His contributions

- Vast volumes of data, carefully collected
- He also took careful observations of the comet of 1577. These indicated that the comet was coming in from deep space. HOW could this happen and NOT shatter Aristotle's crystal spheres that were assumed to be out there to hold up the planets?

Giordano Bruno

- B. 1548

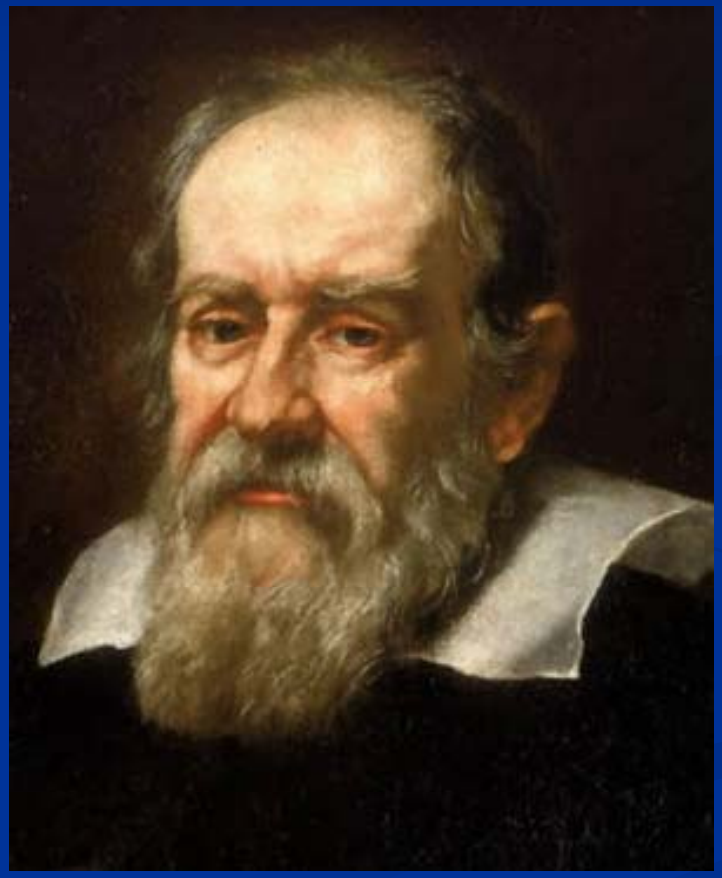


Burned at the stake!

- At the time, Bruno was perhaps the best known writer about science in Europe.
- But, he persisted in arguing that the Earth was not at the center of the universe.
- With the result that the Catholic Inquistion (more about this later) had him burned alive as an example to everyone.

Galileo Galilei

- Born 1564



- According to Stephen Hawking (current endowed Chair in physics at Oxford), Galileo probably contributed more to the creation of the modern natural sciences than anybody else. He is often referred to as the "father of modern astronomy," as the "father of modern physics", and as the "father of science". The work of Galileo is considered to be a significant break from that of Aristotle. The motion of uniformly accelerated objects, treated in nearly all high school and introductory college physics courses, was studied by Galileo as the subject of kinematics.

Galileo's discoveries

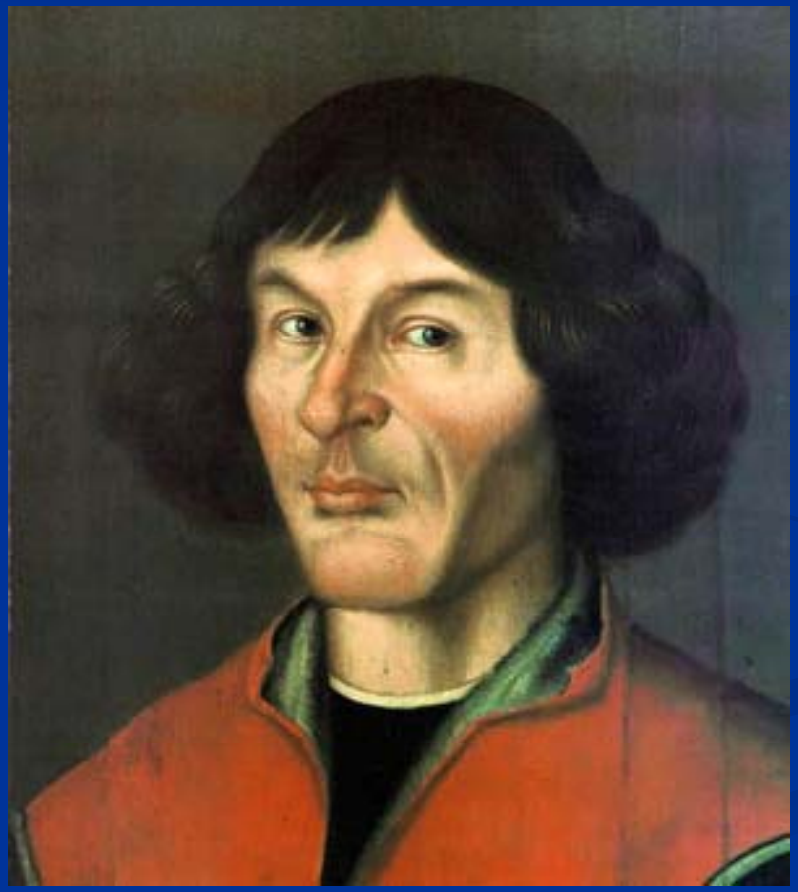
- He acquires one of the first telescopes
- Points it at the Moon, and what does he see!
  - Craters! In Aristotle's perfect heavens
- Points it at Jupiter and sees heavenly bodies circling the planet.
  - According to the Church, everything is supposed to be going around the Earth!
- Notices phases of Venus
  - Can't happen unless the Sun is at the center, and the Earth going around it beyond Venus!

The Inquistion

- Galileo was brought before the Inquisition.
- He knew what had happened to Bruno
- So he recants his arguments that the heavens are not perfect, and the Earth not the center of everything.
- “But is still moves” (referring to the Earth) he is alleged to have muttered as he left his trial.

Nicolaus Copernicus

- B. 1473



Heliocentric universe!

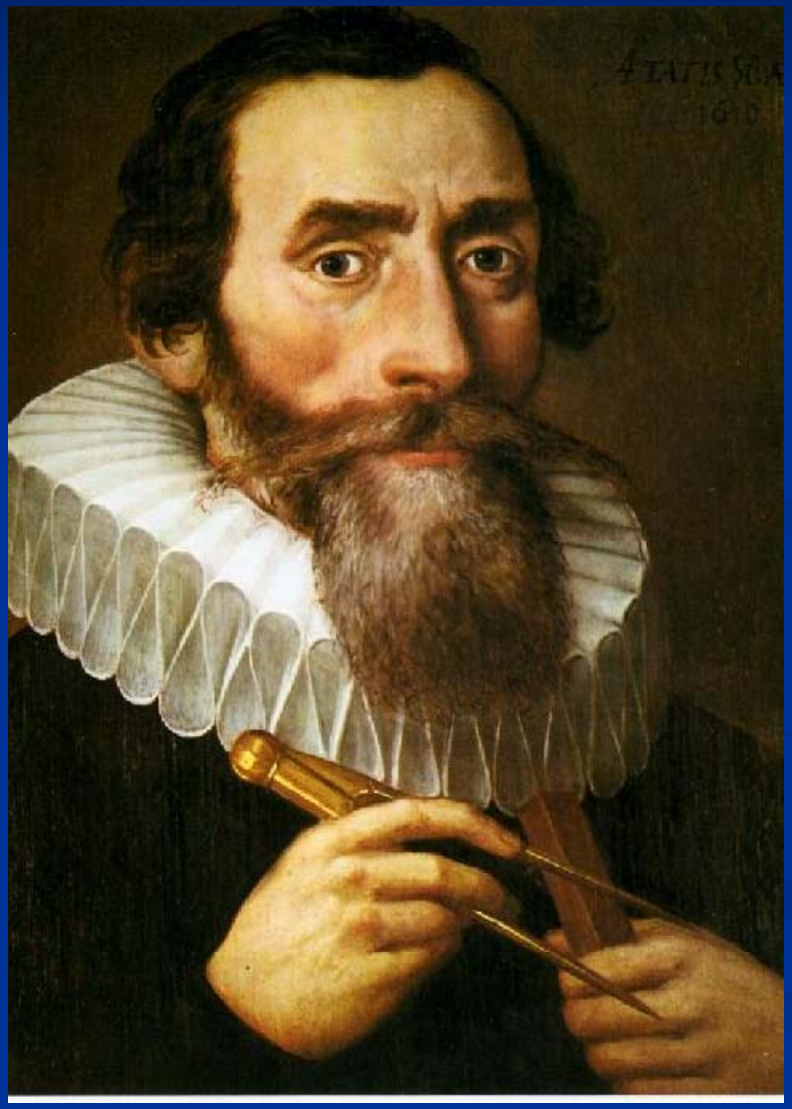
- Copernicus is the first astronomer to popularize the idea that the Sun is the center of the solar system. So, why is that a big deal???
- Well, because you then have to change EVERYTHING else. Man, and his earth is no longer at the center of everything. So everything apparently wasn't made by God for humans and nearly all natural philosophy and theology must be revised. (a "paradigm shift").

Copernicus, cont.

- His epochal text, *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres), is often conceived as the starting point of modern astronomy, as well as a central and defining epiphany in the history of all science.

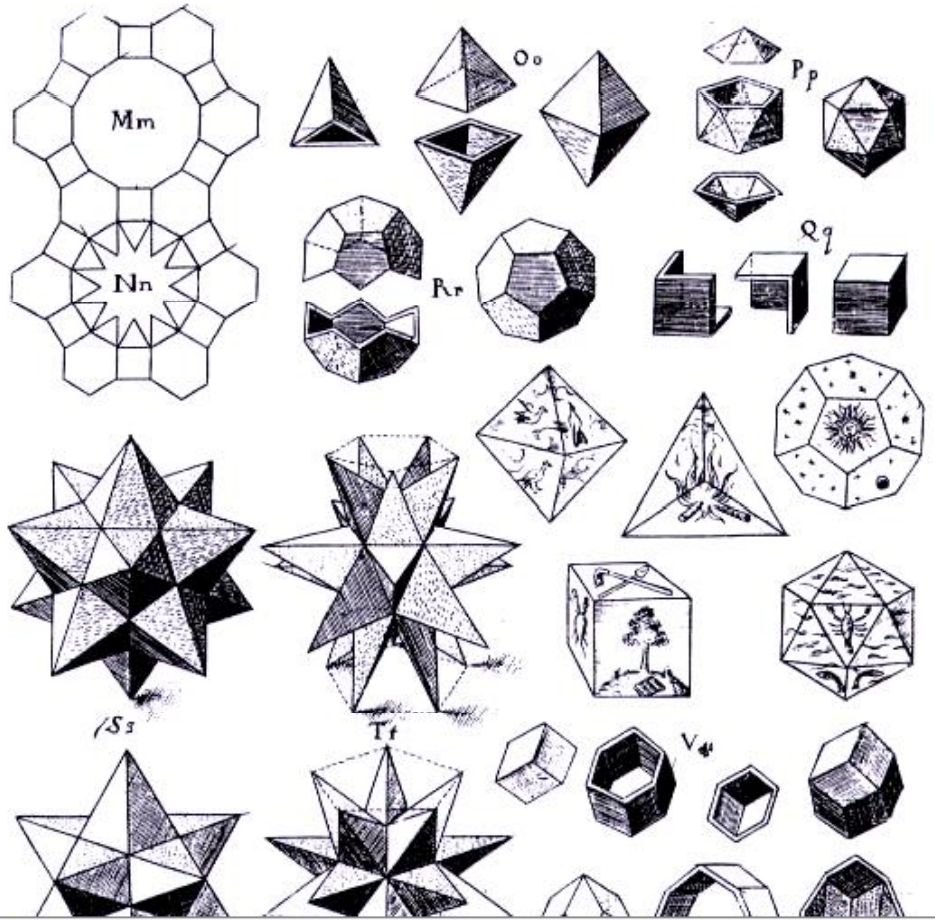
Johannes Kepler

- B. 1571



Plato revisted, sort of

Kepler's logical approach to polyhedra does not mean that he was free of the mysticism of the day. The following illustration, from his 1619 book, *Harmonice Mundi*, graphically shows the Platonic associations of the regular solids with the classical elements: The tetrahedron corresponds to fire, the octahedron to air, the cube to earth, the icosahedron to water, and the dodecahedron to the cosmos or ether:



Kepler and the ellipses

- But Kepler had been Tycho's assistant, and had access to a huge volume of data Tycho had collected on the motion of the heavenly bodies
- By using epicycles, Kepler could make all but about 4% of the observed data fit the idea of a geocentric (as opposed to heliocentric) solar system.
- What would you do if only 4% of your data didn't fit your theory????

- Fortunately, Kepler stuck to good science. He realized that the Sun would have to be at the center of the solar system, and unlike Copernicus he also realized that the planetary orbits would have to be ellipses!

- This latter is important because until Kepler everyone still clung to Aristotle's notion that the heavenly bodies should travel in perfect circles.