

Exploring the Universe

What is Astronomy?

- the study of celestial objects (stars, planets, moons, etc.)
- one of the most ancient sciences
 - there is evidence that people studied astronomy as early as 8000 BCE

Why the fascination with astronomy?

- celestial bodies are visible to the naked eye
- there are patterns in the behavior of celestial bodies (is there also a message?)
- many creation myths and religious beliefs involve the heavens

Ancient Babylon

- developed the first written language
- created catalogues of the stars
- recorded observations of Mercury, Venus, Mars, Jupiter, and Saturn
- invented the base 60 number system (which is the basis for our system of time)

Ancient Greeks

- Aristarchus (310 – 230 BCE)
 - proposed a Sun-centered solar system
 - estimated the distance from Earth to the Sun

- Eratosthenes (275 – 195 BCE)
 - mathematician and astronomer
 - determined the circumference of Earth
 - determined the diameter of the Moon and its distance from Earth

- Hipparchus (190 – 120 BCE)
 - greatest astronomer of antiquity
 - predicted eclipses
 - created a star catalogue
 - calculated length of the year to within 6.5 minutes
 - made extensive observations of the Sun and Moon
 - invented trigonometry

- Aristotle (384 – 322 BCE)
 - probably the most influential thinker of his time
 - supported an Earth-centered model of the universe
 - thought of the universe as divine (and, therefore, perfect)
 - heavenly bodies move in perfect circles
 - the heavens are a nested set of spheres, with the Earth at the center
 - the largest sphere is the Divine sphere, which carries the stars
 - an ether fills the void between spheres

- Ptolemy (90 – 168 AD)
 - built on Aristotle's model of the universe
 - Earth is at the center of the universe, and does not move
 - all other objects orbit the Earth in circular paths
 - developed a model that explained retrograde motion, but it was very complicated
 - created star catalogues (1022 stars and 48 constellations recorded)
 - created tables of planetary locations

Renaissance Europe

- Nicholas Copernicus (1473 – 1543 AD)
 - Polish mathematician, astronomer, and physicist
 - supported a Sun-centered model of the universe
 - system of nested spheres with the Sun at the center
 - each planet orbits the Sun in a circular path on its own sphere
 - the outermost sphere is where the stars are found

Problems faced by Copernicus

- he died shortly after publishing his model (so he couldn't promote his ideas)
- the catholic Church was against him
- his work was not easy to read
- the Ptolemaic model was more accurate

- Tycho Brahe (1546 – 1601 AD)
 - Danish astronomer
 - obsessed with the need for more and better astronomical data
 - collected a vast amount of accurate astronomical data
 - proved that supernovae and comets were not atmospheric events (which was the common belief at the time)
 - worked with Kepler until his death in 1601

- Johannes Kepler (1571 – 1630 AD)
 - German mathematician and astronomer
 - wanted to reconcile the Sun-centered model with religious beliefs
 - determined that all planetary orbits are elliptical (oval) with the Sun at one focus (Kepler's 1st Law)
 - with this discovery, suddenly the Sun-centered model became much more accurate than the Earth-centered model

- Galileo Galilei (1564 – 1642 AD)
 - Italian mathematician, astronomer, and physicist
 - discovered 4 moons orbiting Jupiter (which showed that not all celestial bodies orbit the Earth)
 - supported the Sun-centered model as outlined by Copernicus
 - was persecuted by the Inquisition for his support, threatened with torture, and placed under "house arrest" for the last 10 years of his life
 - his work was the final "nail in the coffin" of the Earth-centered model

- Isaac Newton (1642 – 1727 AD)
 - English mathematician and physicist
 - invented calculus
 - wrote 3 laws of motion
 - Kepler wrote 3 laws of planetary motion...Newton explained (mathematically) why they worked
 - discovered the law of gravity
 - asserted that the laws of physics apply throughout the universe

Modern Astronomy

- Albert Michelson (1852 – 1931 AD)
 - Polish-American physicist
 - determined the speed of light
 - proved that the ether does not exist

- Albert Einstein (1879 – 1955 AD)
 - German physicist
 - determined that light is a particle that travels like a wave (called a photon)
 - wrote the Special and General Theories of Relativity

Relativity

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| <ul style="list-style-type: none"> • Special Theory <ul style="list-style-type: none"> – the velocity of light is constant – nothing can move faster than light | <ul style="list-style-type: none"> • General Theory <ul style="list-style-type: none"> – gravity is the warping of space by celestial bodies – led to the proposal of the Big Bang Theory |
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- Georges Lemaitre (1894 – 1966 AD)
 - Roman Catholic Priest
 - suggested that General Relativity implied that the universe had a moment of creation
 - was rebuffed by Einstein
 - in 1949, Fred Hoyle was the first to use the name Big Bang to describe the theory

Big Bang Theory

- States that the universe emerged from an extremely dense point.
- The initial expansion was very fast.
- Since then, space has been steadily expanding, carrying everything with it.

- Edwin Hubble (1889 – 1953 AD)
 - discovered the “red-shift” of light from stars (which proved that stars are all moving away from us)
 - this was the first observation to support the Big Bang theory
 - has a telescope in orbit named after him