Space Links: NASA http://www.nasa.gov/home/index.html

Early Views About the Cosmos

Objects in the sky have fascinated humans throughout time. The explanations of how these celestial objects came to be are even more fascinating.

Ancient Views of the Cosmos

Myths, folklore and legends were used to explain what ancient people observed in the night sky.

- **First Nations people** – believed the night sky was a pattern on a great blanket overhead, which was held up by a spinning 'world pole' resting on the chest of a woman named Stone Ribs.
- **Inuit in the high Arctic** – used a mitt to determine when seal pups would be born, by holding the mitt at arm's length at the horizon.

Solstice – represents the shortest and longest periods of daylight
Winter solstice - shortest period of daylight (Northern hemisphere - *Dec. 21*)
Summer solstice – longest period of daylight (Northern hemisphere - *June 21*)

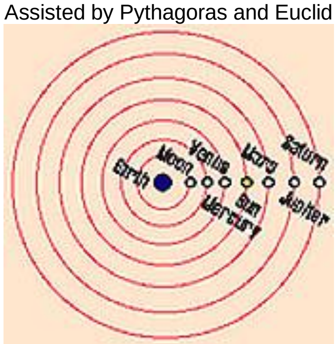
- **The Ancient Celts** set up megaliths, in concentric circles, at Stonehenge to mark the winter and summer solstices.
- **Ancient African** cultures set large rock pillars into patterns to predict the timing of the solstices as well.

Equinox – represents periods of equal day and night
Autumnal equinox – occurs in the fall (Northern hemisphere - *Sept. 22*)
Vernal equinox – occurs in the spring (Northern hemisphere - *Mar. 21*)

- The **Mayans of Central America** built an enormous cylinder shaped tower, at Chichen Itza, to celebrate the two equinoxes.
- The **Ancient Egyptians** built many pyramids and other monuments to align with the seasonal position of certain stars.
- **Aboriginal Peoples** used key rocks, which aligned with certain stars, in their medicine circles.

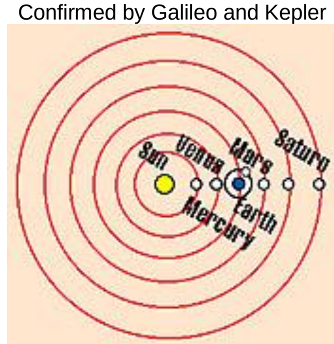
Ancient cultures tried to explain the motions of the stars and planets. Two models of how the planets moved in space evolved over time.

Aristotle's Model
Assisted by Pythagoras and Euclid



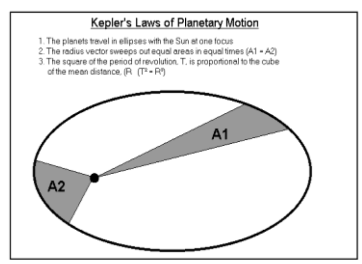
Geocentric

Copernicus' Model
Confirmed by Galileo and Kepler



Heliocentric

Elliptical orbits



Satellites

Animation of each Model at http://www.astro.utoronto.ca/~zhu/ast210/both.html

Discovery Through Technology

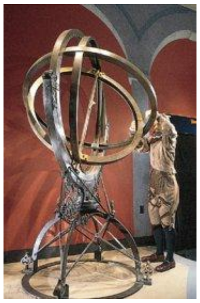
Imagination, and improvements in observation instruments and tools, advanced **Astronomy** into a more precise scientific understanding of the heavens.

Technology has improved our observations and has resulted in changes to the way we view the cosmos.
http://www.vedicobservatory.org/YPreface.html

Looking with the naked eye

Before 1609, when Galileo began using a brand new invention called the telescope, humankind's perception of the cosmos was limited to what could be seen with the naked eye. It was natural to perceive Earth as the center of the universe, with a transparent, starry sphere rotating around it. The earliest astronomers used several tools to chart the position of objects in the sky and to predict where the sun, moon, and certain stars would move. With the heavens serving as both timekeeper and navigational aid, such knowledge was of much more than scholarly interest. One measuring device, the **astrolabe**, had two parts. Its back contained a moveable sighting arm and a scale for measuring altitude, while the front had a flattened map of the heavens that helped to calculate the future position of objects. An astrolabe featured in the exhibit dates from A.D. 1090 and has several interchangeable plates, each engraved with the celestial coordinates for a different latitude. Pointers on the top plate indicate the locations of 22 bright stars. Like a modern star-finder chart, the top plate rotates to show where these stars would lie at different times of the year. With this device, astronomers and others could predict when the sun and certain bright stars would rise or set on any given day.

Armillary Sphere was used to locate celestial objects. As measuring devices became more and more precise, old notions about the universe began to crumble. For example, Brahe's measurements--even though they were made with the naked eye--were fine enough to reveal that comets move through the same region of space as the planets. That destroyed the idea that planets occupied a special place that no other object could penetrate.



Quadrant - Tycho Brahe was an observation genius in astronomy before the age of the telescope. The mural, or Tychonian, **quadrant** was actually a very large brass quadrant, affixed to a wall. Its radius measured almost two meters and was graduated in tens of seconds. Sightings were taken along the quadrant through the small window in the opposing wall, to which Tycho points. The clock shown at the bottom right, accurate to seconds, allowed the observers to note the precise moment of observation.

Astrolabe - The astrolabe is the instrument used to observe the stars and determine their position on the horizon. According to ancient scripts the astrolabe was invented in the 2nd century B.C. by Ipparch. According to Ptolemy the astrolabe was a type of geographical map. In its ancient form the astrolabe was a wooden disc tied from an ring or eyelet. At the end of the disc the subdivisions of the ring were marked. Their was also a view-finder turning around a central axis used to find the sun and the stars. Over time astrolabes became more sophisticated. They were later made of metal and also used to tell the time. The astrolabe was a portable instrument made of copper or bronze, its primary function was to determine the elevation of the Sun or a star and to quickly solve problems of spherical astronomy. Around the rim of the astrolabe, might be inscribed the hours of the day, the days of the year, and the signs of the zodiac. As an altitude device, the astrolabe could also be used to find the height of buildings, or mountains and other topographic features. In the Middle Ages the astrolabe was the main instrument for navigation later to be replaced by the sextant. The nautical astrolabe and the somewhat similar teracycle were made for exclusive use on ships and were used to find the latitude on the open sea by astronomical means.

A **Sextant** is a tool for measuring the angular altitude of a star above the horizon. Primarily, they have been used for navigation. However, the predecessor of the sextant is the astrolabe, which was used up to the end of the 18th century.

Cross-staff - The cross-staff was made up of a straight staff, marked with graduated scales, with a close-fitting sliding cross-piece. The navigator rested the staff on his cheekbone and lined up one end of the moving cross-piece with the horizon and the other end with the bottom of the pole star, or the sun at midday. The position of the cross piece on the staff gave the reading of altitude.

Sextant

This was an instrument used to measure the height of a celestial body from aircraft, spacecraft or the ship's deck, irrespective of the stability of the observer. The main types are the sextant used for ships and the bubble sextant used only on aircraft. The sextant became the main nautical instrument used to determine the angle between the visible horizon and a celestial body, which was usually the sun.

How to use a sextant

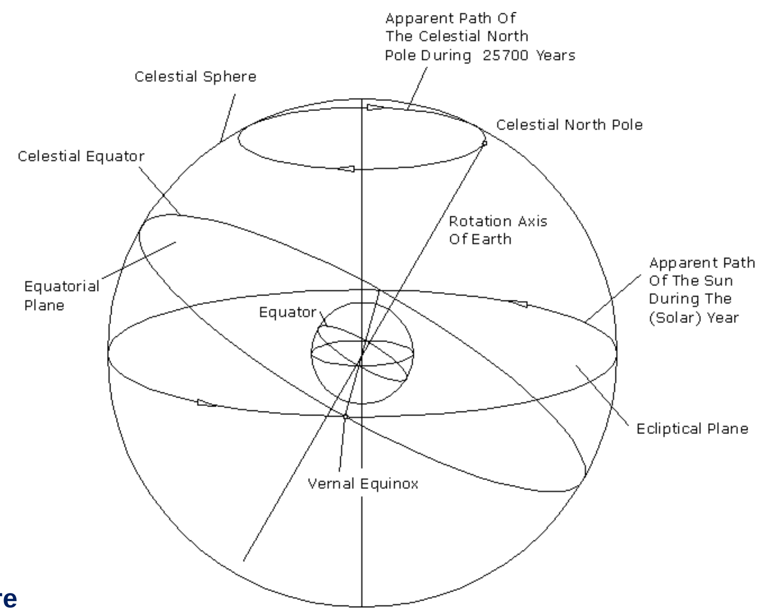
Sundial

Early Telescope

Describing the Position of Objects in Space

Altitude and **Azimuth** are calculated from the observer's position:

- **Altitude** gives you the "*how far from the horizon it is*"; the point straight overhead has an altitude of +90 degrees; straight underneath, an altitude of -90 degrees. Points on the horizon have 0 degree altitudes. An object halfway up in the sky has an altitude of 45 degrees.
- **Azimuth** determines "*which compass direction it can be found in the sky*." An azimuth of zero degrees puts the object in the North. An azimuth of 90 degrees puts the object in the East. An azimuth of 180 degrees puts the object in the South, and one of 270 degrees puts the object in the west. Thus, if Guide tells you that an object is at altitude 30 degrees, azimuth 80 degrees, look a little North of due East, about a third of the way from the horizon to the **zenith** (which is the point directly overhead).



The Celestial Sphere

http://www.ortelius.de/kalender/basic_en.php