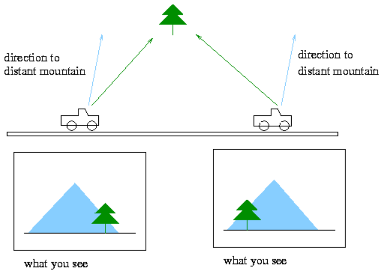
Sun – Part 4 - distance calculation 2

Giovanni Cassini



Parallax

Transit of Venus

Christiaan Huygens was the first to scientifically calculate almost the correct value of the Sun-Earth distance. However, because his method involved some guesswork and was not completely scientifically grounded, he usually does not get the credit. This tends to go to Giovanni Cassini and Jean Richter. In 1672, using a completely different method from Huygens, one with no lucky element to produce the correct result, the two French astronomers accurately determined the distance of Mars from Earth. They were then able to use the same method to refine the then accepted dimensions of the solar system, including the distance of the Sun from Earth.

The method Cassini and Richter used was that of parallax, the angular shift in position of an object caused by a shift in the observer's position. If you use one eye to line up your thumb with a distant object, and then use the other eye, keeping your thumb still, the alignment will appear to have been lost. The angle between the two measurements can be resolved trigonometrically to calculate the distance to the far object. The further away the object, the smaller the parallax angle. To use this method to calculate the Earth-Mars distance, Cassini sent Richter to French Guyana while he stayed in Paris. They took measurements of the position of Mars relative to background stars, then triangulated these with the known distance between the two locations. Once they had calculated the distance to Mars, they could also calculate the distance from Earth to the Sun. They obtained a value which was only 7% short of the modern calculation.

In 1716, Edmund Halley published a way to use a transit of Venus to accurately measure solar parallax and test Cassini and Richter's value. With observers positioned at different latitudes, Venus would appear to move along chords of different length over disk of the Sun. As Venus's motion is nearly uniform, the length of each chord would be equivalent to the duration of the transit at each site. So, observers would not have to measure anything, only time the transit at each site. However, at the next transit, in 1761, for several reasons, for several reasons, it was not possible to precisely time the start and finish of the transit. Fortunately, the method was refined in time for the transit of 1769. Calculations based on data collected in Norway, Canada and Tahiti resulted in a value of Sun-Earth distance very close to the modern figure. The latter was calculated during the 1960s, using radar and spacecraft.

Astronomical unit (AU)
The astronomical unit is a unit of length, the mean distance of the Sun from Earth. Earth's orbit slightly elliptical, so actual distances from the Sun vary during a year. At it closest, at perihelion, in January, the distance is approximately 146 million km, while at aphelion, in June, it is approximately 152 million km. The AU is the mean distance, specifically

149,597,870.7 km. For general purposes, the Sun-Earth distance is rounded up to 150,000,000 km.

Initially, the AU value was the outcome of a calculation, but this could vary, depending on an observer's location in the solar system. In 2012, the International astronomical Unit agreed a number for the AU based on the speed of light, a fixed distance unrelated to other factors.

The unit is used to measure distances throughout solar system eg Jupiter is 5.2 AU and Neptune 30.07 AU from the Sun. The outer edges of the solar system are around 100,000 AU from the Sun and the distance to our nearest star, Proxima Centauri is about 250,000 AU. Light years (ly) are used to measure longer distances eg Proxima Cantauri is about 4.3 ly away.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org,