

Zodiac constellations 3 – Zodiac: precession of the equinoxes



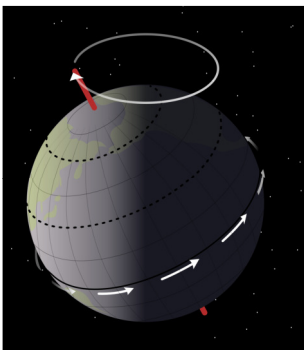
In contrast to the Babylonians, The Greek astronomer Ptolemy (305-30 BCE) clearly and correctly explained the theoretical basis of the zodiac as being a tropical co-ordinate system by which the zodiac is aligned to the equinoxes and solstices rather than the visible constellations that bear the same names as the signs. His definition was based on new understanding of the so-called precession of the equinoxes, which had been discovered around 130 BCE by Hipparchus.

Ptolemy

This explains why the zodiacal area and their originally corresponding constellations no longer overlap. It also explains why the time of year the Sun is in a given constellation has changed since Babylonian times.

Precession of the equinoxes is the motion of equinoxes along the ecliptic, over time. It arises from the combined motion of the equator (lunisolar precession) and the ecliptic (planetary precession). Lunisolar precession is the effect of gravitational attraction of the Sun and the Moon on Earth's equatorial bulge. It causes Earth's poles to sweep out a circle on the sky around the pole of ecliptic. Planetary precession involves perturbation of Earth's orbital plane by the attraction of the planets on Earth's centre of mass.

It causes the equinox to move east along the celestial equator ie opposite direction of lunisolar precession. This effect is much smaller than that of lunisolar precession, so overall the direction of movement is westward.



Precession of the equinoxes is, thus, the combined effect of gravitational attraction of the Sun, Moon and planets. Like the wobbling motion of a spinning top or gyroscope during which the axis of rotation gradually sweeps out a conical shape, the spinning Earth undergoes a slow precession, taking about 25,800 yrs to describe one complete circle on celestial sphere. The equinoxes make one circuit of ecliptic in the same time. The circle radius is approx. 23.5 degrees i.e., the inclination of Earth's axis.

Earth's spinning wobble

The result of precession is that right ascension (longitude) and declination (latitude) of stars change over time. The equinoxes move westwards on the celestial sphere by 1° in about 72 years.

Precession of the equinoxes means that, although the first degree of Aries is nominally the start of the system at the March equinox, this point is actually presently near the end of Pisces constellation, having been within Pisces since the 2nd century CE.

Around 2,000 years ago, when the ancient Greeks named the zodiacal signs, the location of their eponymous constellations occupied the same position on the celestial sphere. As a result of precession, however, these constellations have drifted and moved east by over 30° and no longer coincide with the signs. Also, because the constellations take up varying

widths of the ecliptic eg Virgo takes up 5x the amount of ecliptic longitude than Scorpius, the Sun is not in each constellation for the same amount of time.

Zodiac signs have never been used to determine the boundaries of astronomical constellations fully or partly within the zodiac because of their differing sizes and shapes. However, use of the zodiac to determine astronomical measurements was the main method for finding celestial positions in western astronomy continued for centuries. The convention of measuring celestial longitude within individual signs was used until the mid-19th century. Modern astronomy numbers degrees of celestial longitude from 0 -360 degrees, rather than 0 – 30 within a zodiac sign. This is part of the equatorial co-ordinate system measures astronomical positions by right ascension and declination rather than ecliptic-based definitions of celestial longitude and latitude.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary of astronomy Oxford, OUP, Ridpath, I (Ed) 2006 Astronomy London, Dorling Kindersley, en.wikipedia.org