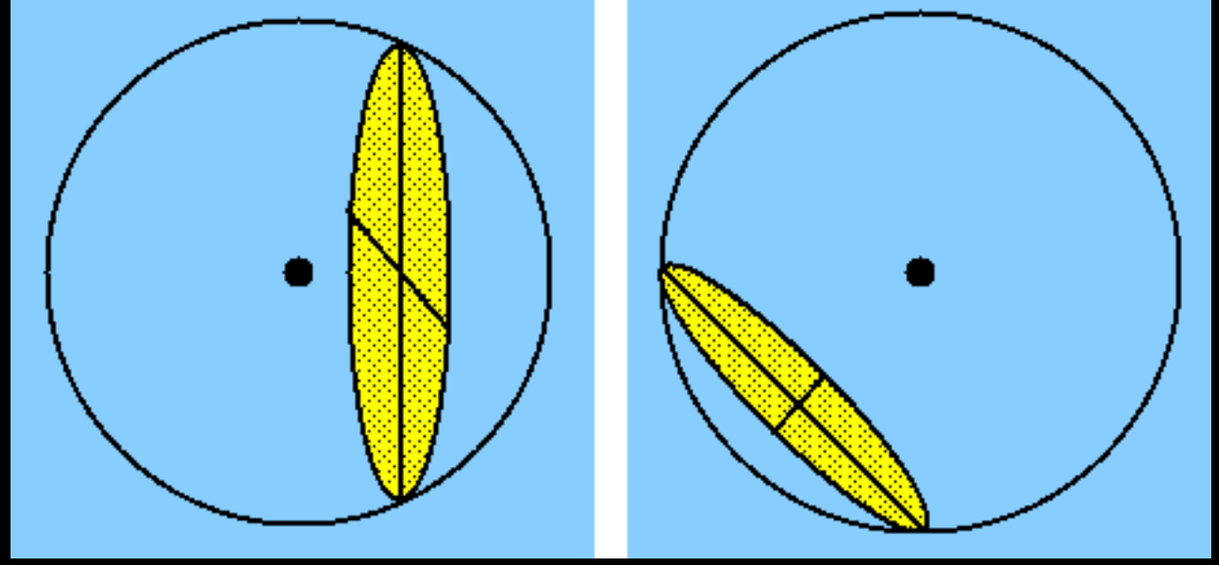
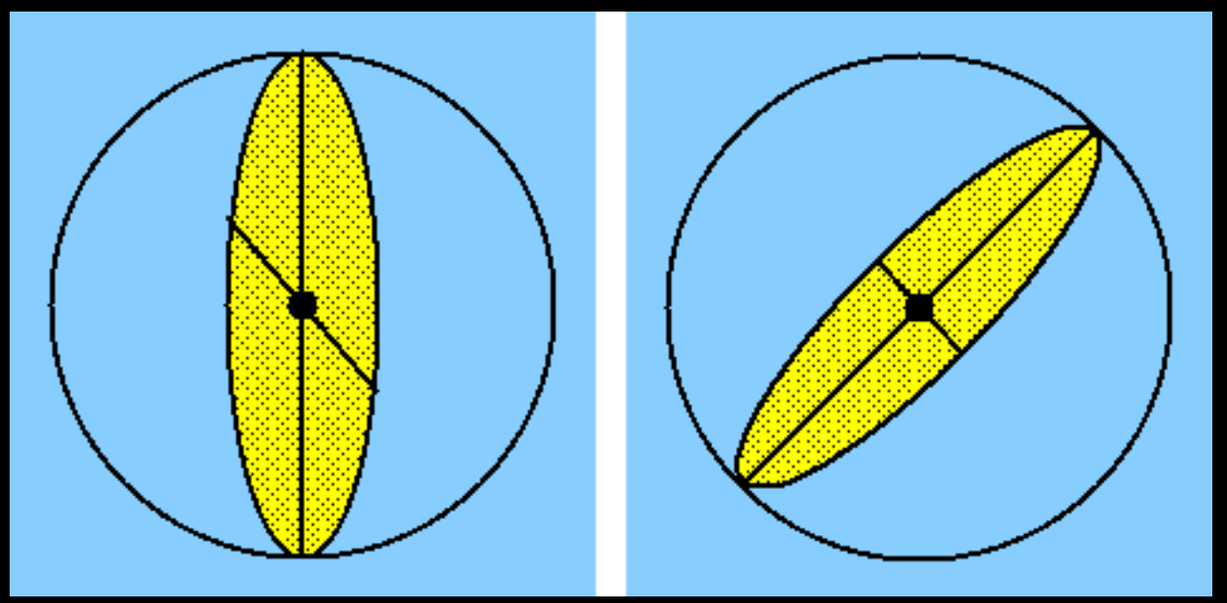
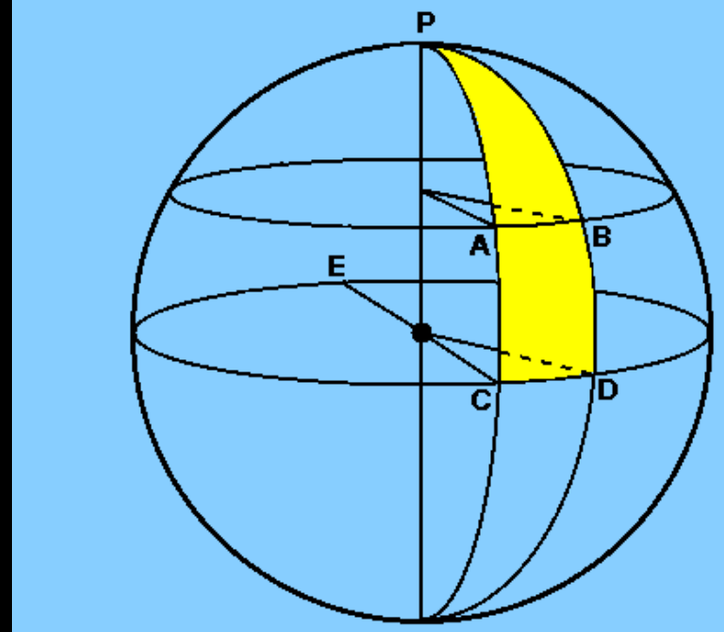


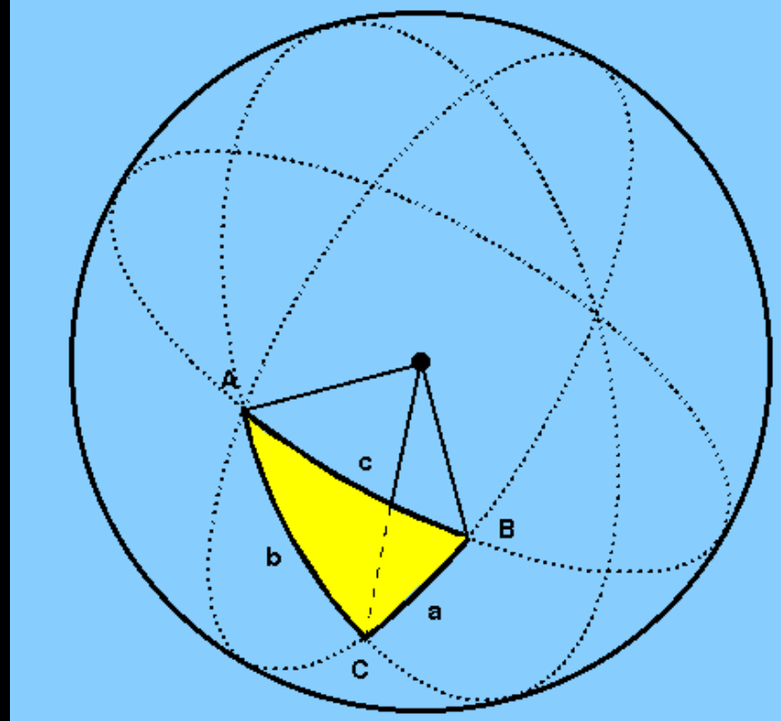
Small circles



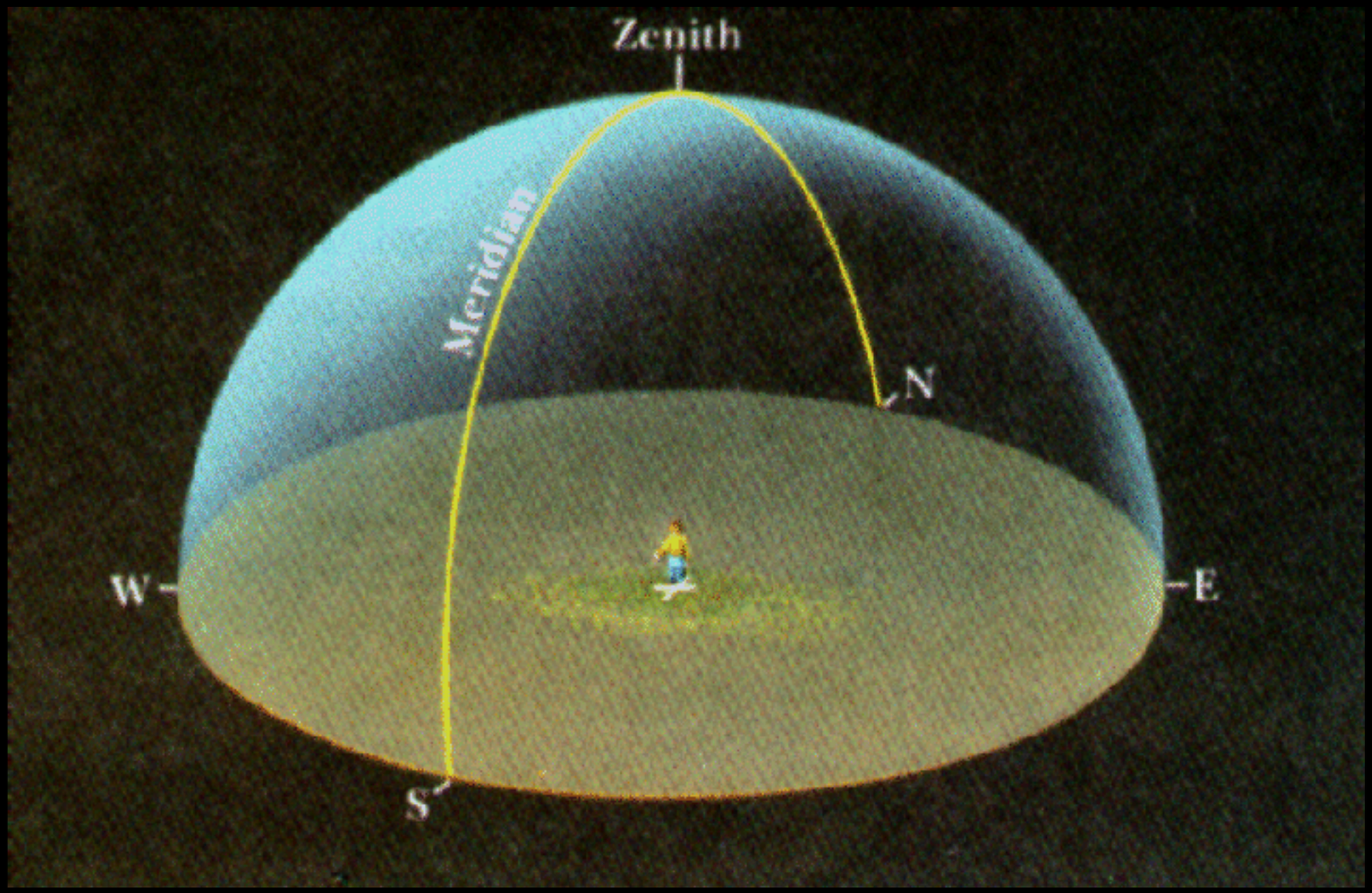
Great circles

The shortest path between two points on a plane is a straight line. On the surface of a sphere, however, there are no straight lines. The shortest path between two points on the surface of a sphere is given by the arc of the great circle passing through the two points. A great circle is defined to be the intersection with a sphere of a plane containing the center of the sphere.

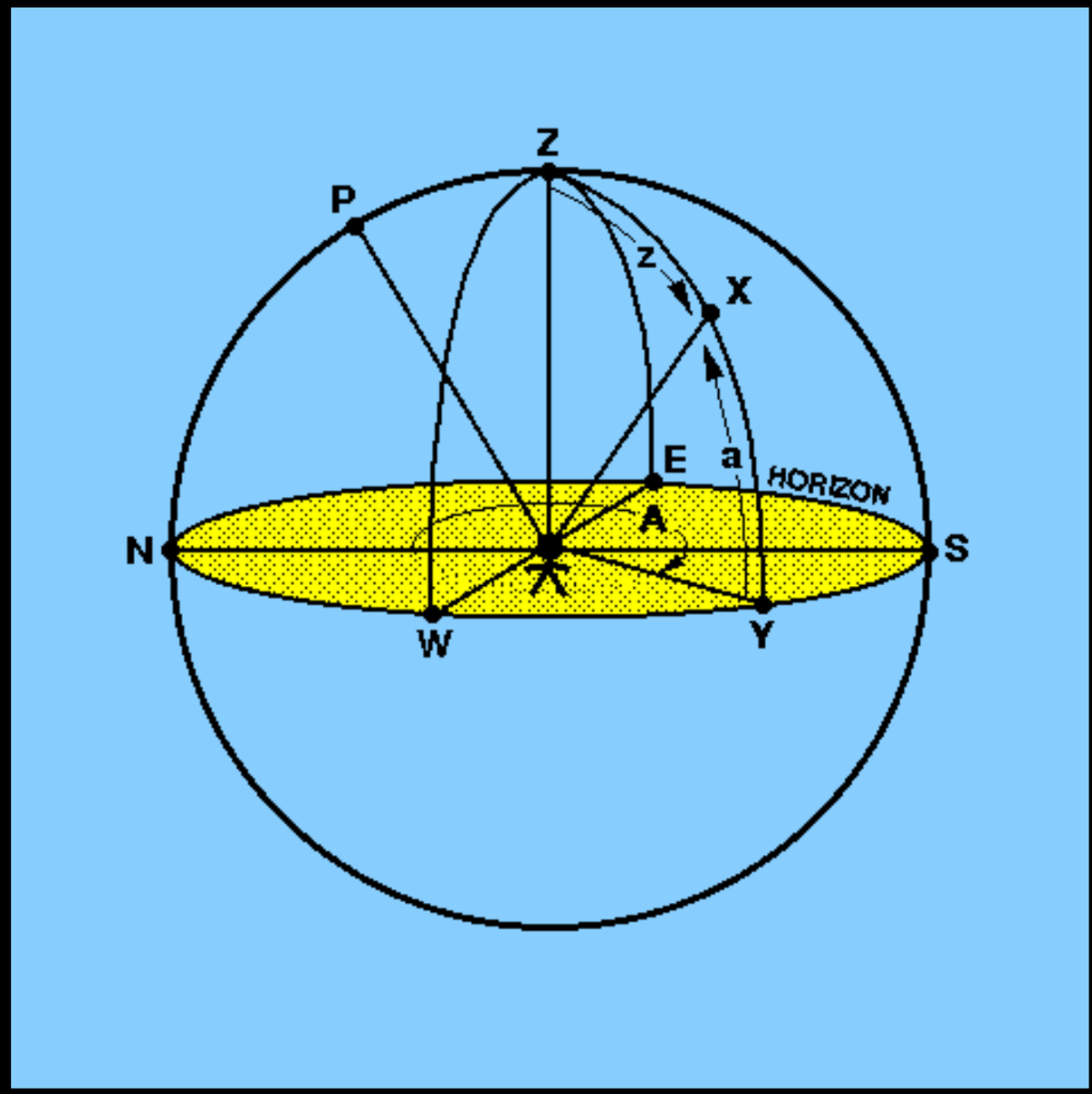




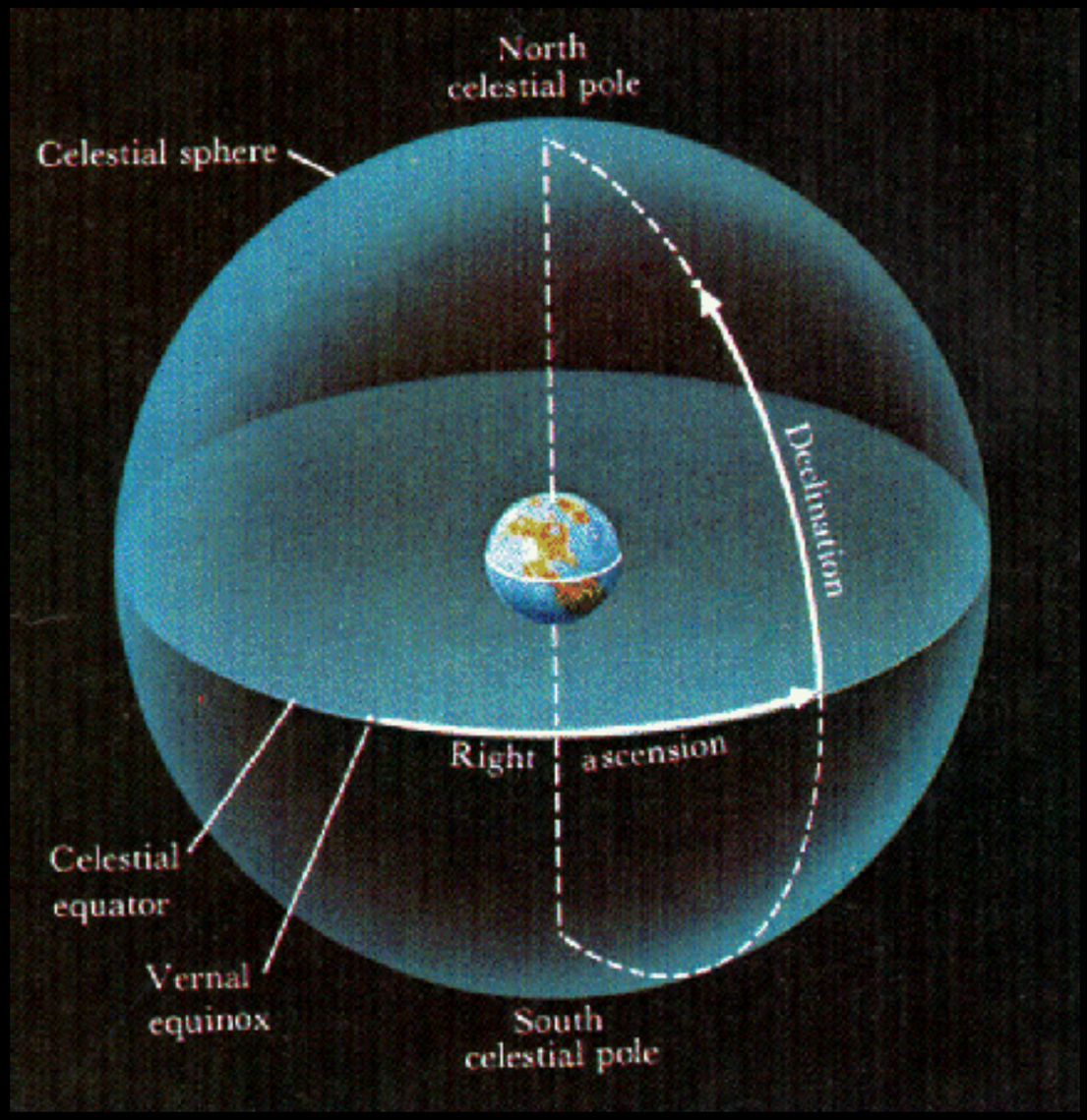
If we wish to connect three points on a plane using the shortest possible route, we would draw straight lines and hence create a triangle. For a sphere, the shortest distance between two points is a great circle. By analogy, if we wish to connect three points on the surface of a sphere using the shortest possible route, we would draw arcs of great circles and hence create a spherical triangle.



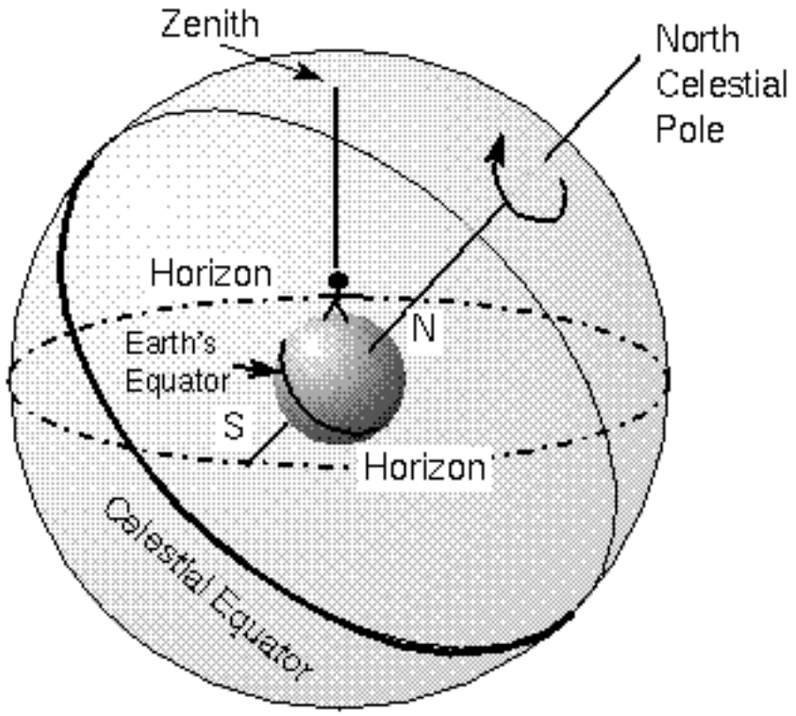
Humans perceive in Euclidean space -> straight lines and planes. But, when distances are not visible (i.e. very large) than the apparent shape that the mind draws is a sphere -> thus, we use a spherical coordinate system for mapping the sky with the additional advantage that we can project Earth reference points (i.e. North Pole, South Pole, equator) onto the sky.



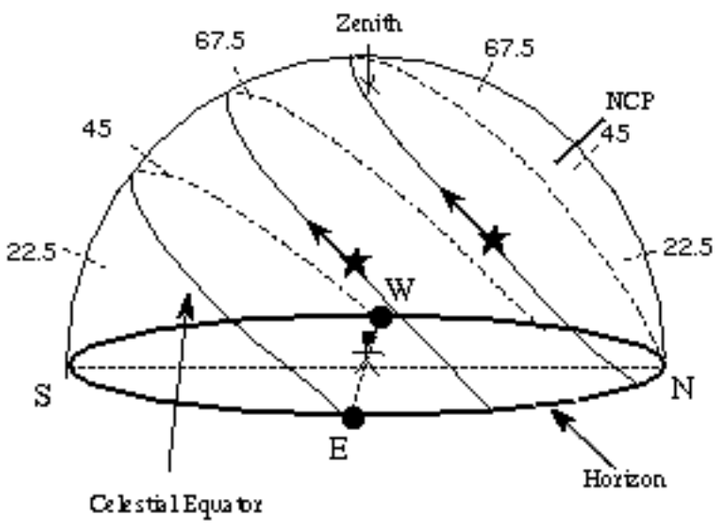
The two numbers which specify the position of a star, X, in this system are the azimuth, A, and the altitude, a. The altitude of X is the angle measured along the vertical circle through X from the horizon at Y to X. It is measured in degrees. An often-used alternative to altitude is the zenith distance, z, of X, indicated by ZX.



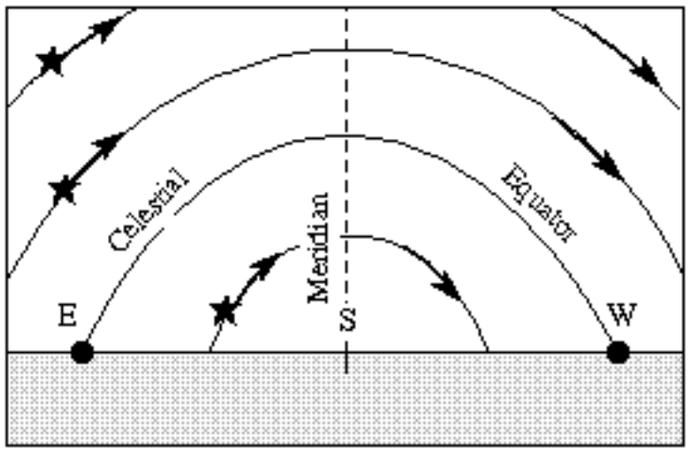
The celestial sphere has a north and south celestial pole as well as a celestial equator which are projected reference points to the same positions on the Earth surface. Right Ascension and Declination serve as an absolute coordinate system fixed on the sky, rather than a relative system like the zenith/ horizon system.



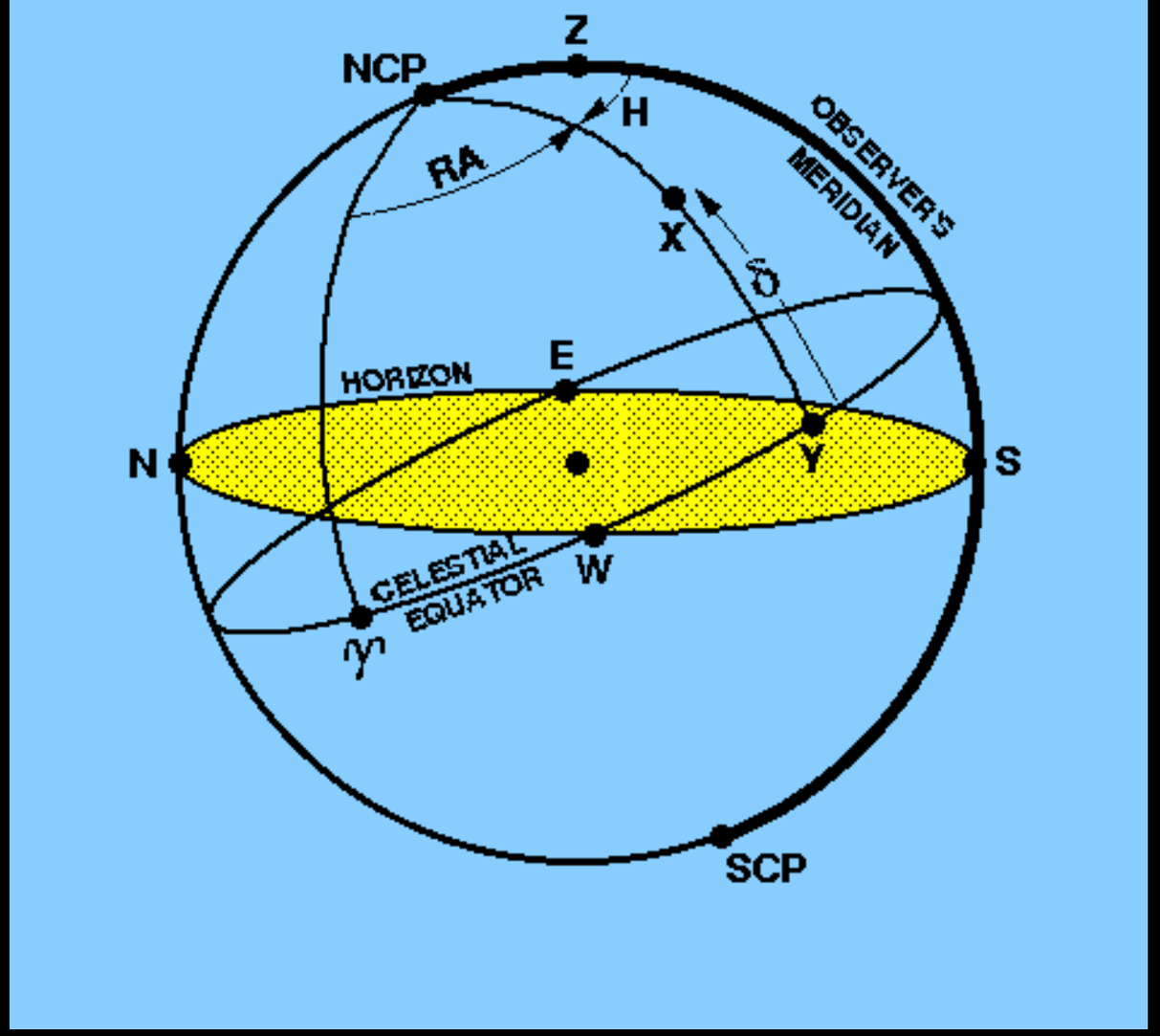
The celestial sphere for an observer in Seattle.
The angle between the zenith and the NCP = the angle between the celestial equator and the horizon.
That angle = 90° – observer's latitude.



Stars motion at Seattle. Stars rotate parallel to the Celestial Equator, so they move at an angle with respect to the horizon here. Altitudes of 1/4, 1/2, and 3/4 the way up to the zenith are marked.



Your view from Seattle. Stars rise in the East half of the sky, reach maximum altitude when crossing the meridian (due South) and set in the West half of the sky. The Celestial Equator goes through due East and due West.

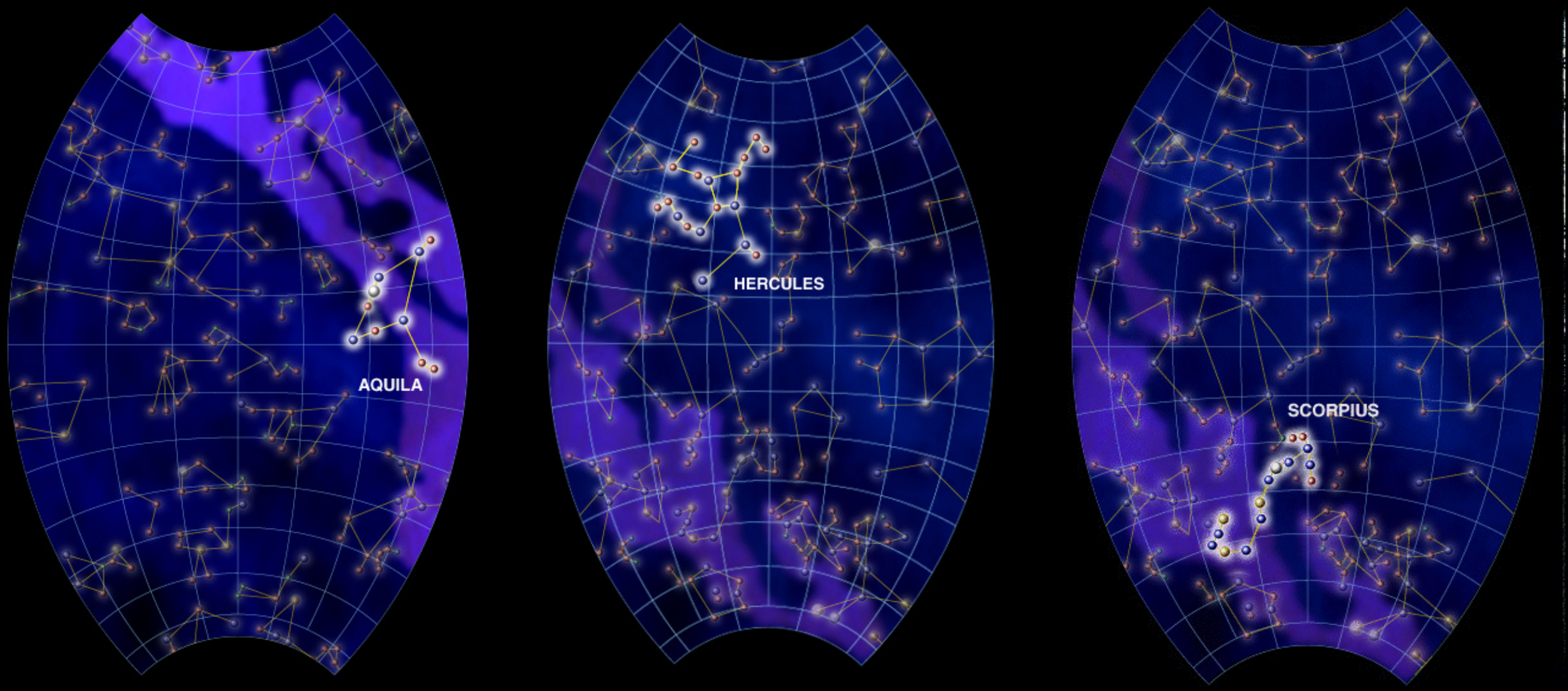


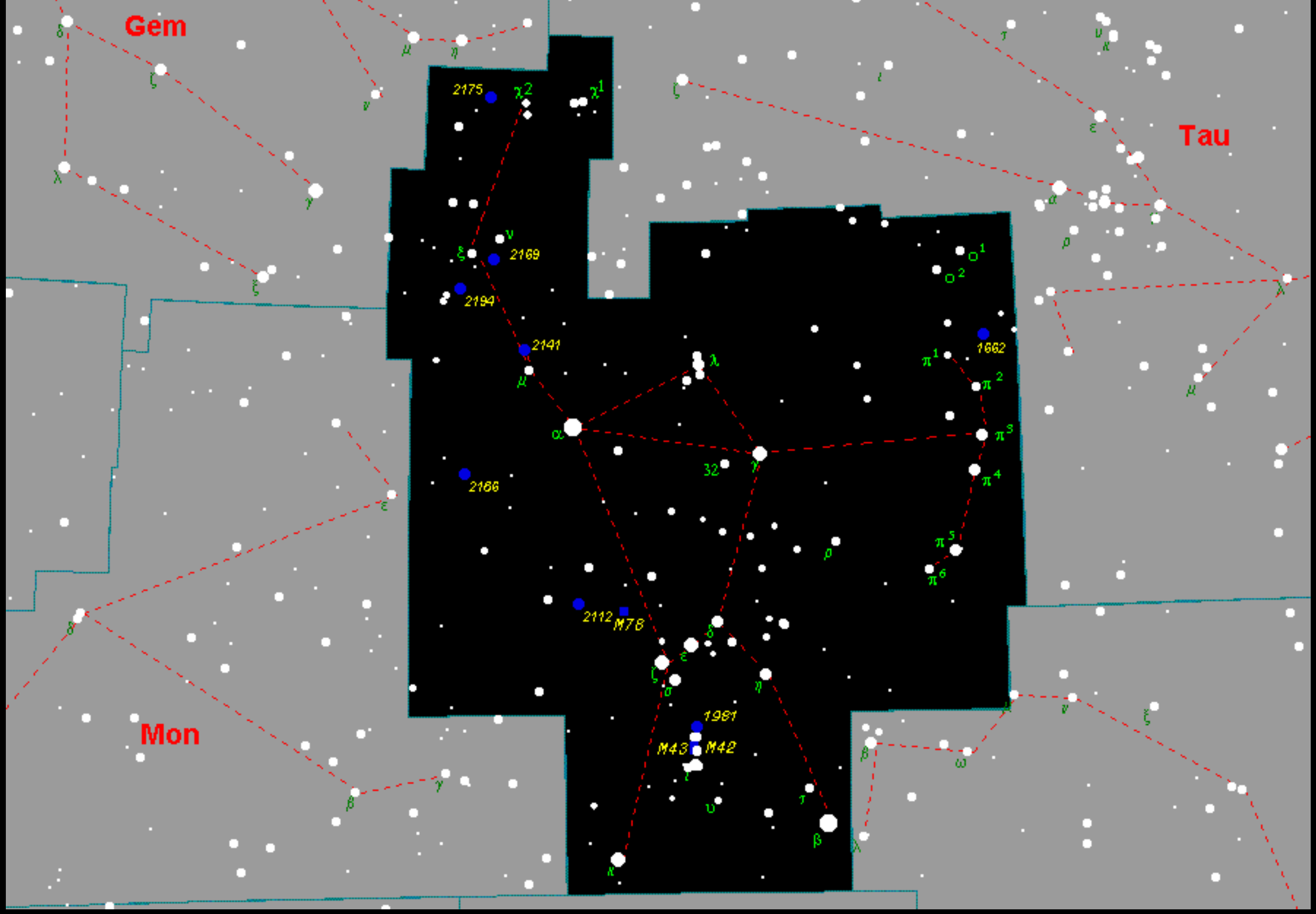
The analog of longitude in the equatorial system is the hour angle, H (you may also see the symbol HA used). Defining the observer's meridian as the arc of the great circle which passes from the north celestial pole through the zenith to the south celestial pole, the hour angle of a star is measured from the observer's meridian westwards (for both northern and southern hemisphere observers) to the meridian through the star (from 0° to 360°). Because of the rotation of the Earth, hour angle increases uniformly with time, going from 0° to 360° in 24 hours.

Northern Sky

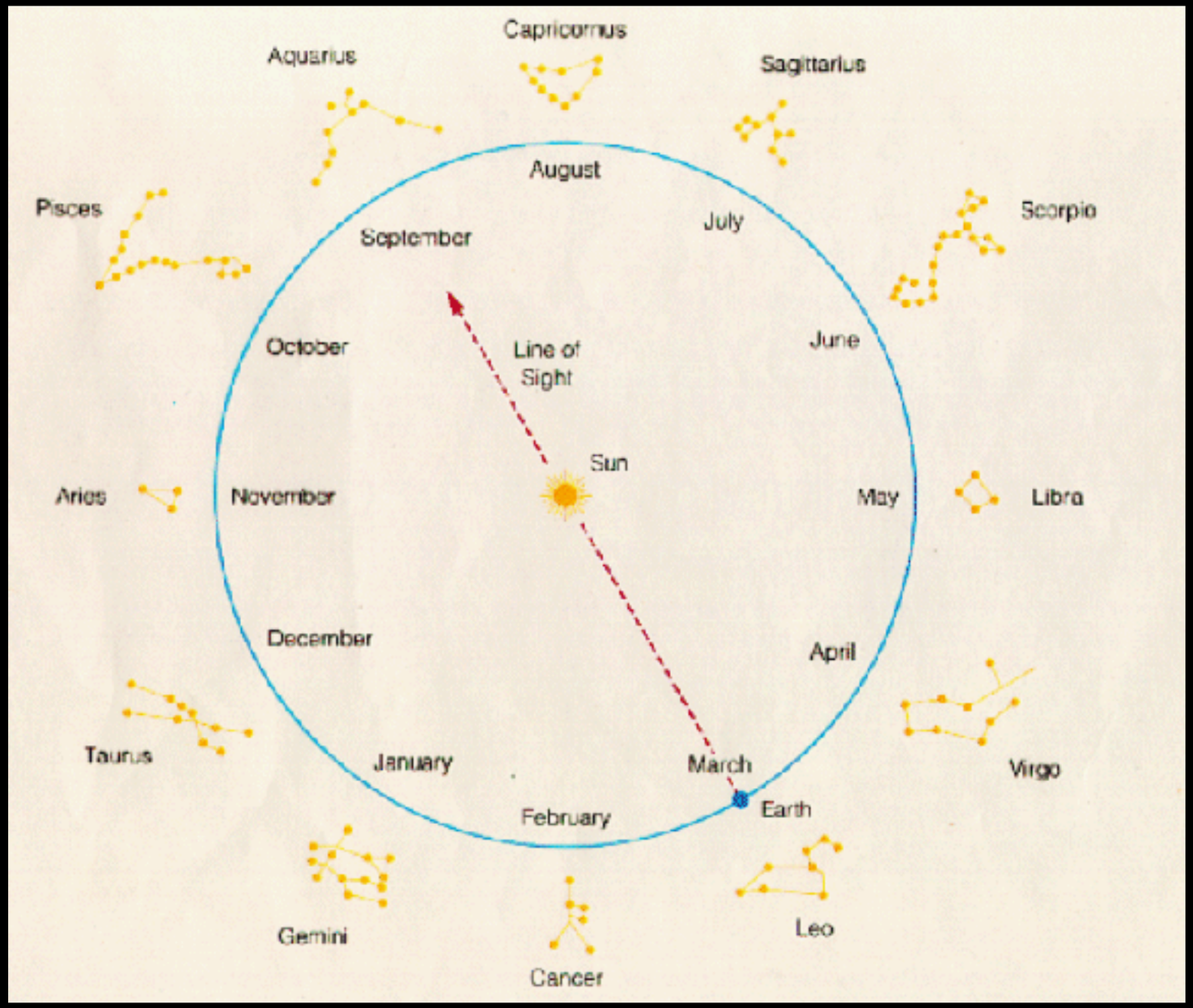
Southern Sky

Drawn onto the celestial sphere are imaginary shapes called constellations, Latin for `group of stars'. Due to the nature of the Earth's surface, the sky is divided into the northern and southern sky as seen from each hemisphere.

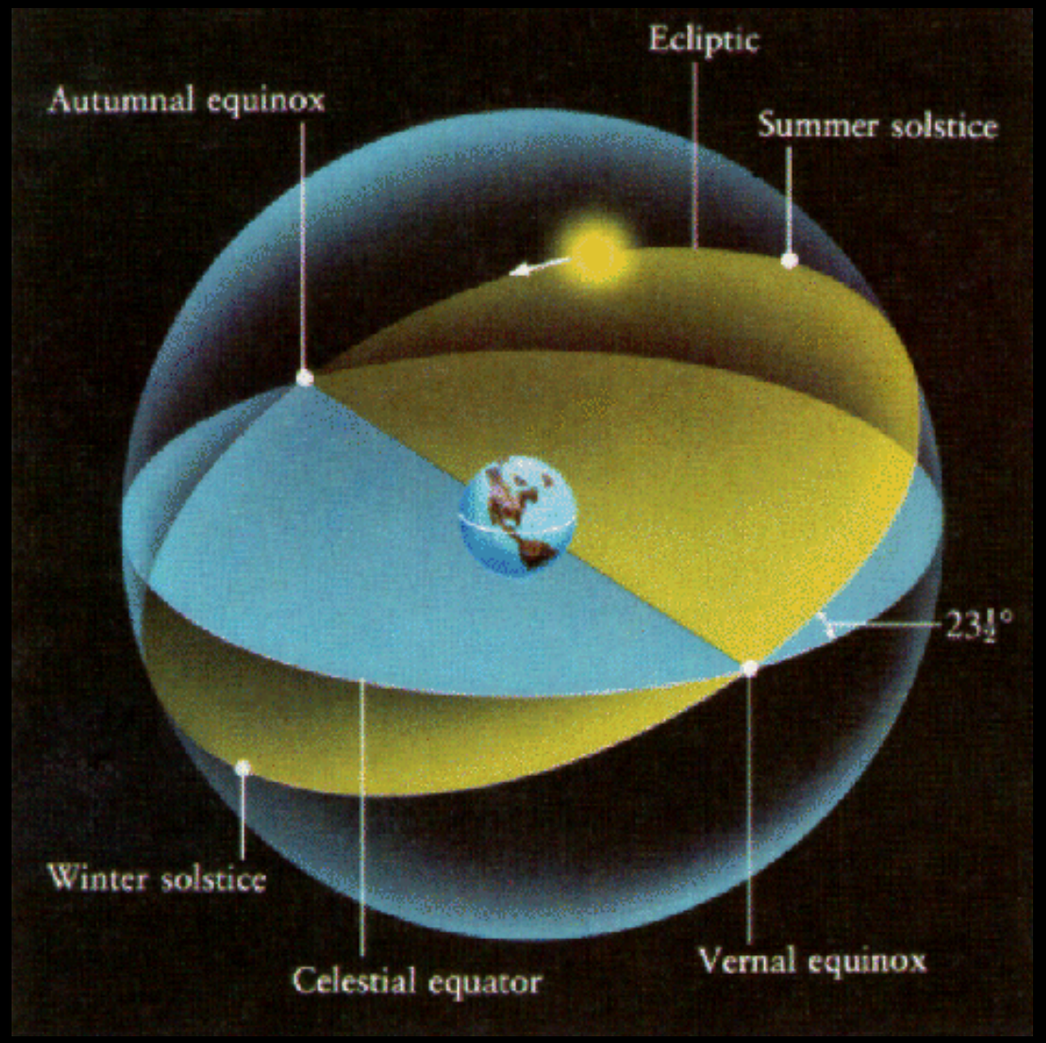

AQUILA
HERCULES
SCORPIUS

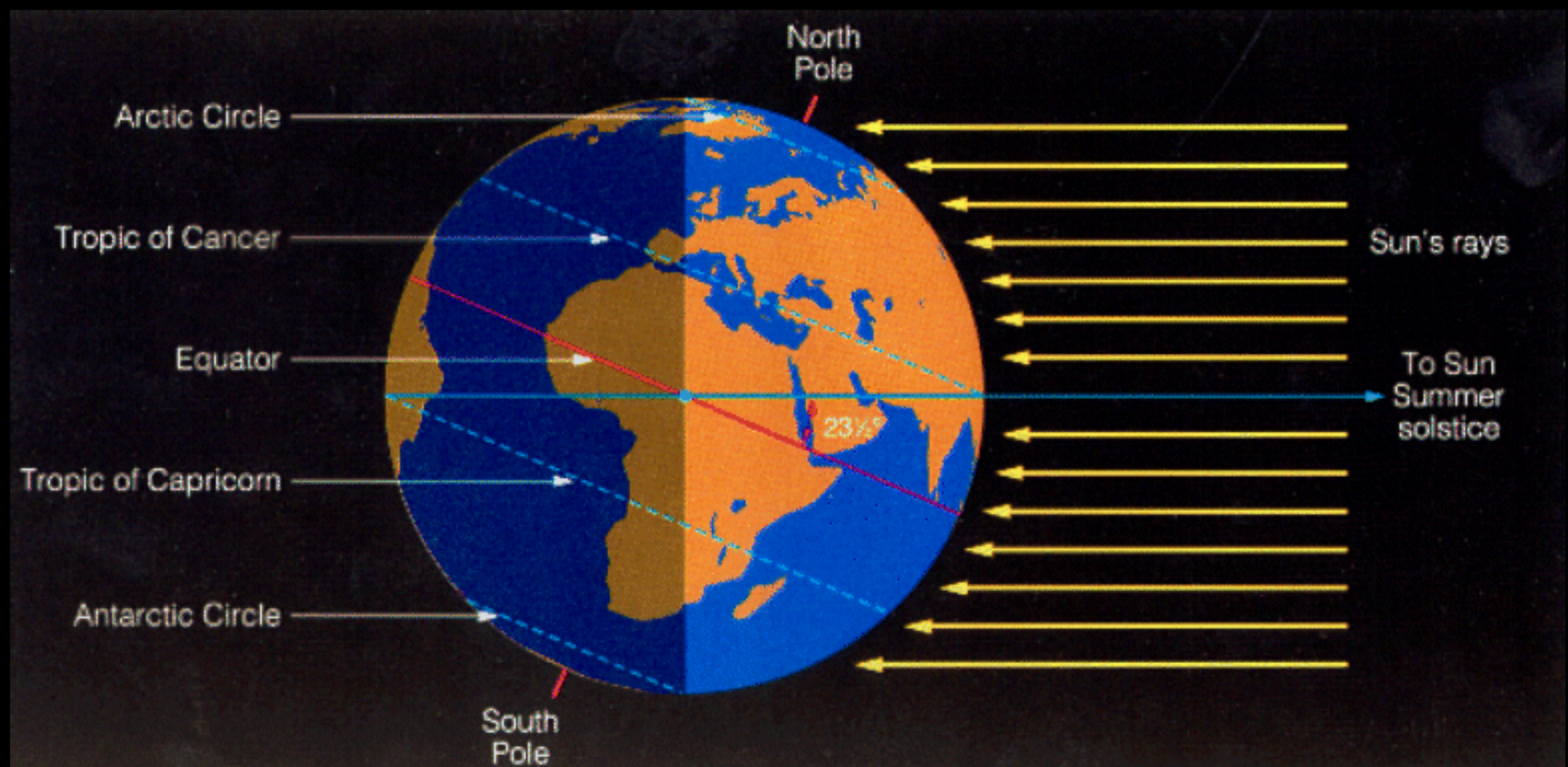


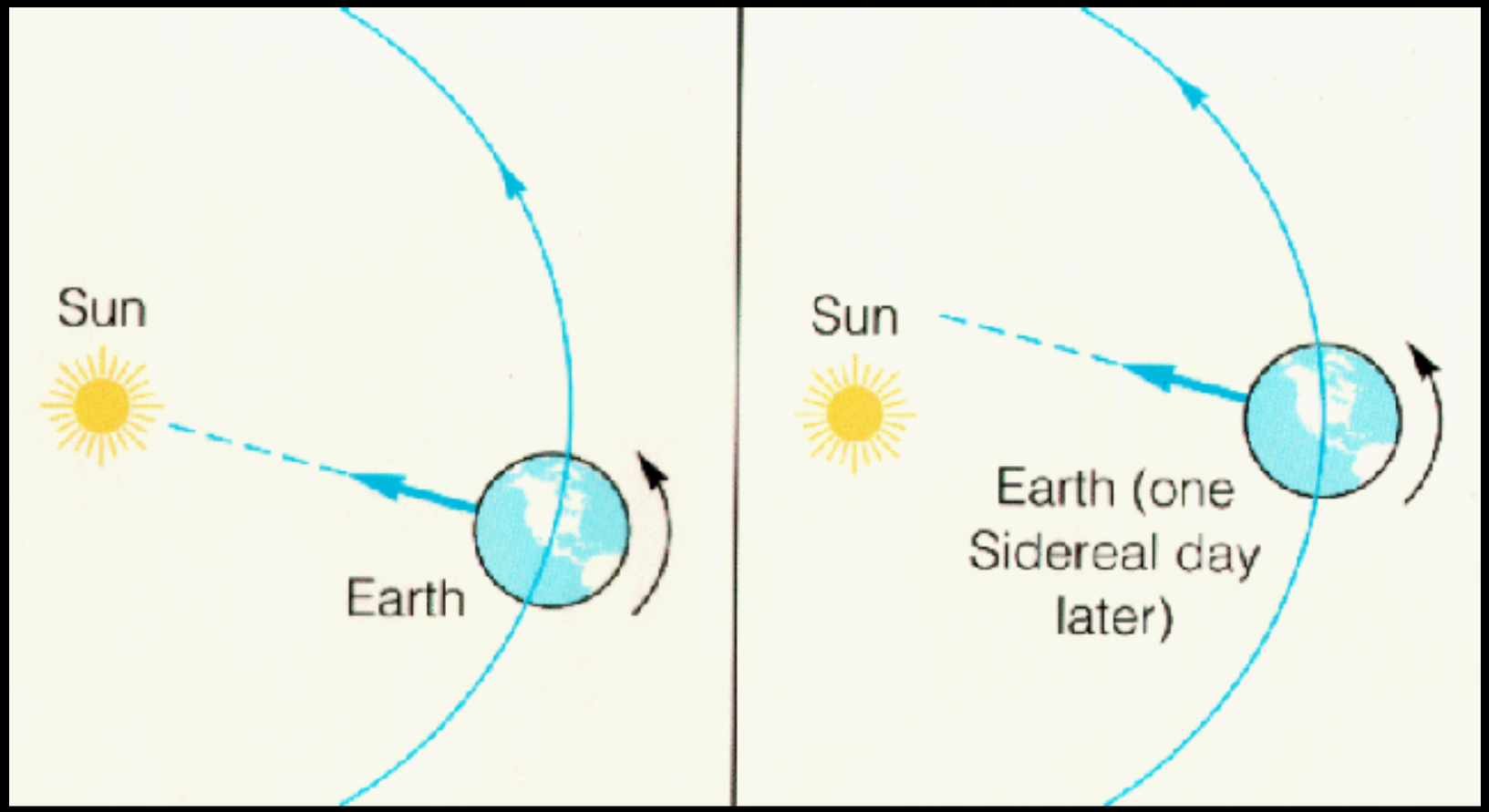
Hipparchus also developed a simply method of identifying the stars in the sky by using a letter from the Greek alphabet combined with the constellation name.



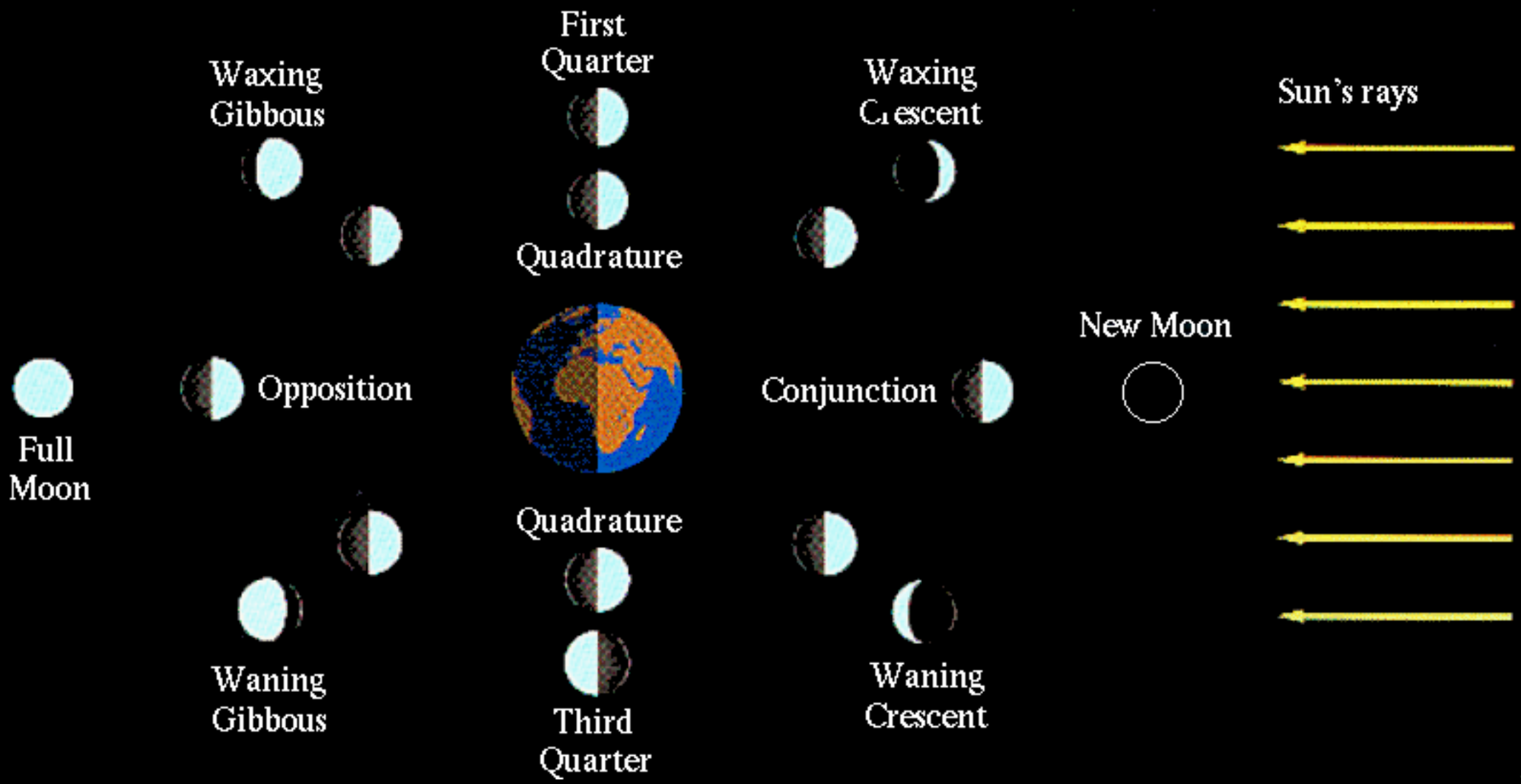
Since the Earth's axis is tilted 23 1/2 degrees from the plane of our orbit around the Sun, The apparent motion of the Sun through the sky during the year is a circle that is inclined 23 1/2 degrees from the celestial equator. This circle is called the ecliptic and passes through 12 of the 88 constellations that we call the zodiac.


Ecliptic
Autumnal equinox
Summer solstice
23½°
Winter solstice
Celestial equator
Vernal equinox

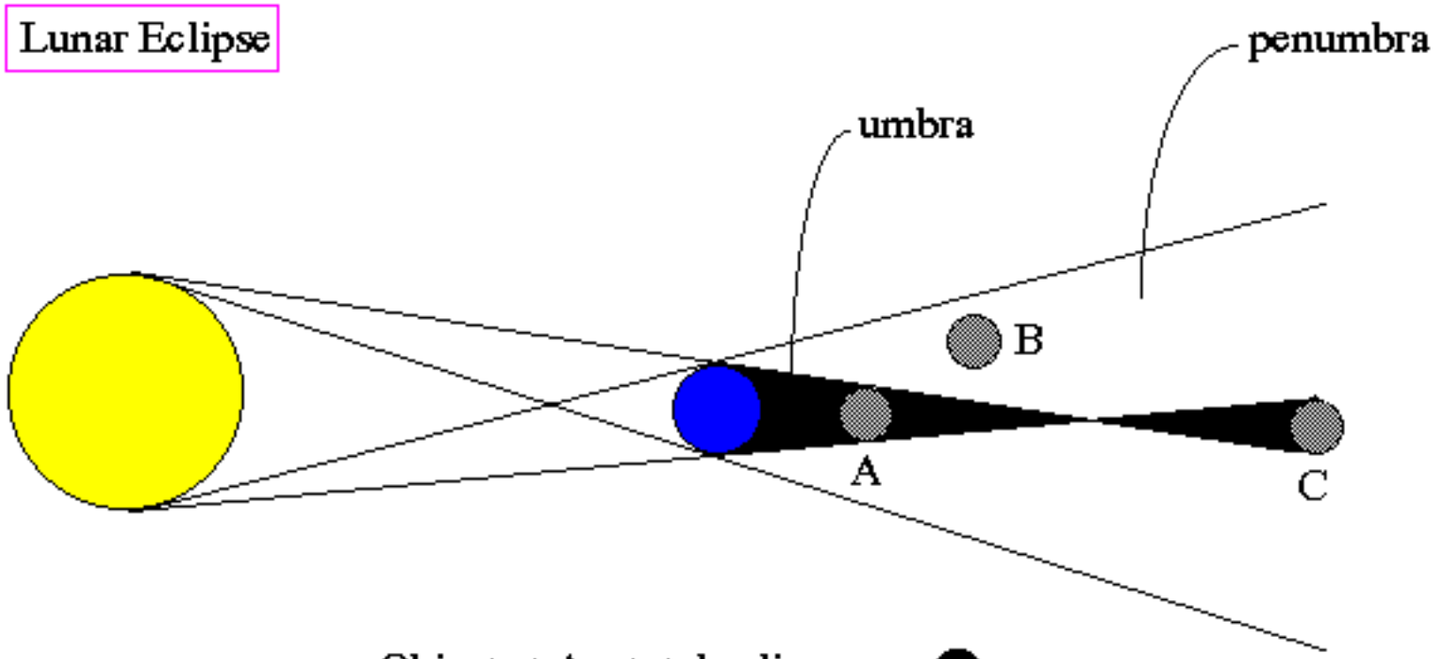

North Pole
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
South Pole
Sun's rays
To Sun Summer solstice
23½°



Typical we use synodic time, which means with respect to the Sun, in our everyday life. For example, noon, midnight, twilight are all examples of synodic time based on where the Sun is in the sky (e.g. directly overhead on the equator for noon). Astronomers often use sidereal time, which means time with respect to the stars, for their measurements.


First Quarter
Waxing Gibbous
Waxing Crescent
Sun's rays
Quadrature
New Moon
Opposition
Conjunction
Full Moon
Quadrature
Waning Gibbous
Third Quarter
Waning Crescent

Lunar Eclipse



Object at A = total eclipse

Object at B = partial eclipse

Object at C = annular eclipse