ASTRONOMICAL LEAGUE

A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION

- *To promote the science of astronomy:*
- *By fostering astronomical education;*
- *By providing incentives for astronomical observation and research;*
- *By assisting communication among amateur astronomical societies.*

ASTRO NOTES

Produced by the Astronomical League

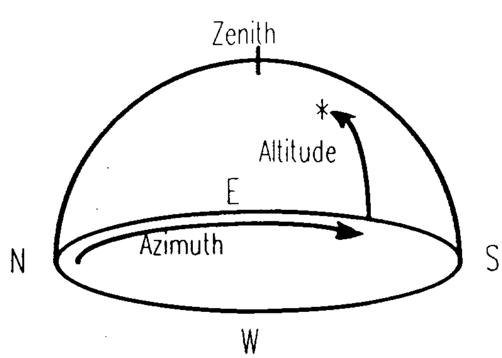
Note 11: Celestial Coordinate Systems

As we look up into the night sky, the stars appear to be placed on a large, inverted bowl above us. This inverted bowl is called the celestial sphere. Since all objects on the celestial sphere appear to be at the same, arbitrarily large distance from the observer, it is usually not necessary to know the object's true distance. It is only necessary to know the object's angular position as projected onto the celestial sphere.

Since the celestial sphere appears as a two dimensional, curved surface, two angular measurements are required to specify one object's position relative to another. Although any arbitrary coordinate system could be used, these measurements are usually made in two specific systems by amateur astronomers. Each is characterized by a specific plane of reference, which determines a great circle when projected onto the celestial sphere, and by a specific reference point on that great circle. Coordinates are then specified by angular measure around the great circle from the reference point and by angular distance from the reference plane along another great circle perpendicular to that plane.

Topocentric Coordinates

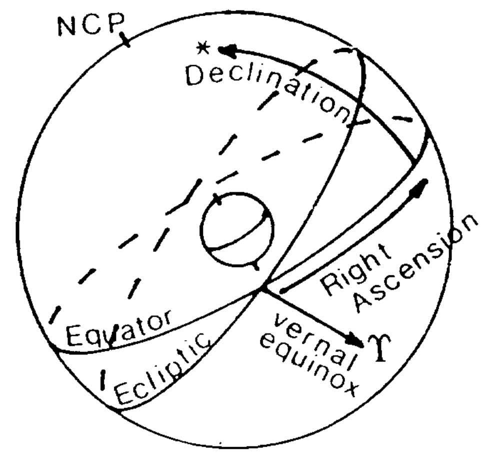
Also called alt-azimuth or horizon coordinates, this system uses the plane of the local horizon as the plane of reference. The reference point within the plane is the geographic north point. (It might just as easily have been the geographic south point except that early civilizations and, hence, directional conventions, first developed in the Northern Hemisphere. The northern bias continues to this day.)



The **azimuth**, designated θ (*theta)*, is measured along the horizon, eastward from the north point. From the definition, azimuth ranges from 0^o to 360^o. The common directions of due north, east, south and west correspond respectively to azimuths of 0^o, 90^o, 180^o, and 270^o.

Altitude, designated a, is measured perpendicular to the horizon. Altitude values range from -90^o to +90^o. If the altitude of an object is negative, it is below the horizon. If the altitude is greater than 90^o, it should be measured from a point on the horizon 180^o away in azimuth. This would bring the altitude back to less than 90^o. The point directly overhead, having +90^o altitude, is called the zenith.

Equatorial Coordinates



As the name suggests, the plane of the Earth's equator is chosen as the plane of reference. The projection of this plane intersects the celestial sphere in a great circle called the celestial equator. The reference point on the celestial equator is defined with the aid of another plane, the plane of the Earth's orbit, called the ecliptic.

The Sun appears to follow the ecliptic as it moves day-to-day against the stellar background. The path was named ecliptic because lunar and solar eclipses occur along this path.

Since the equator is inclined about 23.5^o to the ecliptic, the two projected great circles intersect at two points. That intersection where the Sun appears to cross the celestial equator from south to north is chosen as the reference point and is known as the vernal equinox.

Right ascension, designated α *(alpha)*, is measured along the celestial equator eastward from the vernal equinox. For convenience, right ascension is normally measured in hours and ranges from 0h to 24h. Note that, in the Northern Hemisphere, right ascension increases clockwise when you are facing north.

Declination, designated δ *(delta)*, is measured perpendicular to the celestial equator. Declination ranges from -90^o to +90^o. Negative declinations indicate objects south of the celestial equator. As with altitude, a declination greater than 90^o should be measured from a right ascension 12h (=180^o) away so that the correct value is always within the $\pm$90^o range.