The Astronomical League

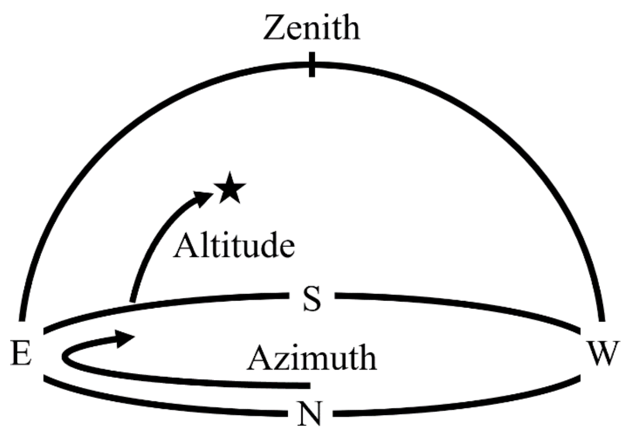
A Federation of Astronomical Societies

Astro Note E4 – Celestial Coordinate Systems

Introduction – 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 one of two specific coordinate systems by amateur astronomers. Each sstem 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



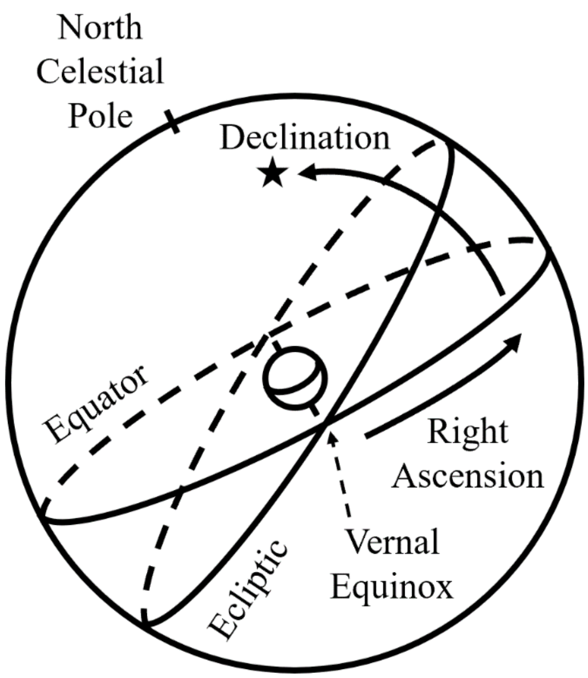
Also called alt-az (altitude/azimuth) or horizon coordinates, this system uses the plane of the local horizon as the plane of reference. The reference point within the plane is the geographic north point.

Azimuth, designated θ (theta), is the angular measurement along the horizon, eastward from the north direction. As you move around the horizon, azimuth ranges from 0° to 360°. The common directions of north, east, south and west correspond to azimuths of 0°, 90°, 180°, and 270°, respectively.

Altitude, designated a, is the angular measurement perpendicular to (above) the horizon. It is the angular height above the horizon. Altitude values range from -90° to +90°. If the altitude of an object is negative, it is below the horizon and is not visible to the observer.

Zenith, the point directly overhead, having a value of +90° altitude.

Equatorial Coordinates



As the name suggests, the plane of the Earth's equator is chosen as the plane of reference and is extended out into space. 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° 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. (The other crossing is known as the autumnal equinox.)

Right Ascension, designated α (alpha), is the angular measurement 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 the angular measurement perpendicular to the celestial equator. Declination ranges from -90° to +90°. Negative declinations indicate objects south of the celestial equator. Polaris, the North Star, is located very close to declination +90°.