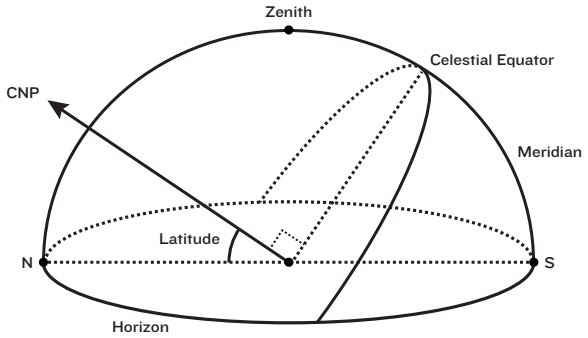
Astronomical Coordinates

The most common coordinate systems used in observational astronomy is the **Equatorial coordinate system**.



The fundamental plane of the equatorial coordinate system is formed by projection of the Earth's equator onto the celestial sphere, forming the *celestial equator*. The projection of the Earth's north pole is called the *celestial north pole*, and the Earth's south pole is the *celestial south pole*.

The position of the celestial equator, and the celestial poles in the sky depends on the observer's location on the Earth.

The coordinates of objects in the sky are given by two values that are roughly equivalent to latitude and longitude on the Earth.

Declination (Dec or δ) is equivalent to terrestrial latitude projected onto the celestial sphere, and is measured in degrees north and south of the celestial equator. Points north of the celestial equator have positive declinations, while those to the south have negative declinations. The sign is customarily included even if it is positive. Declination is expressed in degrees [$^\circ$], arc-minutes [$\prime$], and arc-seconds [$\prime\prime$]. For Example: $\delta = +23^\circ\ 52'\ 12.12''$

- The celestial equator has a $\delta = 0^\circ$
- The celestial north pole has a $\delta = +90^\circ$
- The celestial south pole has a δ = -90°

Right Ascension (RA or α) is roughly equivalent to terrestrial longitude. The units of right ascension are hours, minutes, seconds [hms]. There are 24 hours in 360° so 1 hour is equivalent to 15°. For Example: α = 20h 23m 12.12s

The zero-point for right ascension is the position of the Sun on the first day of spring (Vernal Equinox). RA is measured eastward from the Vernal equinox. The position of the Sun at the beginning of each season is given in the table below.

Season	Approx Date	α	δ
Vernal Equinox	Mar 21	0h	0°
Summer Solstice	Jun 21	6h	+23.4°
Autumnal Equinox	Sep 21	12h	0°
Winter Solstice	Dec 21	18h	-23.4°

As you can see, the Sun moves about 1h in RA every 2 weeks.

Meridian. The meridian is the great circle running from due north to south, passing through the celestial pole. The moment an object is on the meridian, that object will have a right ascension equal to the Local Sidereal Time (LST).

LST = α of the meridian. Since the zero-point of right ascension is a fixed point in space, the value of the LST will constantly be changing (the Earth is rotating), and will be depend on your location on Earth.

Midnight The LST at any location at local midnight will be the α of the Sun + 12 h

Zenith. This is the point on the celestial sphere directly above the observer's location. It is the point on the meridian with the highest altitude. An object at the zenith will have the coordinates: α = LST, δ = observer's latitude (θ).

Visibility. The ability of an observer to see an object in the sky depends on the observer's latitude and longitude ($\theta,\ \phi$), the time of the observation (LST), and the coordinates of the object ($\alpha,\ \delta$).

Some objects may always be above the observer's horizon. These objects are called **circumpolar** objects. Of course you may not be able to see these objects if the Sun is in the sky. Conversely, some objects may never rise above the observer's horizon.

The table below summarizes the visibility of objects in the sky. The rising and setting times are very rough "rule-of-thumb" guides.

Visibility	Northern Observer ($\theta > 0$)	Southern Observer ($\theta < 0$)
Circumpolar	$\delta > 90° - \theta$	$\delta < -90° - \theta$
Never Visible	$\delta < -90° + \theta$	$\delta > 90° + \theta$
Best Visibility	α = LST at midnight	
Object Rises	$\alpha \sim$ LST - 4h	
Object Sets	$\alpha \sim$ LST + 4h