Investigating the Celestial Sphere

Objectives

- Understand the following Astronomical terms;
    1. Right Ascension
    2. Declination
    3. Hour Angle
    4. Azimuth
    5. Altitude
    6. Solar Time
    7. Sidereal Time

The Celestial Sphere

- In astronomy and navigation, the **celestial sphere** is an imaginary sphere of arbitrarily large radius, concentric with Earth. All objects in the observer's sky can be thought of as projected upon the inside surface of the celestial sphere, as if it were the underside of a dome or a hemispherical screen. The celestial sphere is a practical tool for spherical astronomy, allowing observers to plot positions of objects in the sky when their distances are unknown or unimportant.
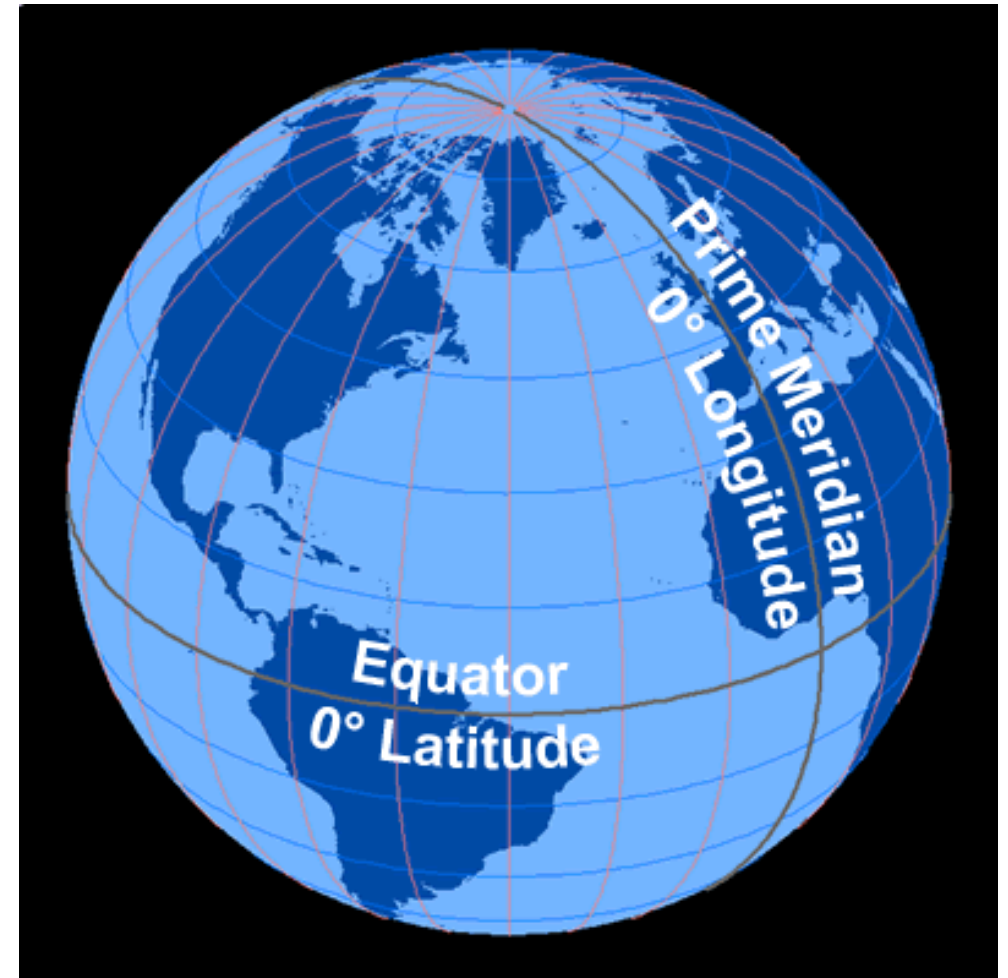
Latitude & Longitude

For the purpose of positioning and navigation, the earth is divided, horizontally and vertically into lines of latitude and longitude respectfully.

Latitude is given in degrees, either decimal or DMS north or south of the equator. So here in Bury St Edmunds we are around 52° N or 52 degrees above the equator. Sydney Australia is 33.8° S or 33.8 degrees below the equator.

Longitude can be given in degrees or hours and is the great circle that goes through both poles and your location. It is given in degrees west or east of the prime meridian. The prime meridian 0° was set to run through Greenwich London by political agreement in 1884. essentially it is an arbitrary starting point for measurements in longitude.

As the earth rotates 360° in 24 solar hours we can also define a new unit of hours. Each hour is equal to 360/24 or 15°. Each time zone across the earth spans 15° or 1 hour.

Finding Latitude
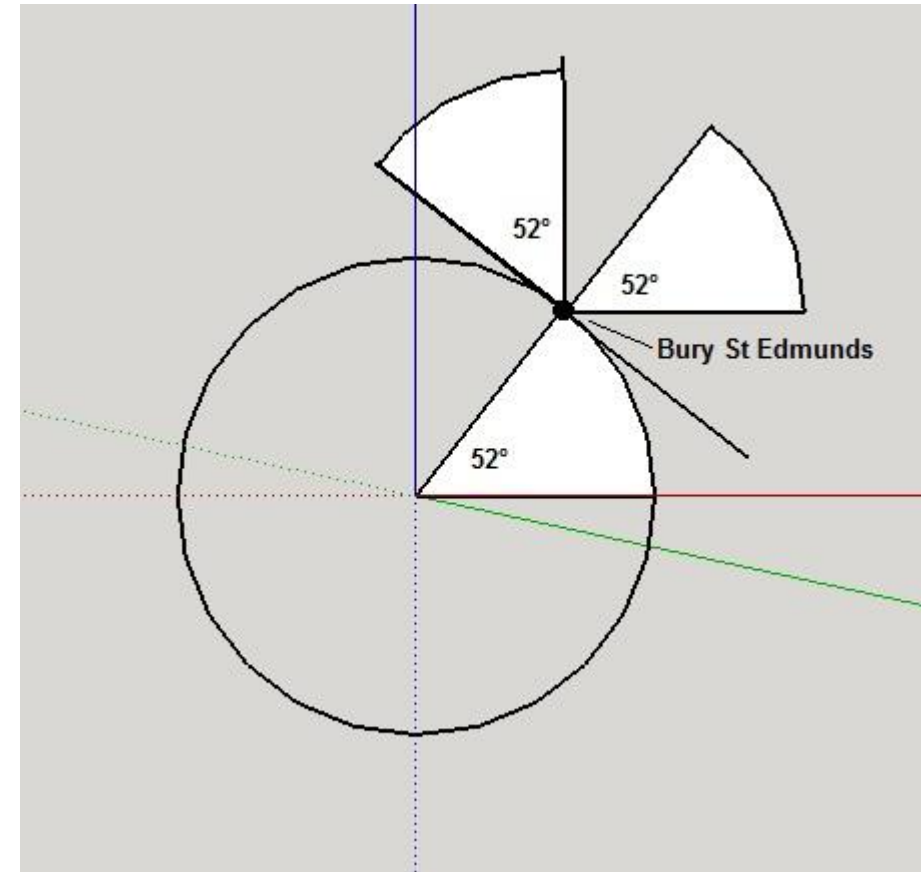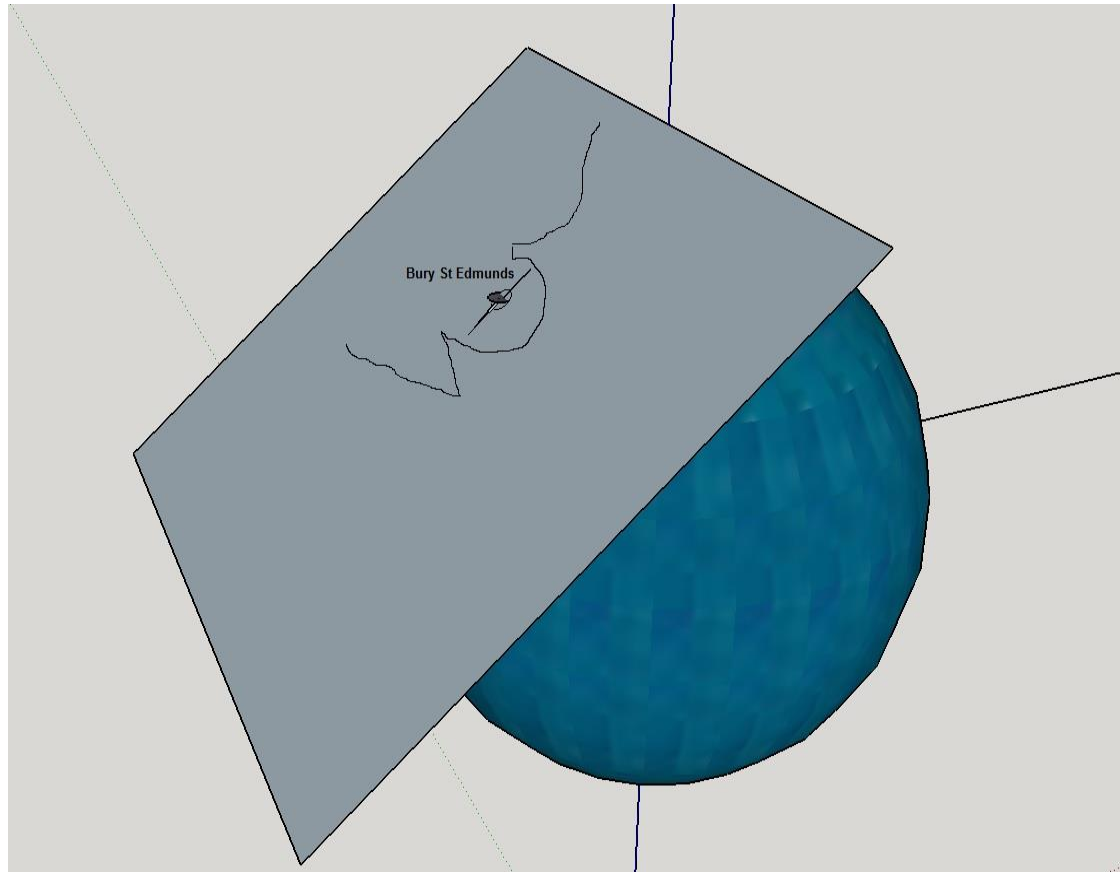
Finding Longitude

- Longitude = Time

With sufficiently accurate clock longitude can be found from the difference in the local solar noon to the time at Greenwich. So a watch set at Greenwich will give the hours between Greenwich Noon and local noon (or at any other time). Multiplying the hours by 15 (the hour angle) gives degrees of longitude.

The problem in the 18th Century was to make a sufficiently accurate stable clock.

The story of Longitude is told at the Greenwich observatory where the Harrison clocks are on display.

Celestial Sphere

We can use the idea of lat and long to imagine a coordinate system for the celestial sphere. Analogous with latitude is "Declination". It too has a 0° line "the celestial equator" with values given as +/- degrees. Analogous with longitude is "Right Ascension" and like longitude can also be given in degrees or hours. But where do we start measuring it from. What is the celestial equivalent of the prime meridian?
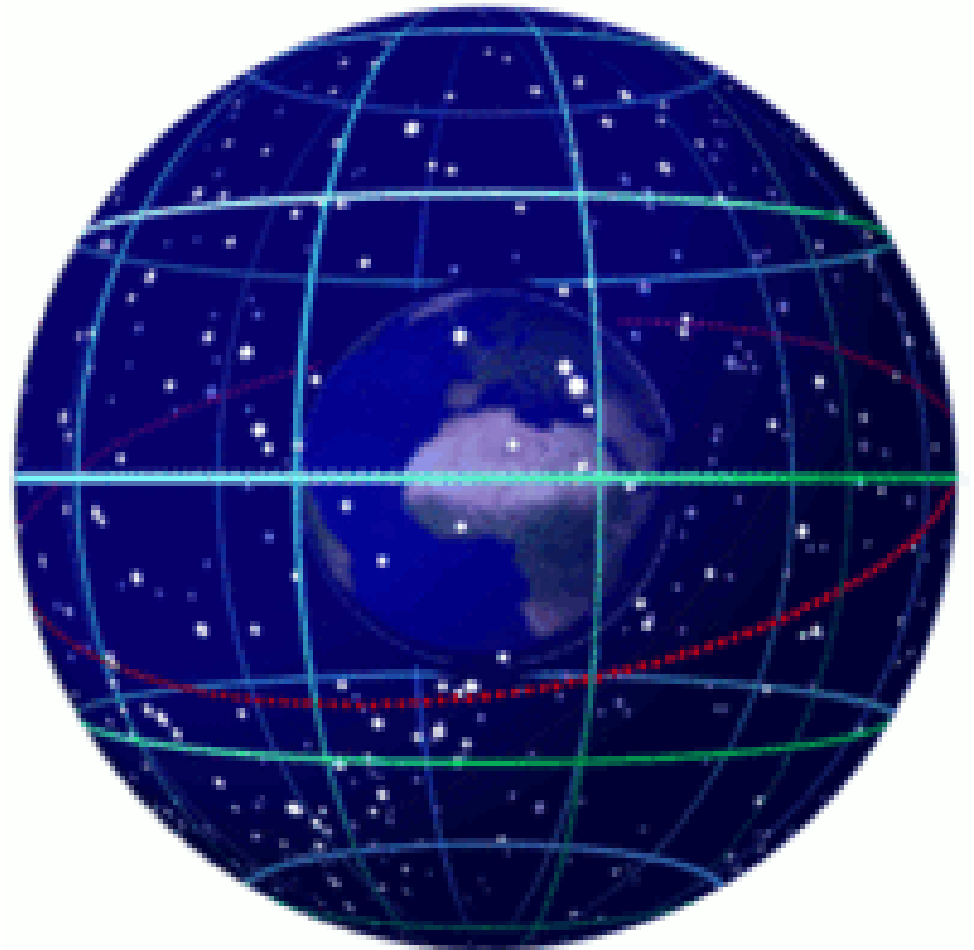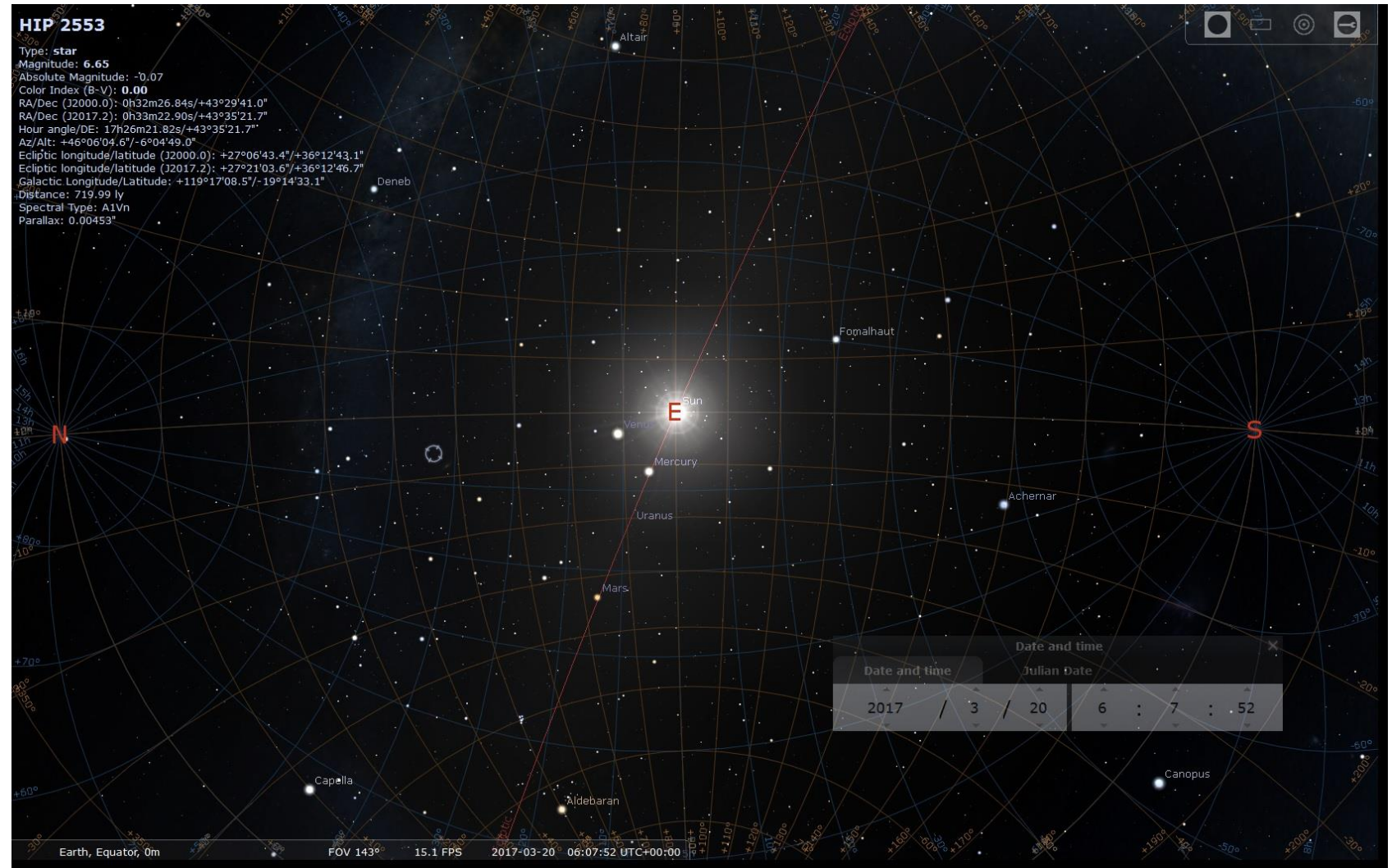
First Point of Aries

Where the line of the ecliptic intersects the Celestial equator on the Vernal (spring) Equinox is defined as 0° right ascension. Also called the First point of Aries. It has a counterpart "the First point of Libra"
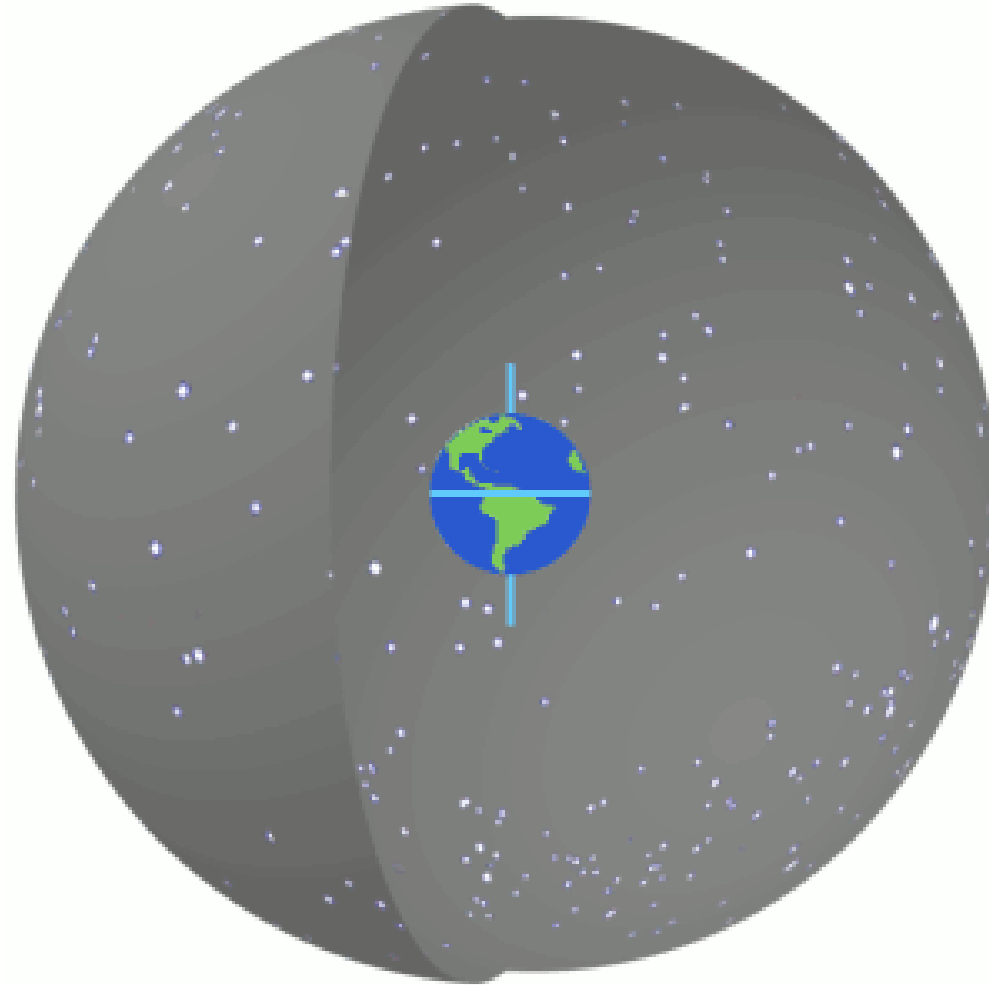
Can you guess where when that is?

Q:What is the RA & Dec of the First Point of Libra

A: RA = 12 hours of 180° Dec = 0°

RA and Dec Animation

Solar time versus Sidereal time

Solar v Sidereal

- Solar from the latin sol for the sun

- Sidereal from the latin sidus for a star

- So we have sun time or star time

- As you can see from the picture, whilst rotating on its axis the earth also moves along its orbit, meaning it has to turn a little more, to make a full day relative to the sun than it does relative to a distant star.
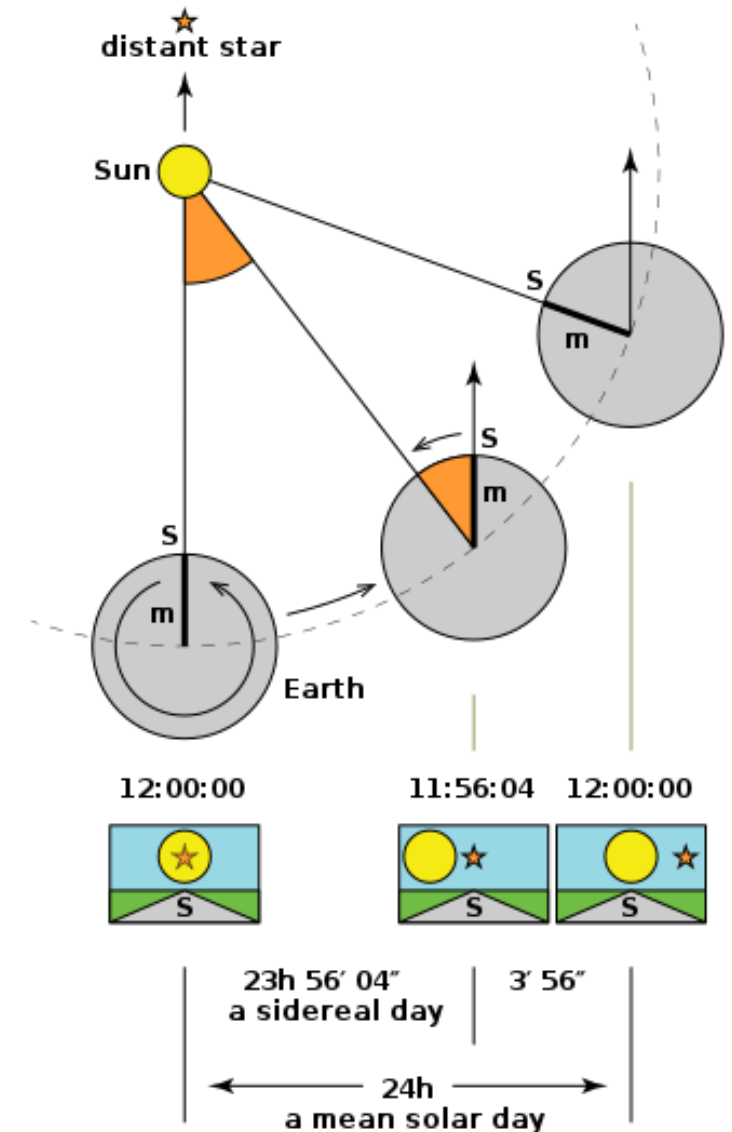
Summary

- Understand the following Astronomical terms;
  1. Right Ascension
     - The celestial equivalent of Longitude. Measured from a fixed point on the sphere where the ecliptic crosses the celestial equator at the vernal equinox.
  2. Declination
     - The celestial equivalent of Latitude. Given as degree above or below +/- celestial equator
  3. Hour Angle
     - The amount in degrees the Sun moves in one hour
  4. Azimuth
     - The horizontal angle between North and the object
  5. Altitude
     - Vertical angle between the local horizon and the object.
  6. Solar Time
     - Time based on the rotation of the Earth using the Sun
  7. Sidereal Time
     - Time based on the rotation of the Earth using a distant star