

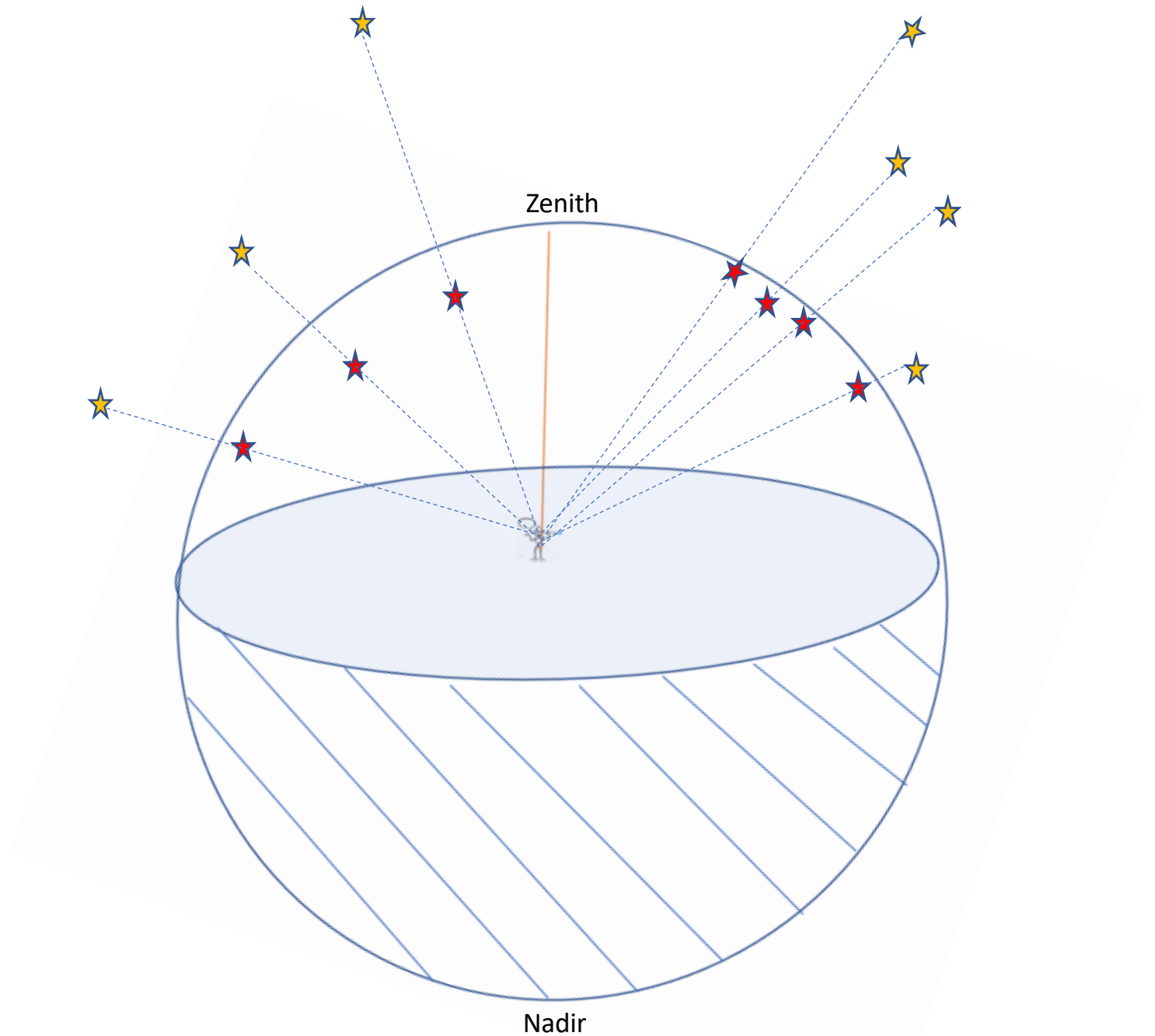
# Astronomy Essentials

## Coordinate Systems

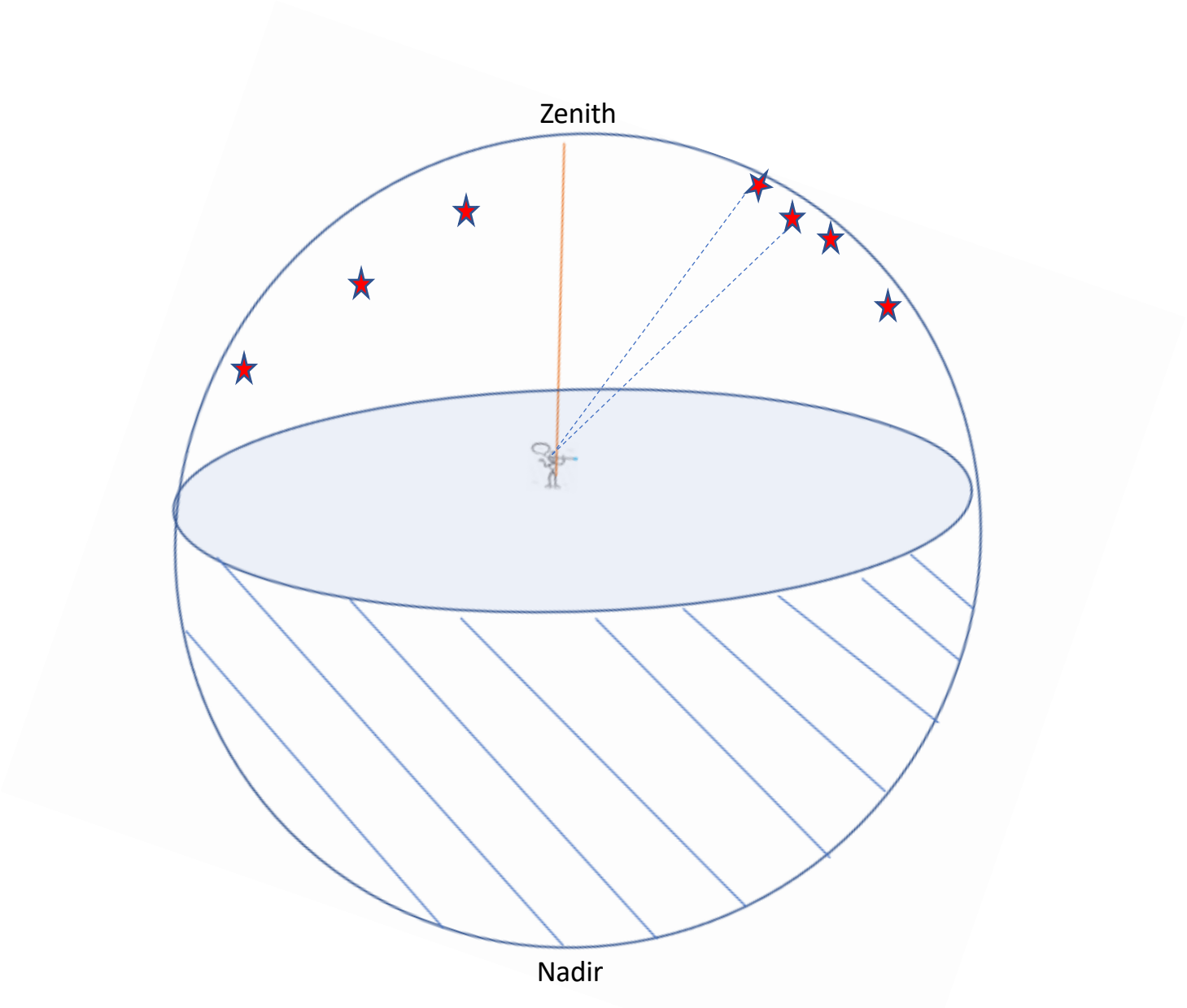
**S N Hasan**

MANUU, Hyderabad

# Celestial Sphere



# Celestial Sphere



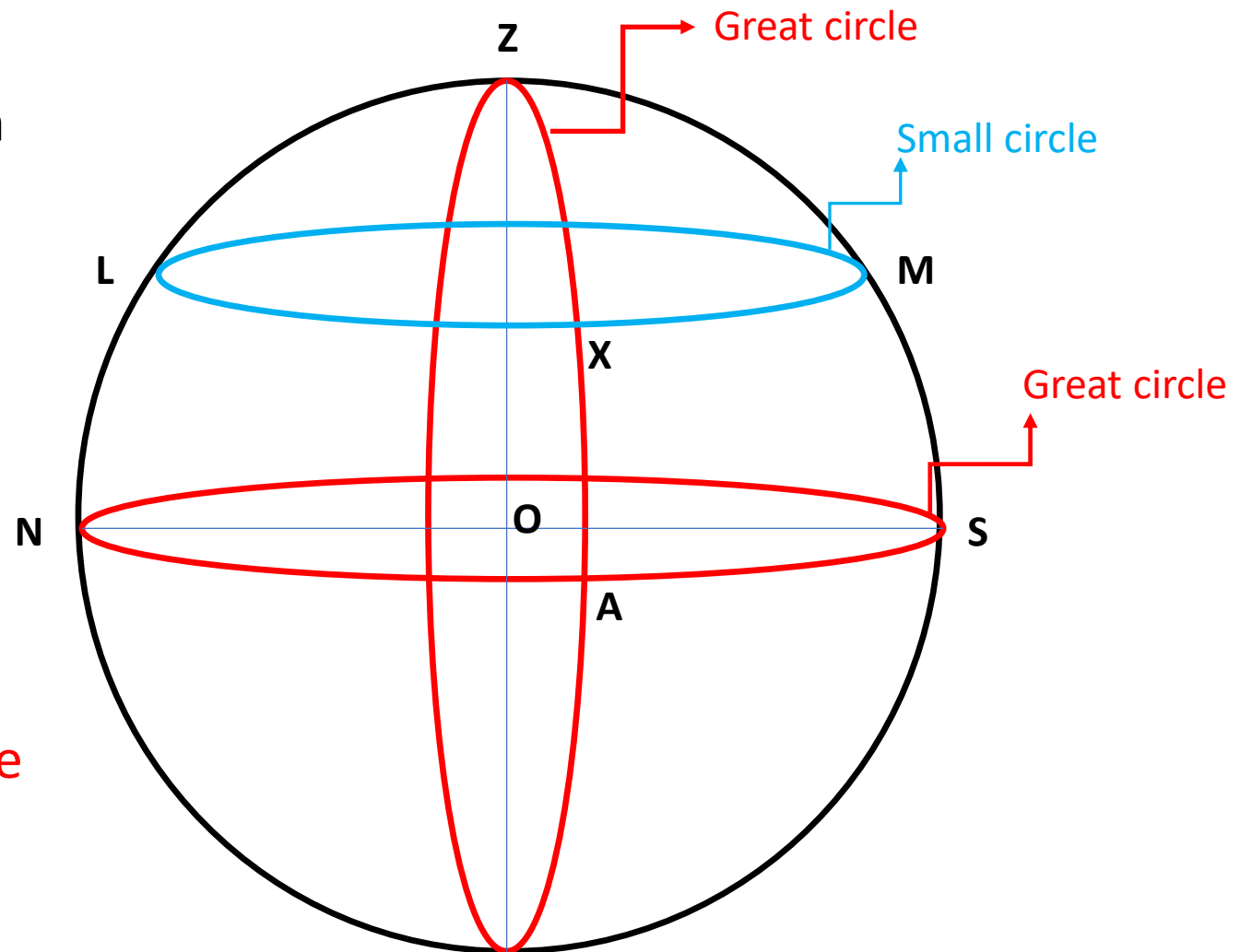
# Spherical Geometry

**Great Circle:** Any plane passing through the center of the sphere

**Small Circle:** Any plane intersecting the sphere but NOT passing through the center of the sphere

NOTE:

The shortest distance between two points on a sphere is along a **Great circle**  
- Equivalent to a straight line (geodesic)



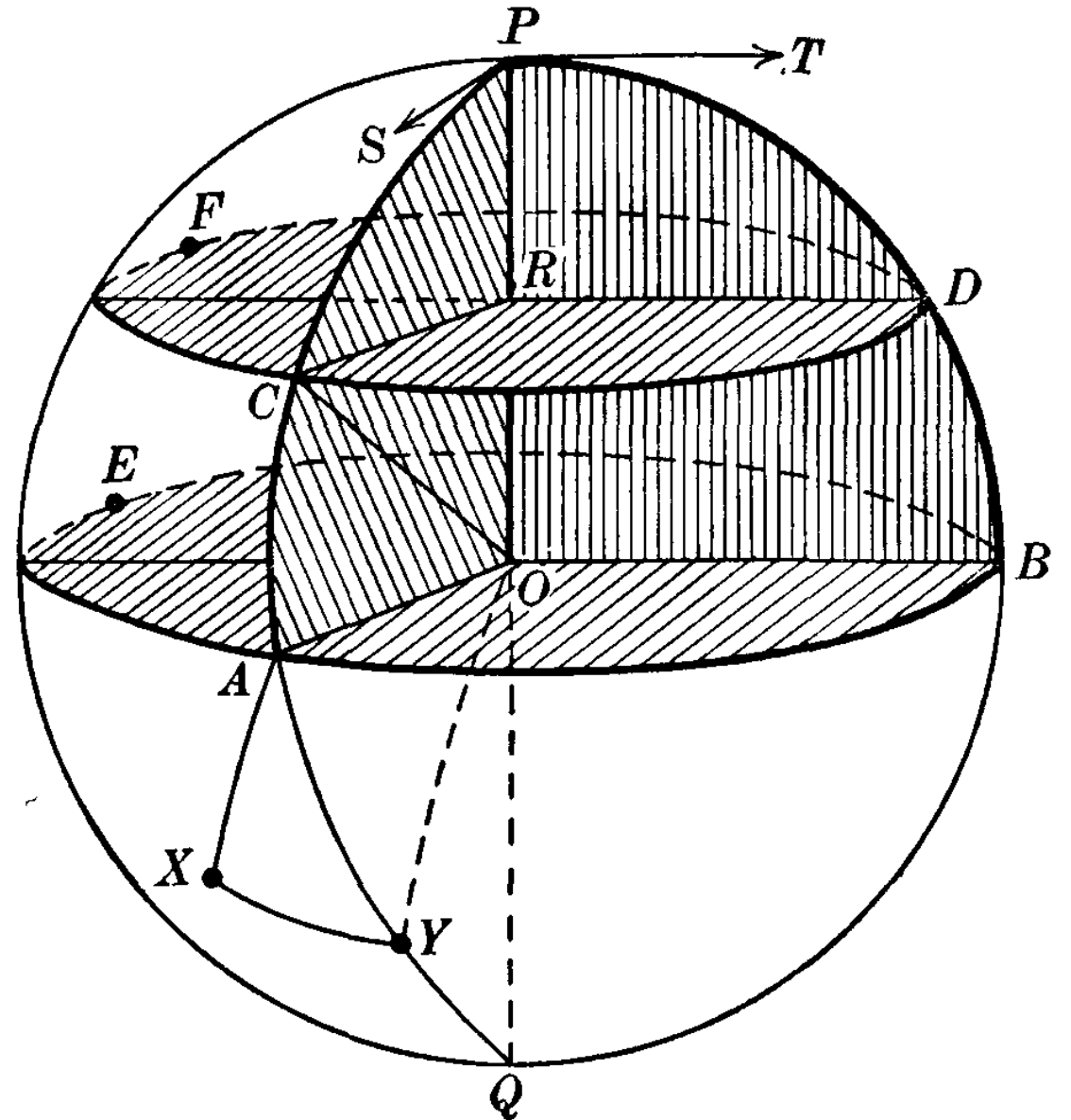
# Spherical Triangle

Arcs  $\widehat{AB}$ ,  $\widehat{BDP}$  and  $\widehat{PCA}$  forms a spherical triangle

$$\sin A/\sin a = \sin B/\sin b = \sin P/\sin p$$

where

$$a = \widehat{BDP}, b = \widehat{PCA} \text{ \& } p = \widehat{AB}$$



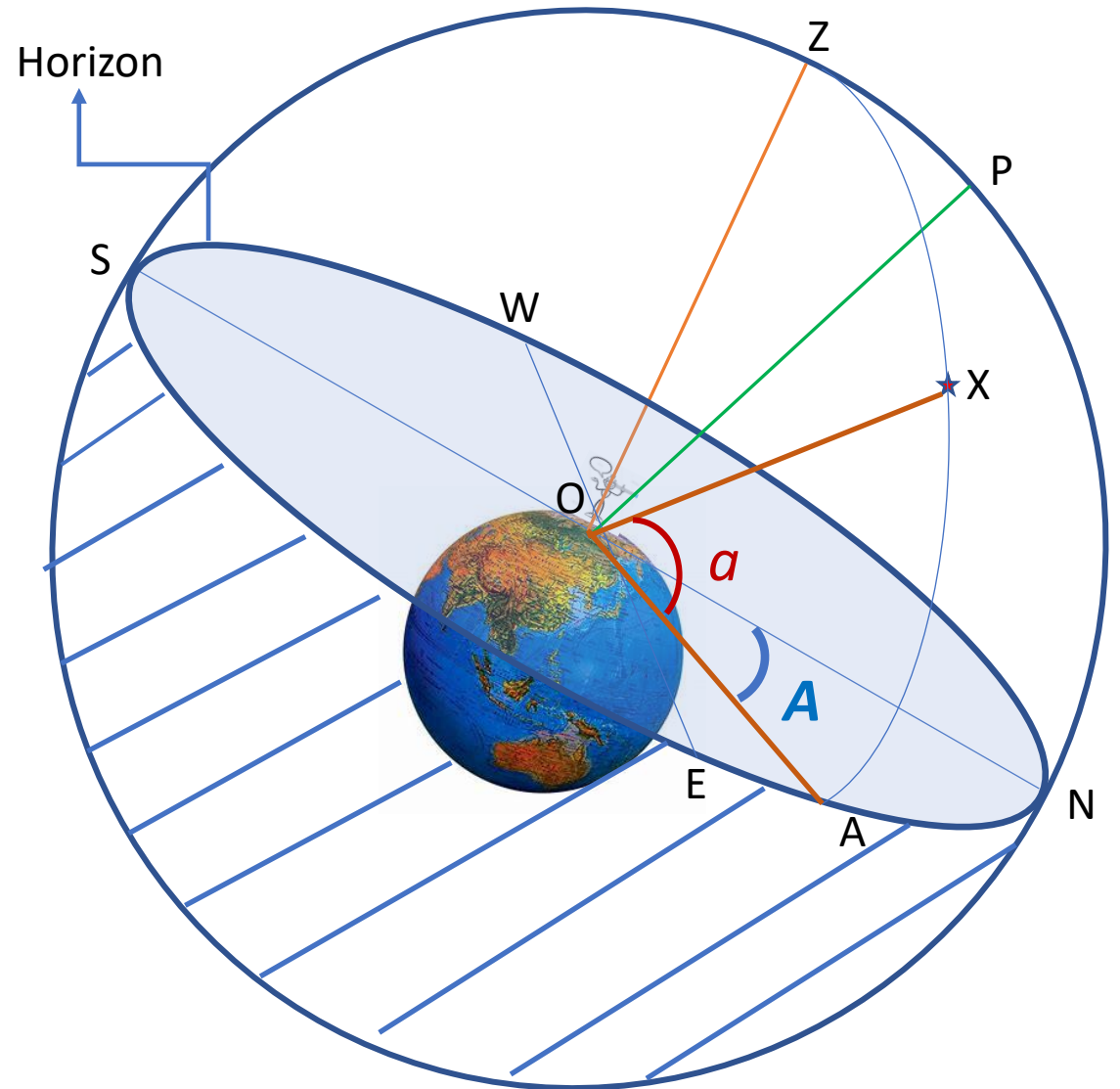
# Horizontal Coordinates

## *Altitude and Azimuth*

$$\widehat{AX} = \text{AOX} = a \quad \textit{altitude}$$

$$\widehat{AN} = \text{NOA} = A \quad \textit{azimuth}$$

$(a, A)$  *Altitude and Azimuth*



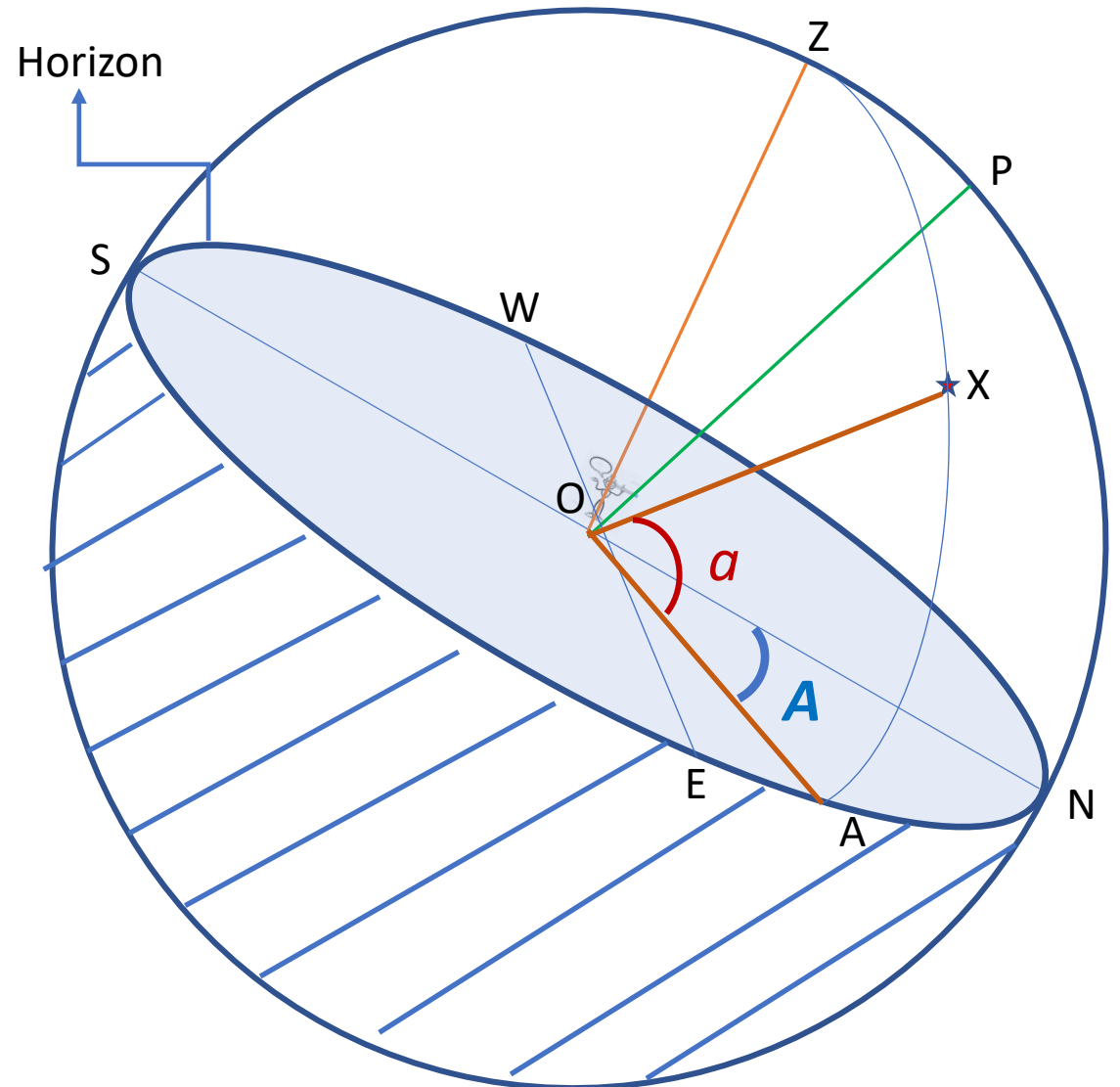
# Horizontal Coordinates

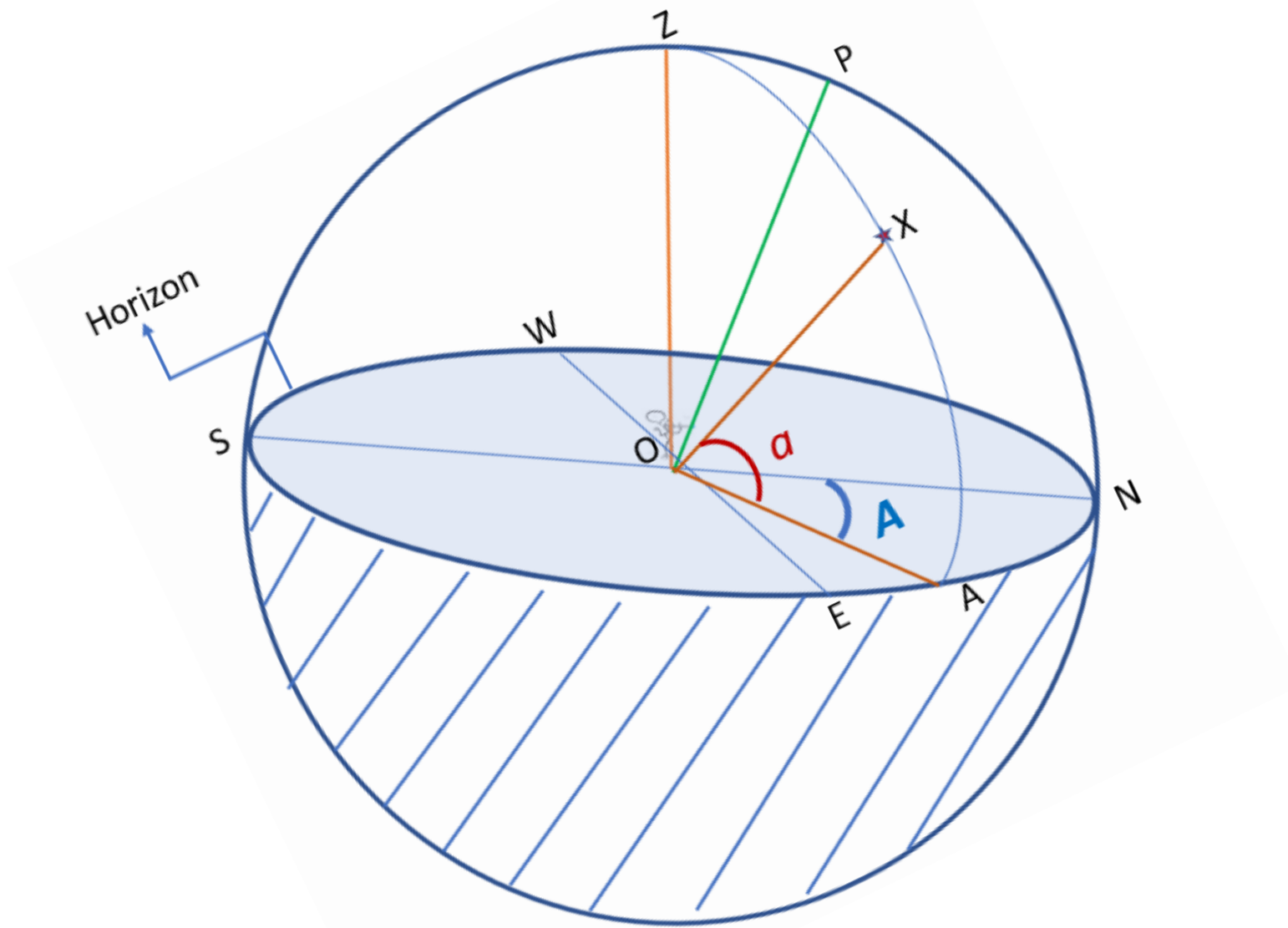
## *Altitude and Azimuth*

$$\widehat{AX} = \text{AOX} = a \quad \textit{altitude}$$

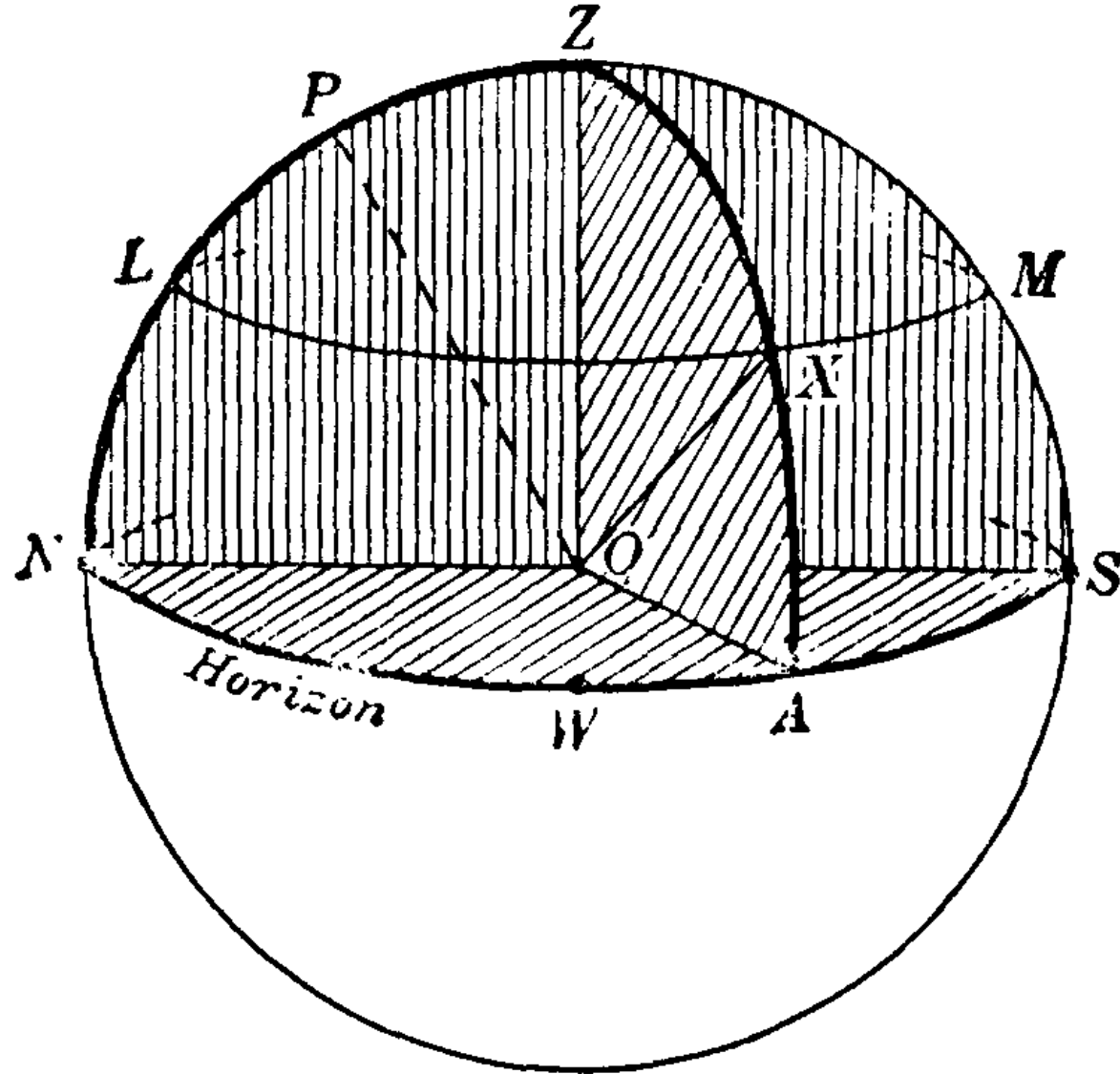
$$\widehat{AN} = \text{NOA} = A \quad \textit{azimuth}$$

$(a, A)$  *Altitude and Azimuth*

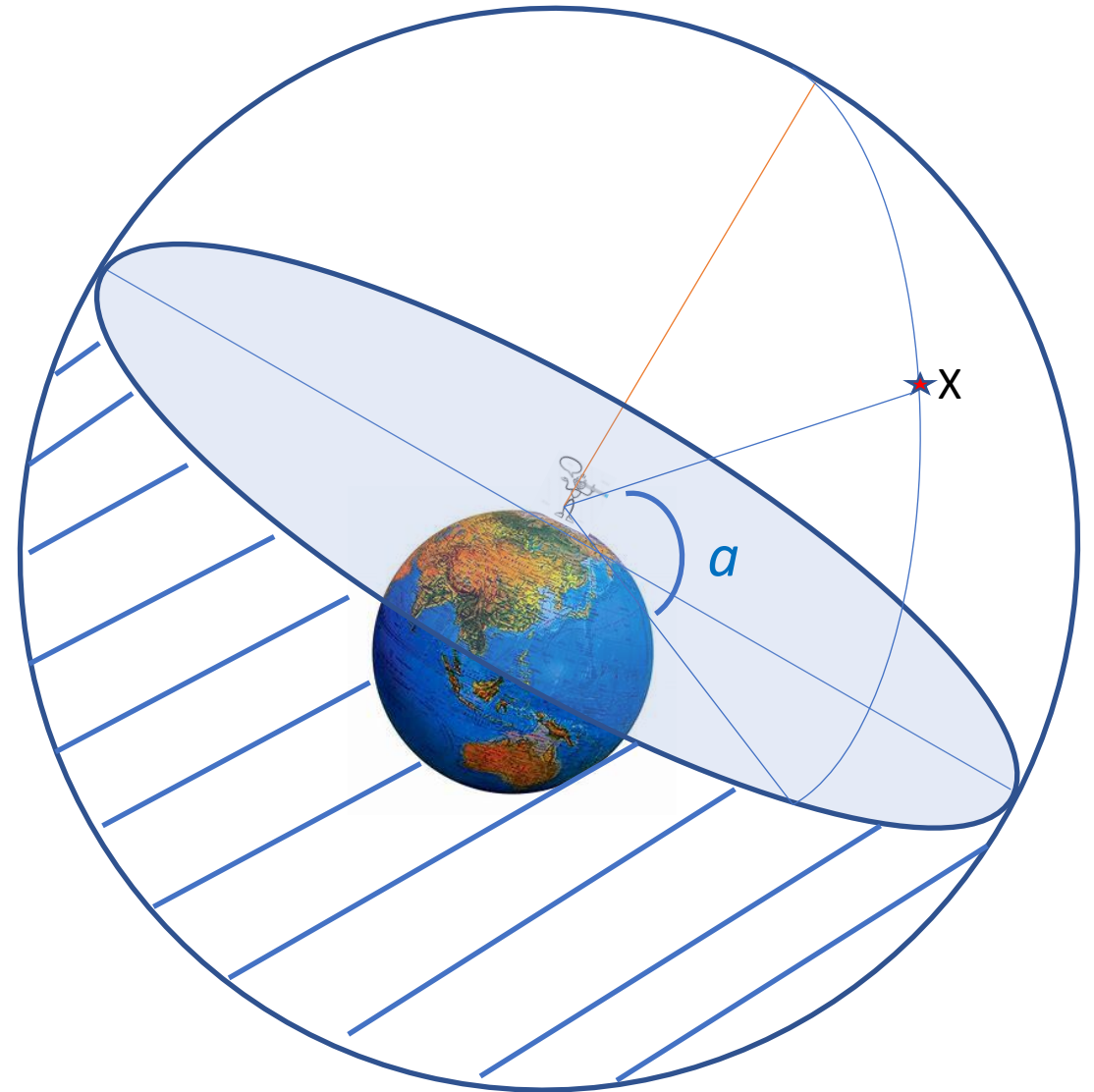
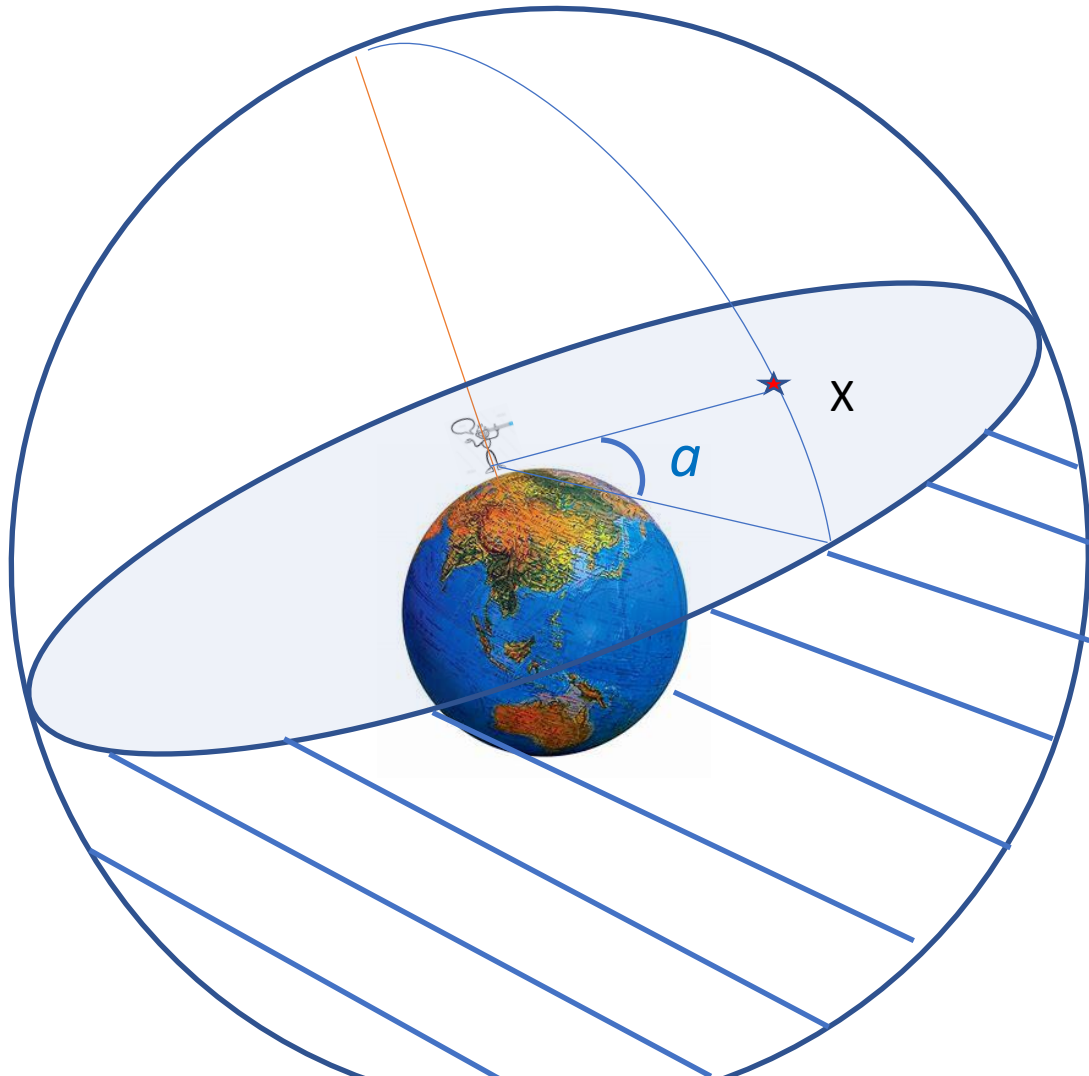






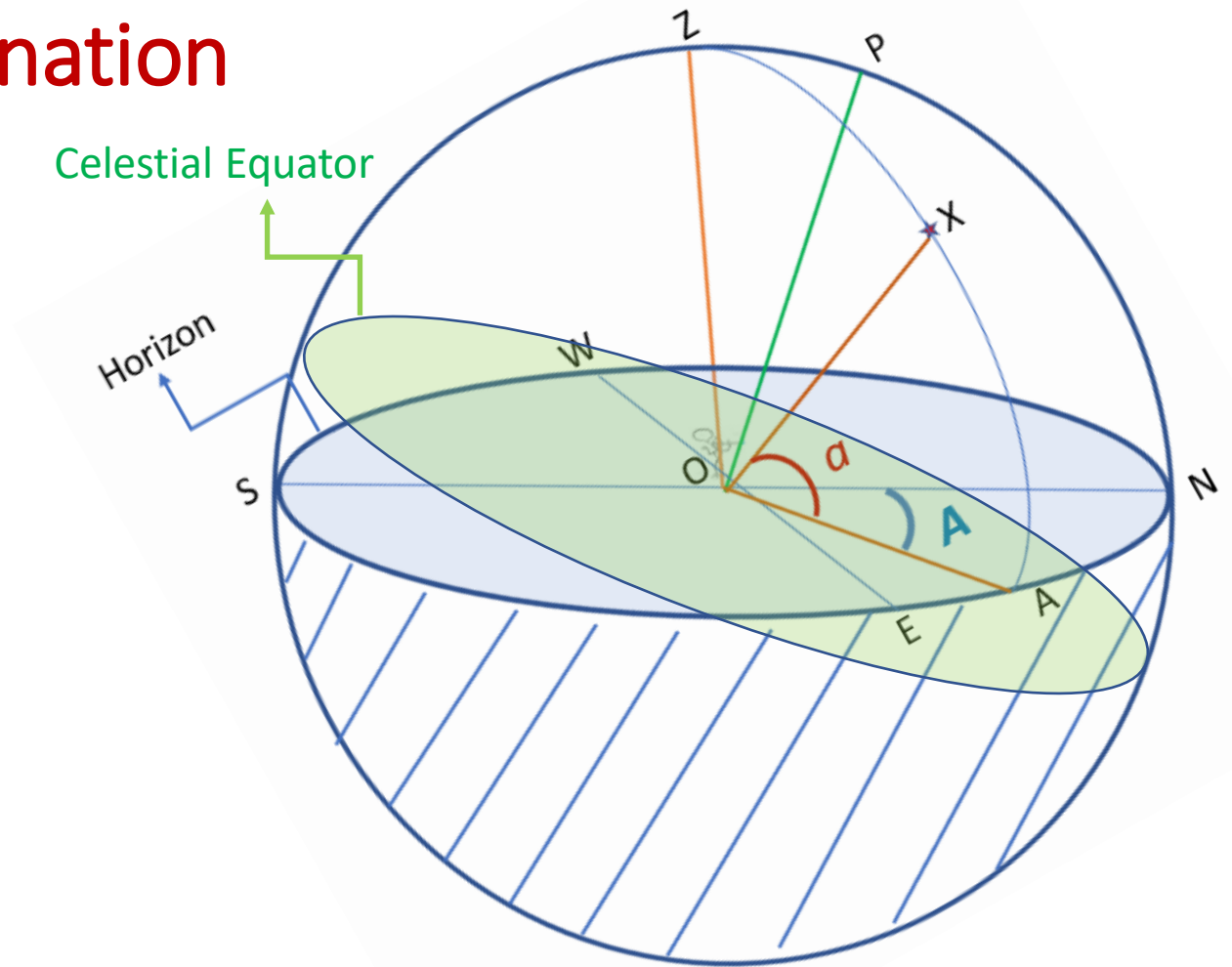


# *Altitude and Azimuth*



# Equatorial Coordinates

## Right Ascension and Declination



# Equatorial Coordinates

## Right Ascension and Declination

$\widehat{TD} = \text{TOD} = \alpha$  right ascension R.A.

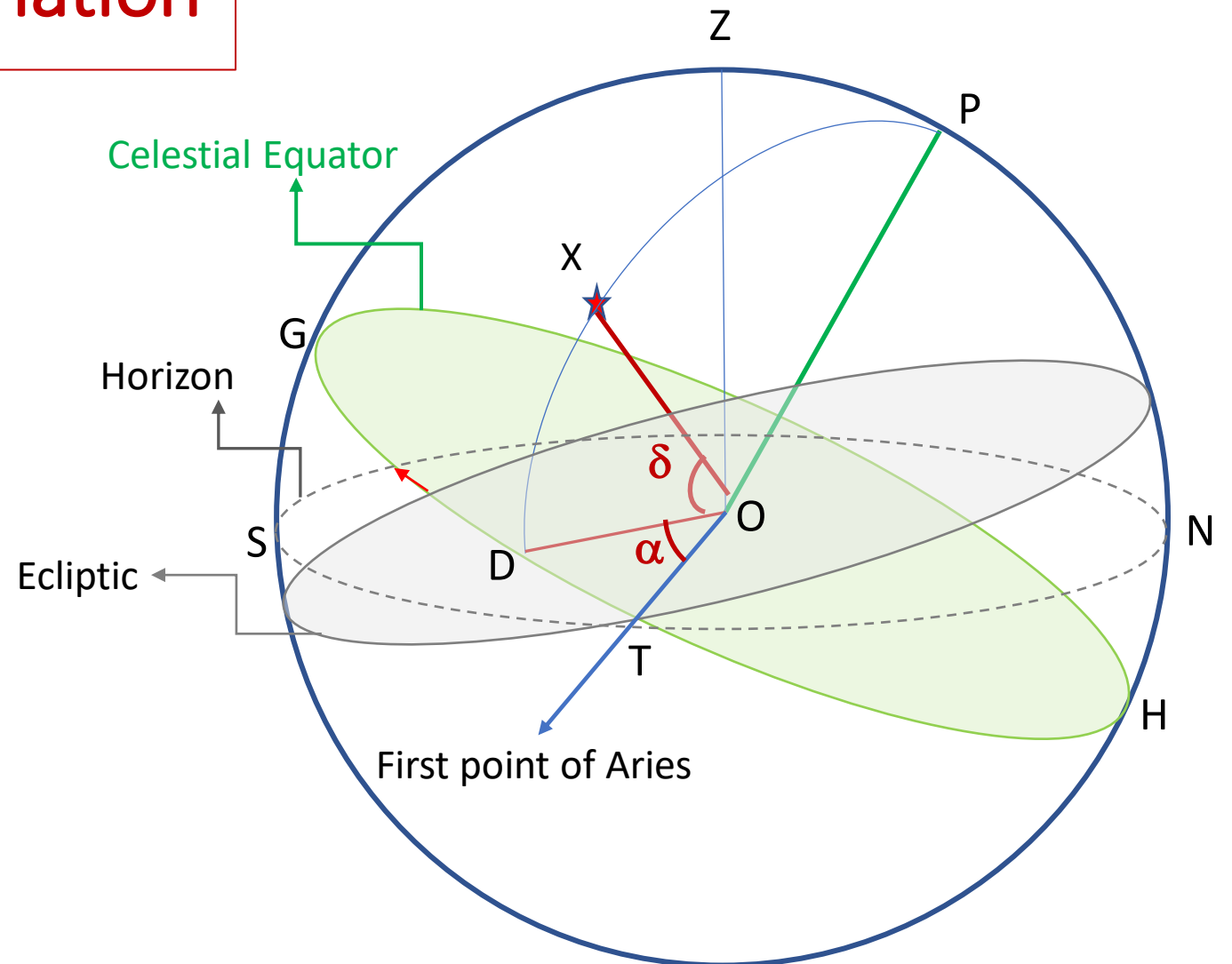
$\widehat{DX} = \text{DOX} = \delta$  declination dec.

$(\alpha, \delta)$  Right Ascension & Declination

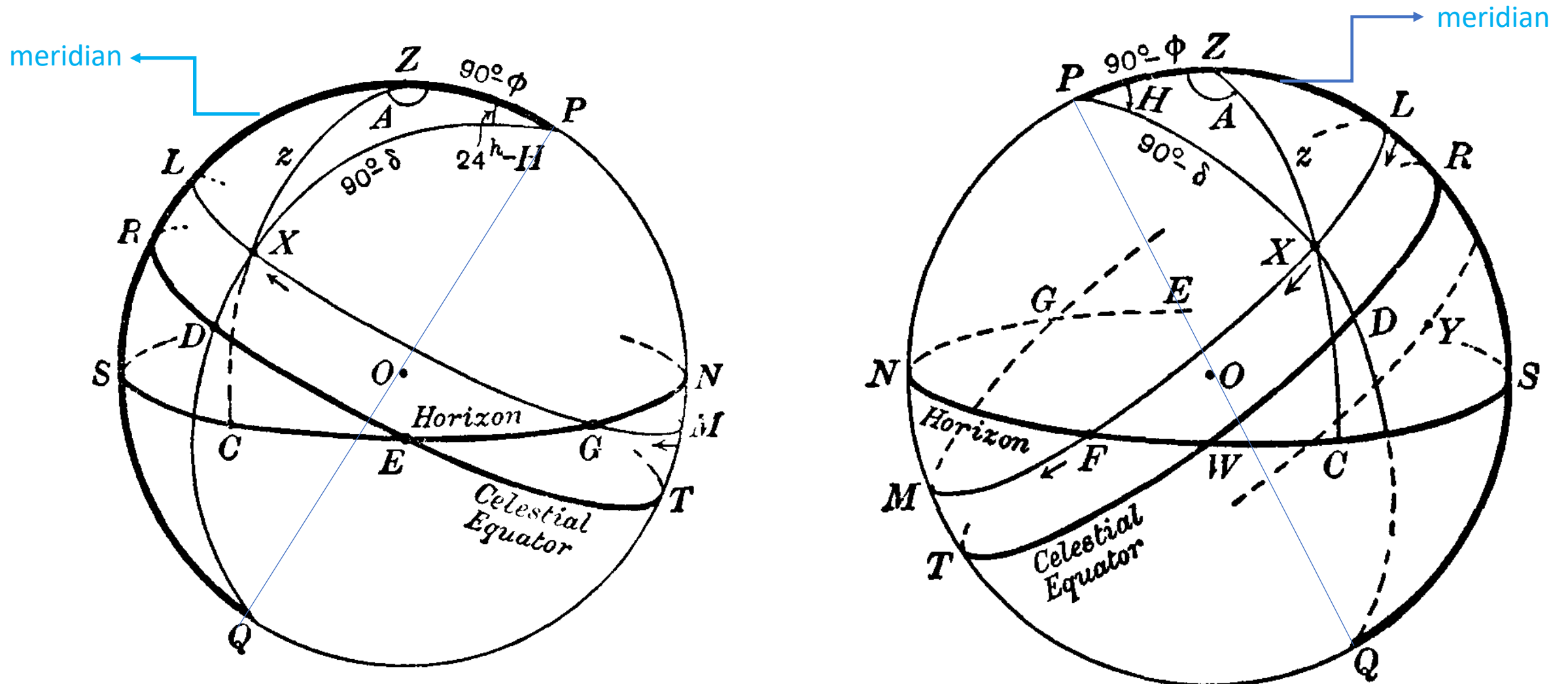
$\widehat{TD} = \text{R.A.}_{\star}$

$\widehat{DG} = \text{H.A.}_{\star}$  Hour Angle

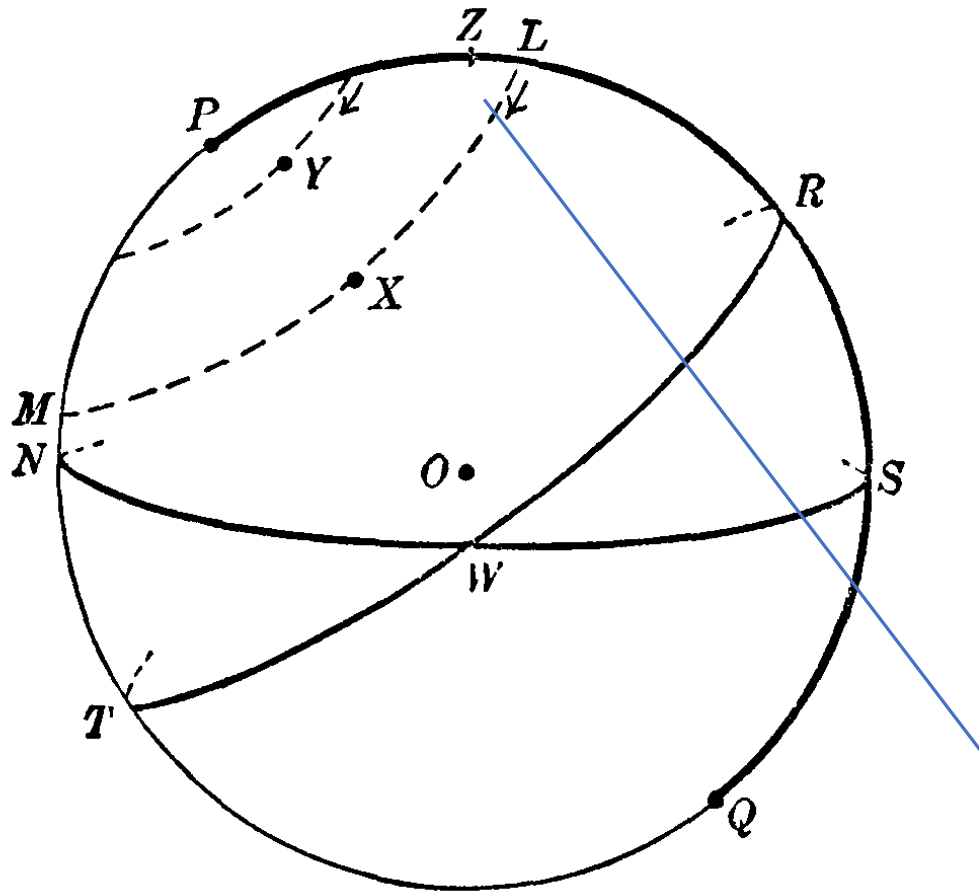
Sidereal Time =  $\text{R.A.}_{\star} + \text{H.A.}_{\star}$

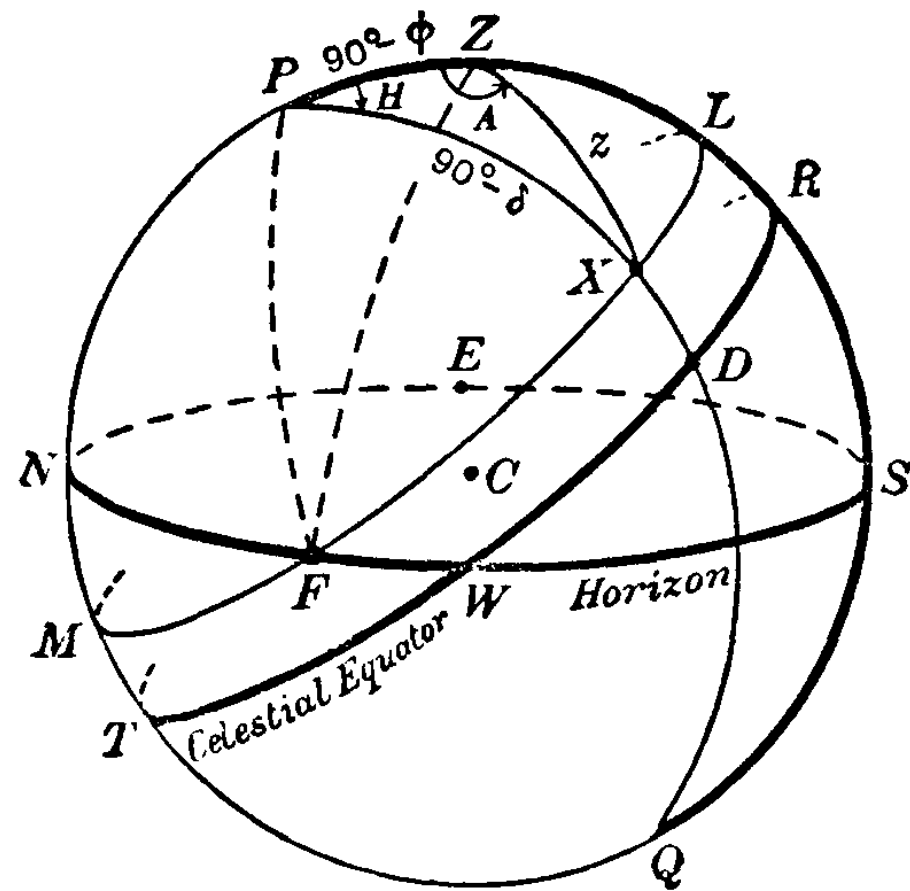


# Right Ascension & Declination

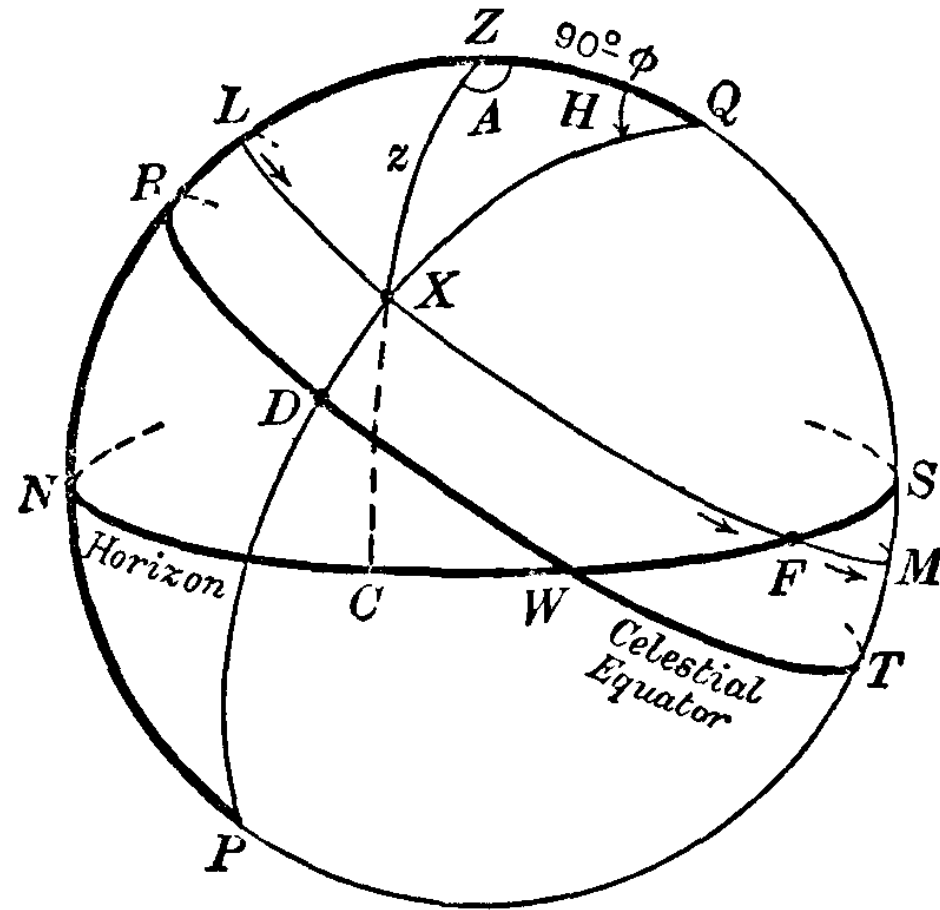


# Circumpolar Stars





# Celestial Sphere for the Southern Hemisphere

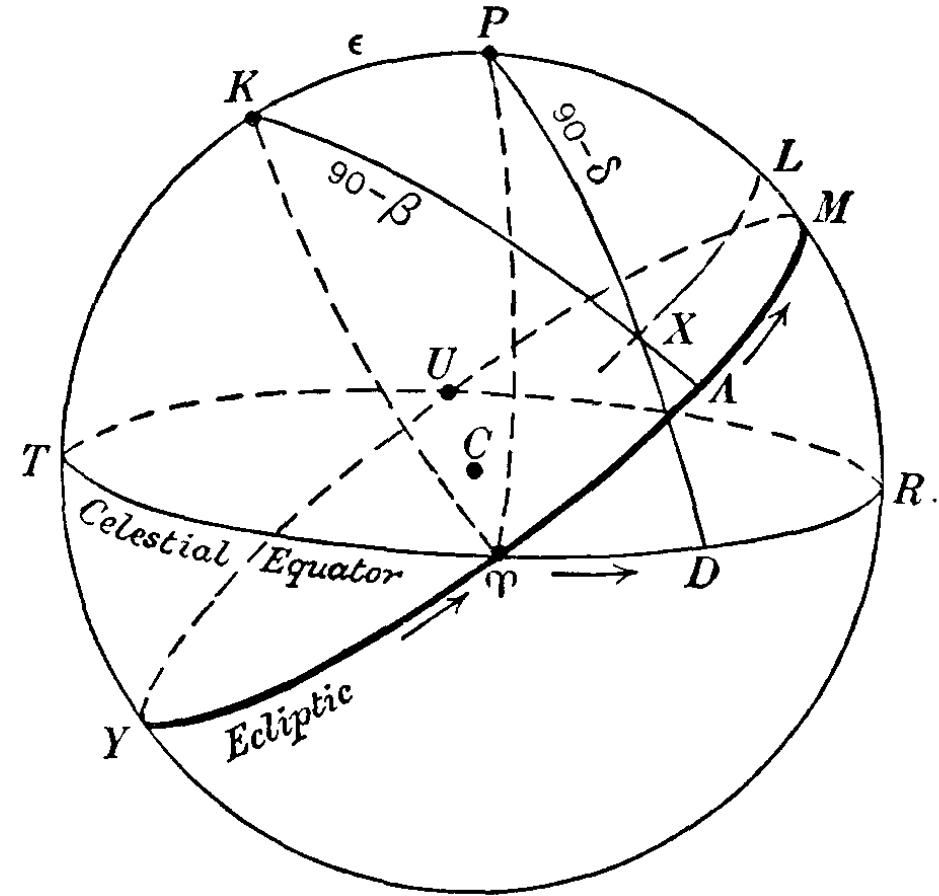




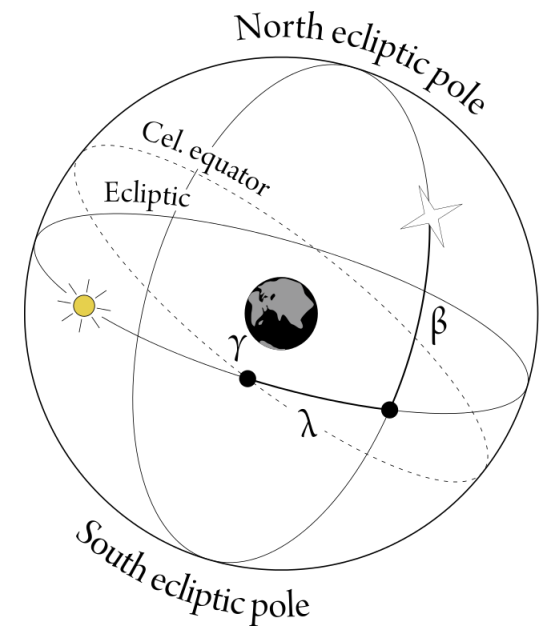
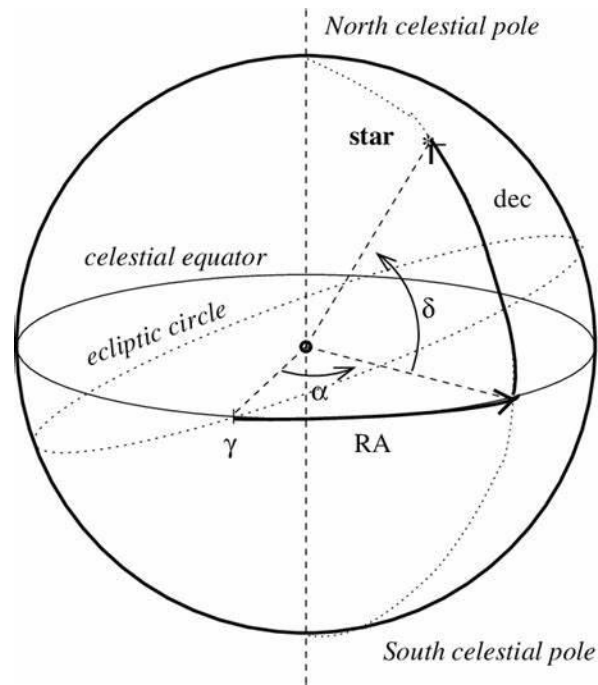
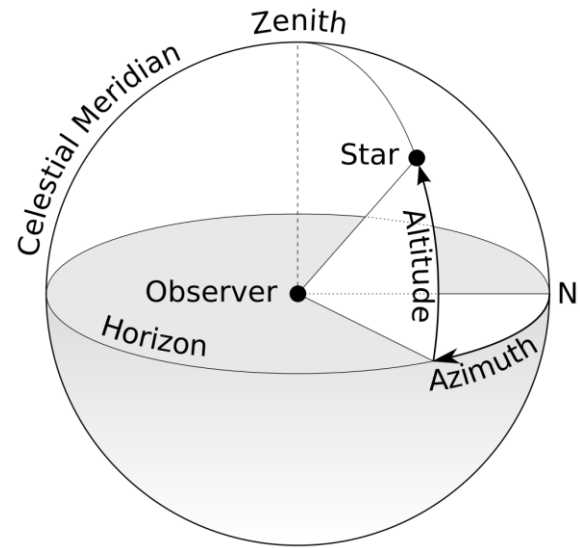
# Ecliptic Coordinates

$\lambda$  Ecliptic Longitude

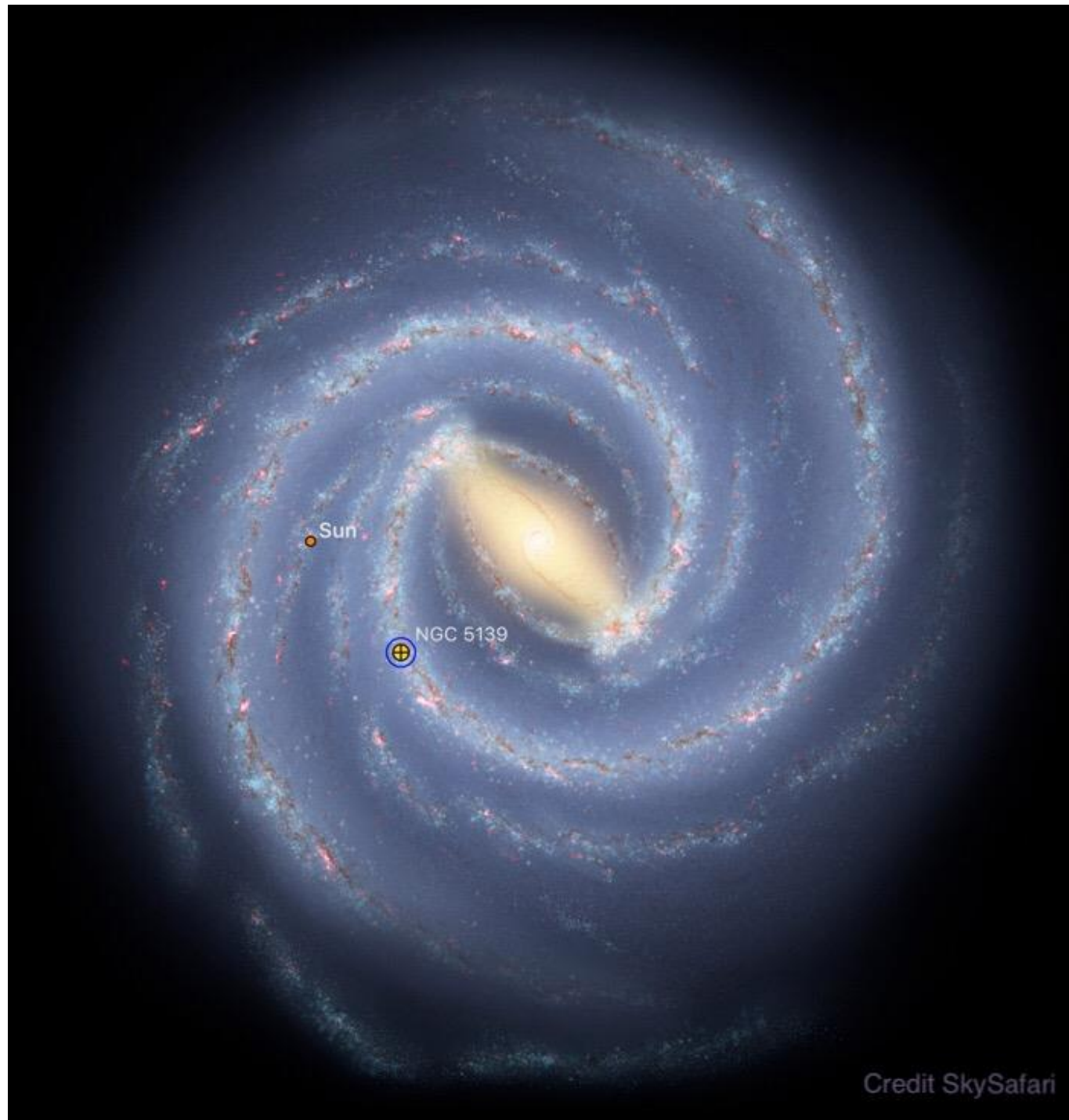
$\beta$  Ecliptic Latitude



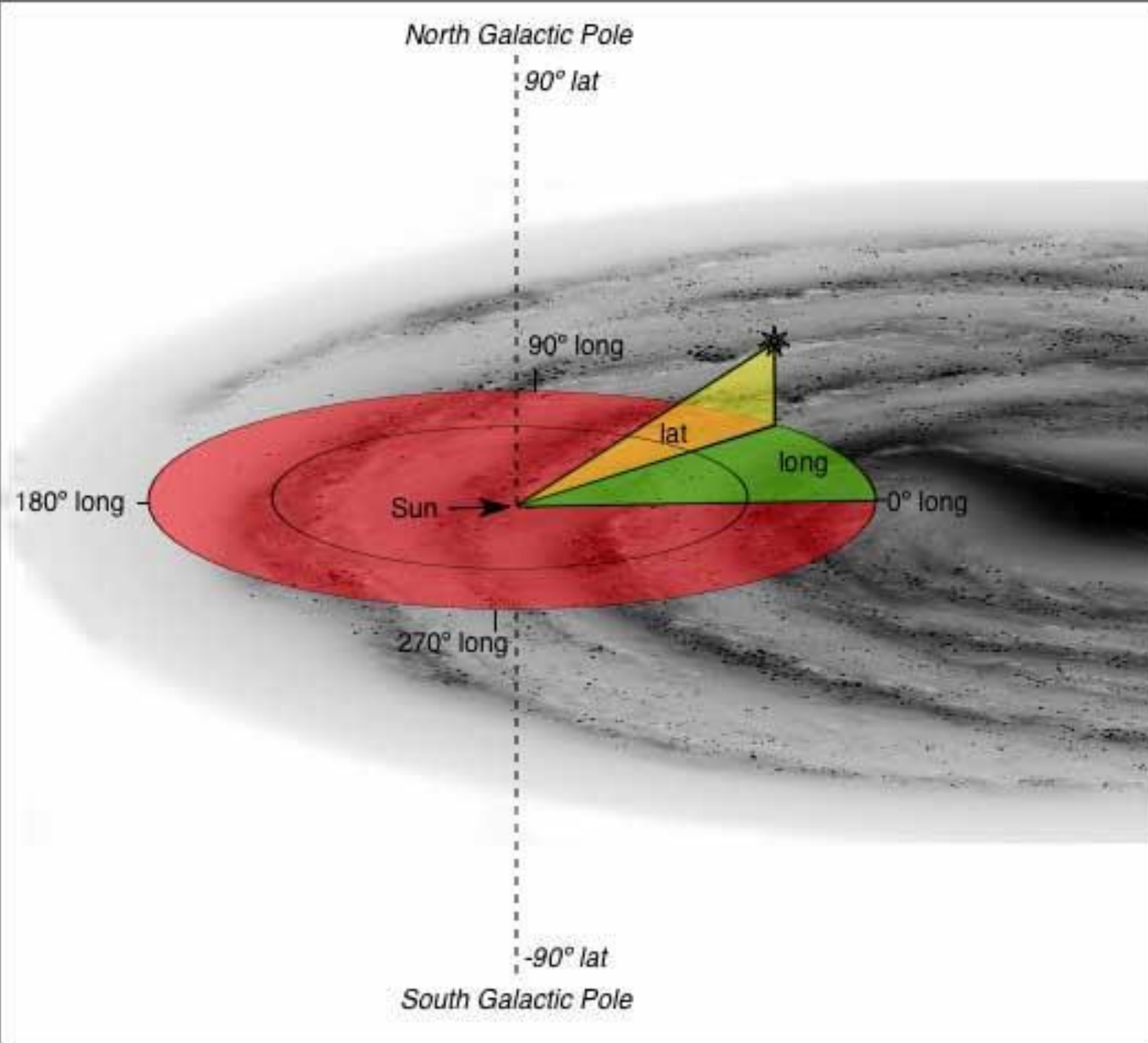
# Coordinate Systems

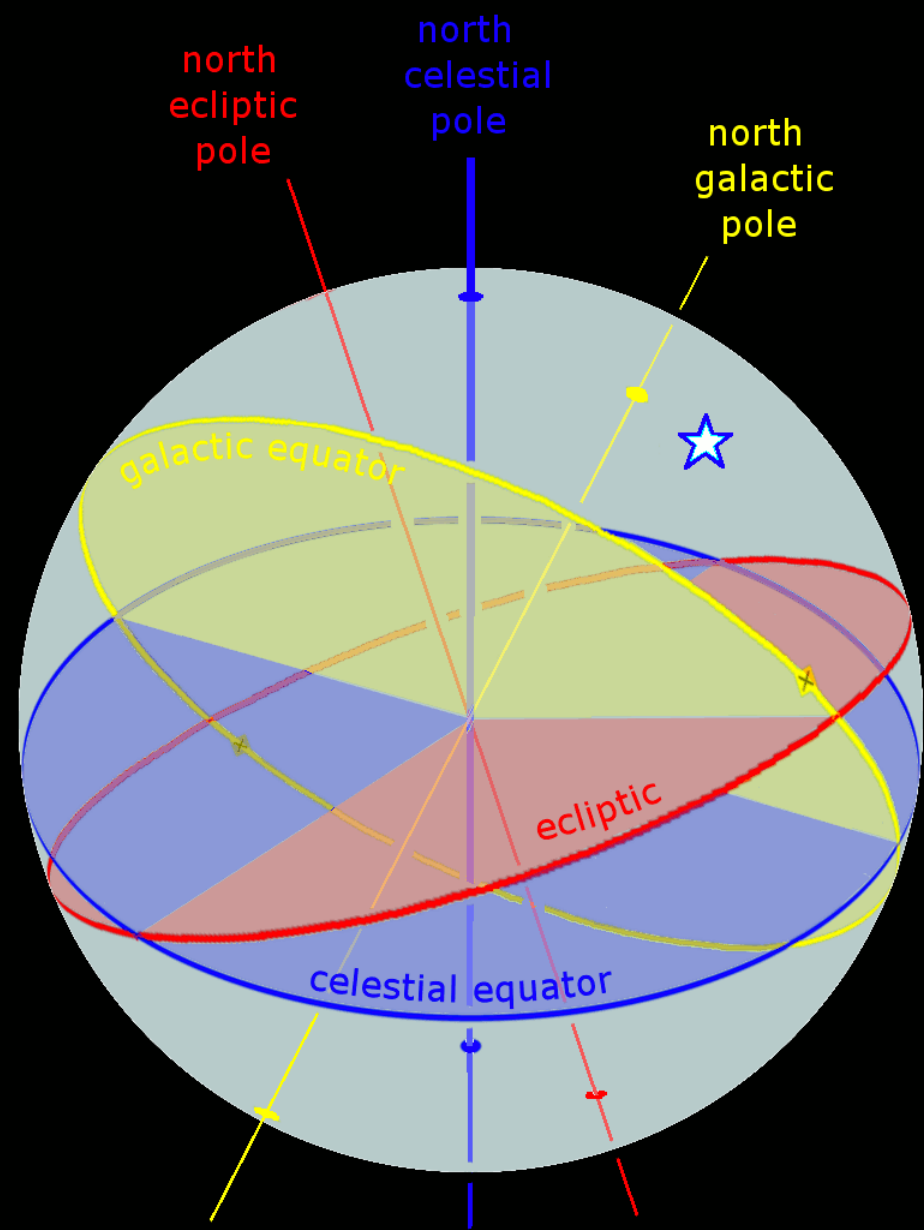


# Milky Way Galaxy



# Galactic Co-ordinates





# Conversion formulae:

$$H = t - \alpha$$

$$\sin(a) = \sin(\delta) \sin(\phi) + \cos(\delta) \cos(\phi) \cos(H)$$

$$\sin(A) = -\sin(H) \cos(\delta) / \cos(a)$$

$$\cos(A) = \{ \sin(\delta) - \sin(\phi) \sin(a) \} / \cos(\phi) \cos(a)$$

$$\sin(\delta) = \sin(a) \sin(\phi) + \cos(a) \cos(\phi) \cos(A)$$

$$\sin(H) = -\sin(A) \cos(a) / \cos(\delta)$$

$$\cos(H) = \{ \sin(a) - \sin(\delta) \sin(\phi) \} / \cos(\delta) \cos(\phi)$$

$$\alpha = t - H$$

where:

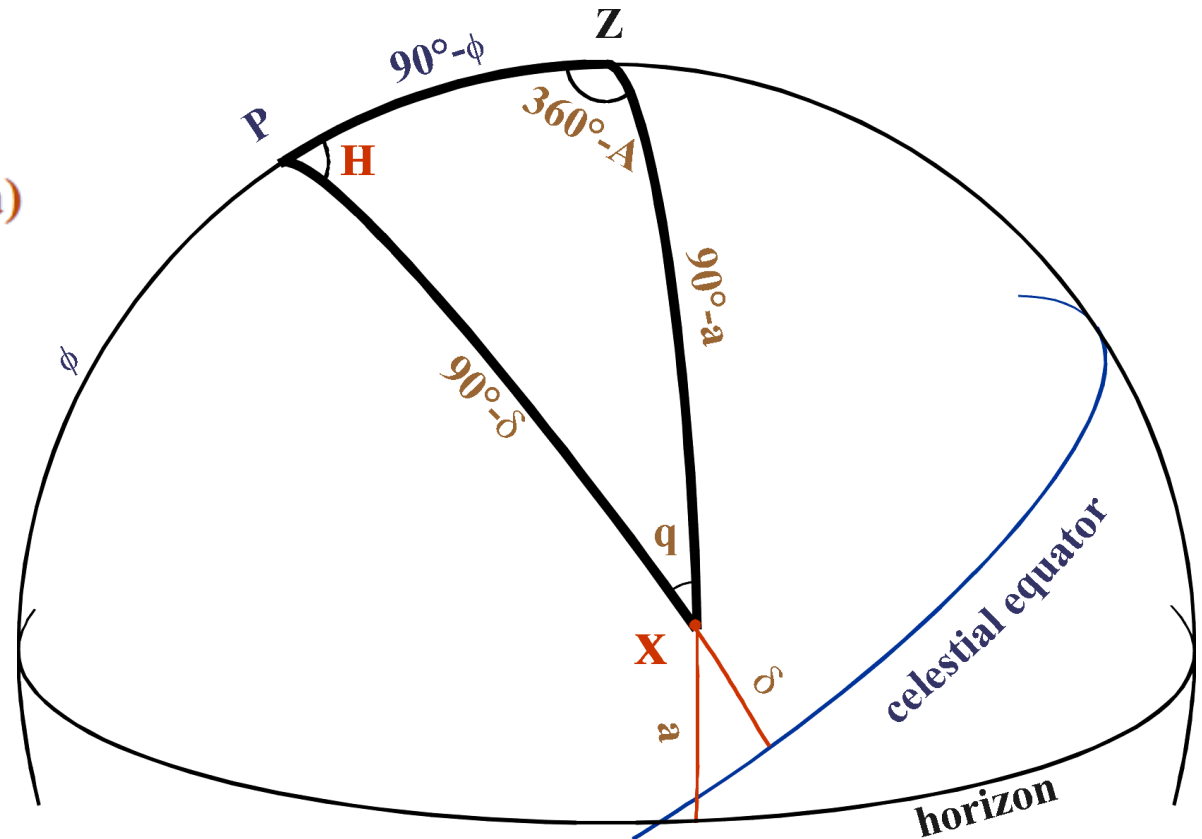
a, d are R.A. and declination

a, A are Altitude and Azimuth

$\phi$  is latitude of the observer

H Hour Angle

t Local Sidereal Time



# NASA/IPAC EXTRAGALACTIC DATABASE

## Coordinate Transformation & Galactic Extinction Calculator

[Help](#) | [Comment](#) | [NED Home](#)

### Input parameters:

System:  Equinox:

Observation epoch:

RA or Longitude:

DEC or Latitude:

PA (East of North):

### Output Parameters:

System:  Equinox:

[Back to NED Home Page](#)

# A relook at Equatorial Coordinates

## Right Ascension and Declination

$\widehat{TD} = \widehat{TOD} = \alpha$  right ascension R.A.

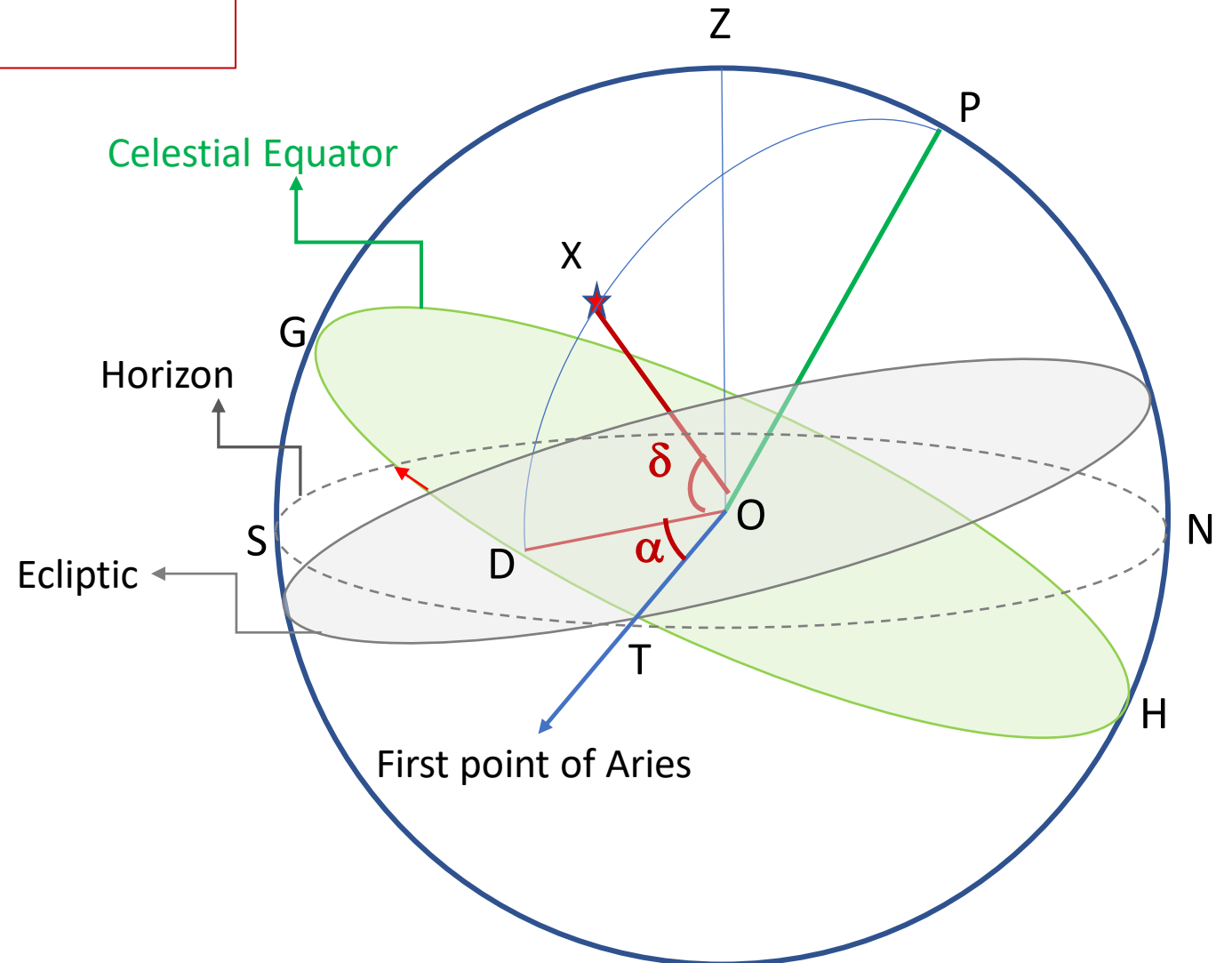
$\widehat{DX} = \widehat{DOX} = \delta$  declination dec.

$(\alpha, \delta)$  Right Ascension & Declination

$\widehat{TD} = \text{R.A.}_{\star}$

$\widehat{DG} = \text{H.A.}_{\star}$  Hour Angle

Sidereal Time =  $\text{R.A.}_{\star} + \text{H.A.}_{\star}$

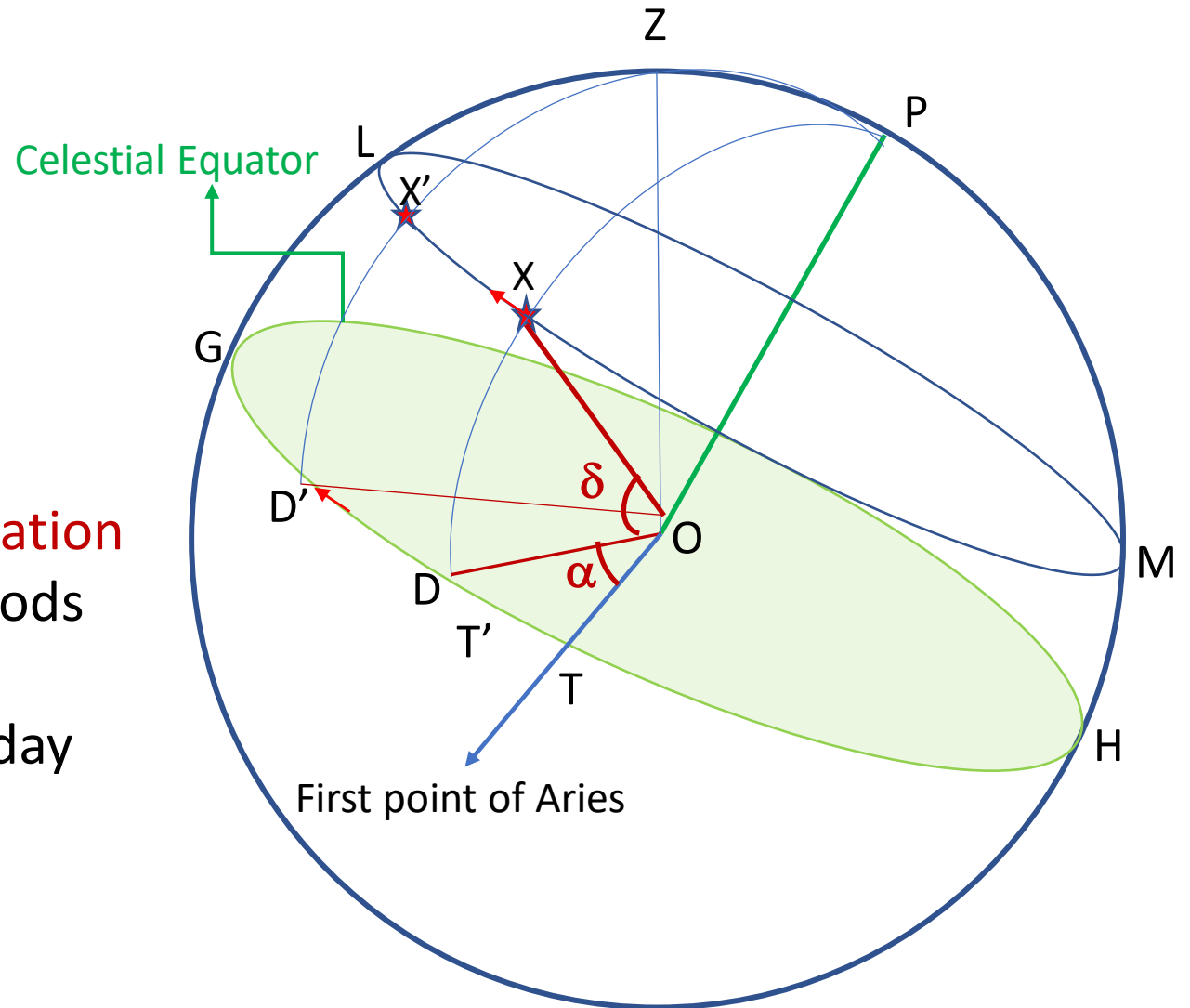




- **Declination** is measured in **degrees**  
(0 to +90° for northern hemisphere  
0 to -90° for southern hemisphere)

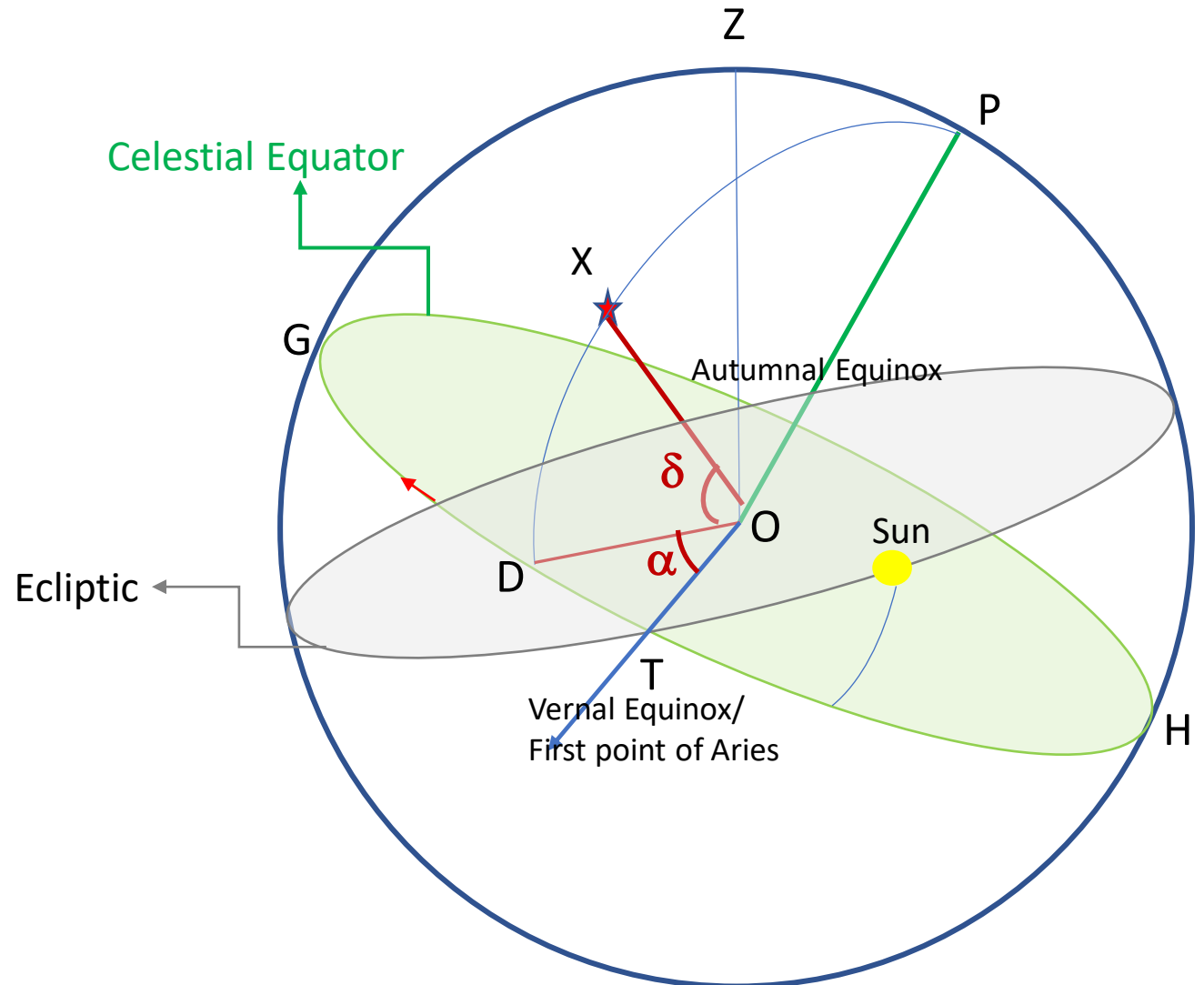
**Right Ascension** is measured in **hours**  
(0 to 24 hours)

- For stars & distant celestial objects **declination** and **R.A.** remains the same over long periods of time  
but the **H.A.** varies from 0 to 24 during a day



Angle between the Ecliptic and the  
Celestial Equator is  $23.5^\circ$

Declination of the Sun varies from  
 $+23.5^\circ$  to  $-23.5^\circ$  over the year



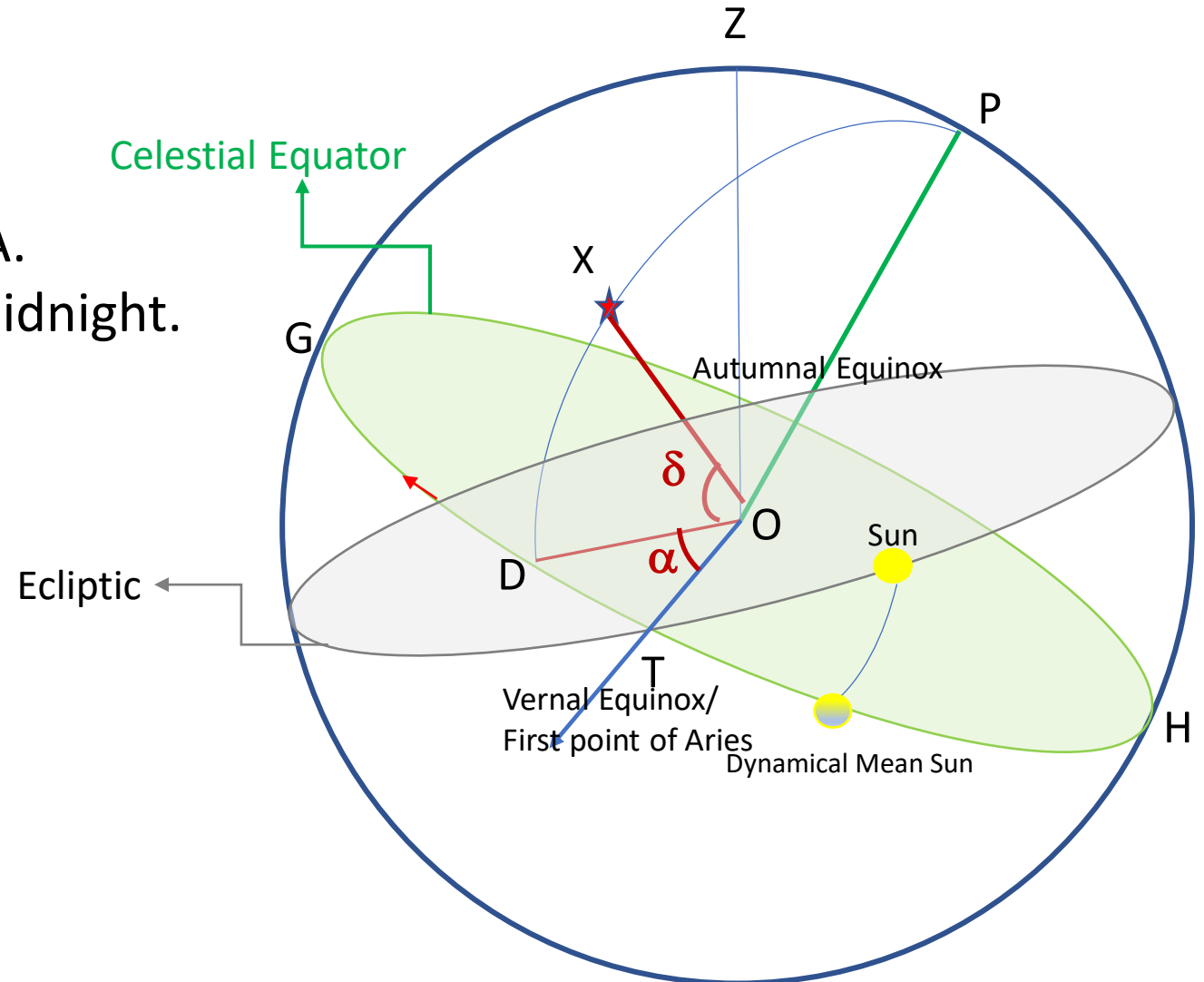
## Time

**Mean Solar Time** – 12 noon when sun is upper culminating

**Local Sidereal Time** – 0 hours when First Point of Aries is upper culminating

## Note:

- Around March 21 Sun is in Vernal F.P.A.  
Hence 12 hour objects culminate at midnight.
- A star rises 4 minutes (Solar time)  
earlier from day to day.



Thank you