Today: Introduction

Coordinate Systems

Transformations

Astrometry

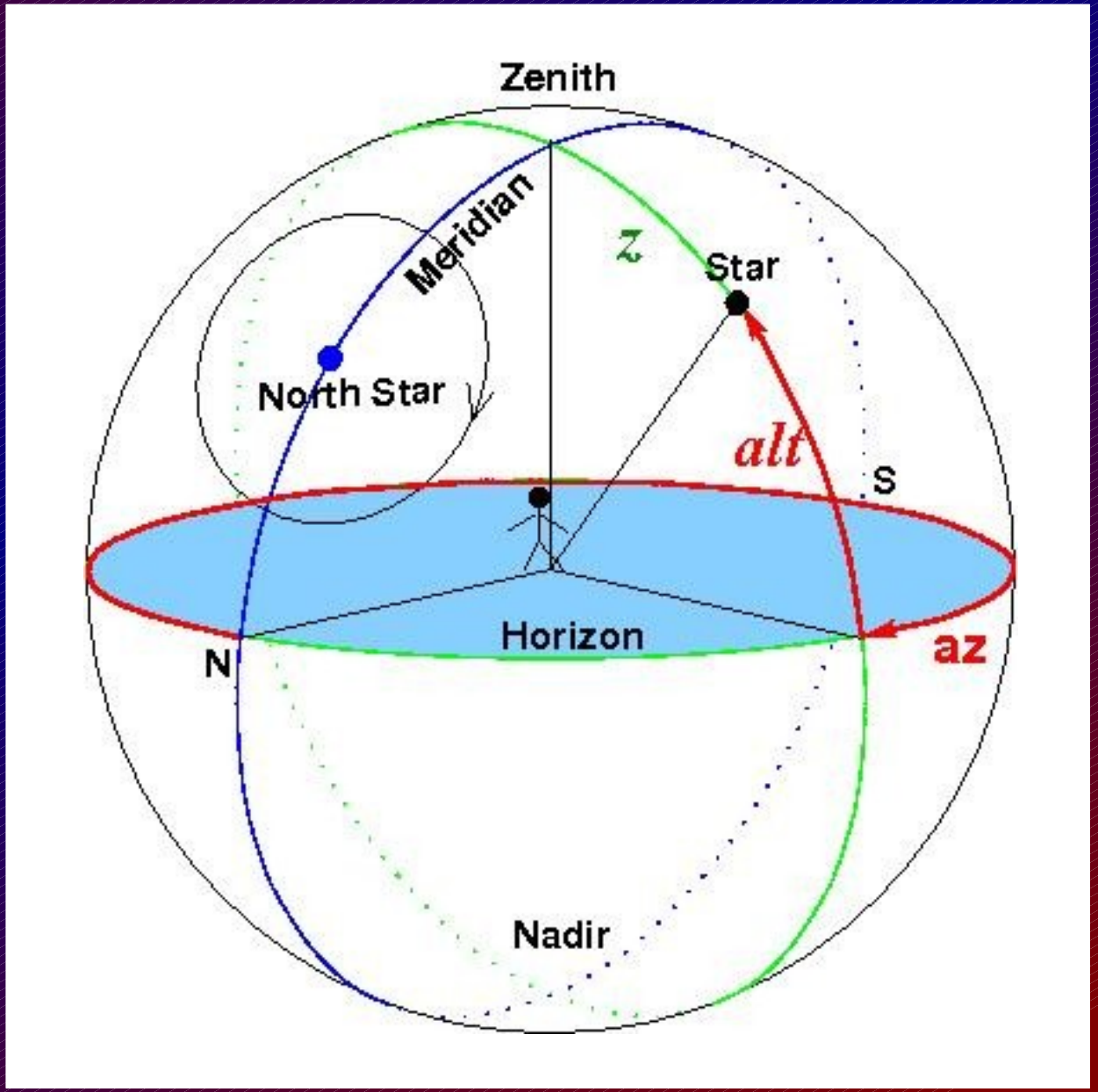
Reading: Ch. 1, 4

Altitude – Azimuth Coordinate System

alt (a) = altitude

az (A) = azimuth

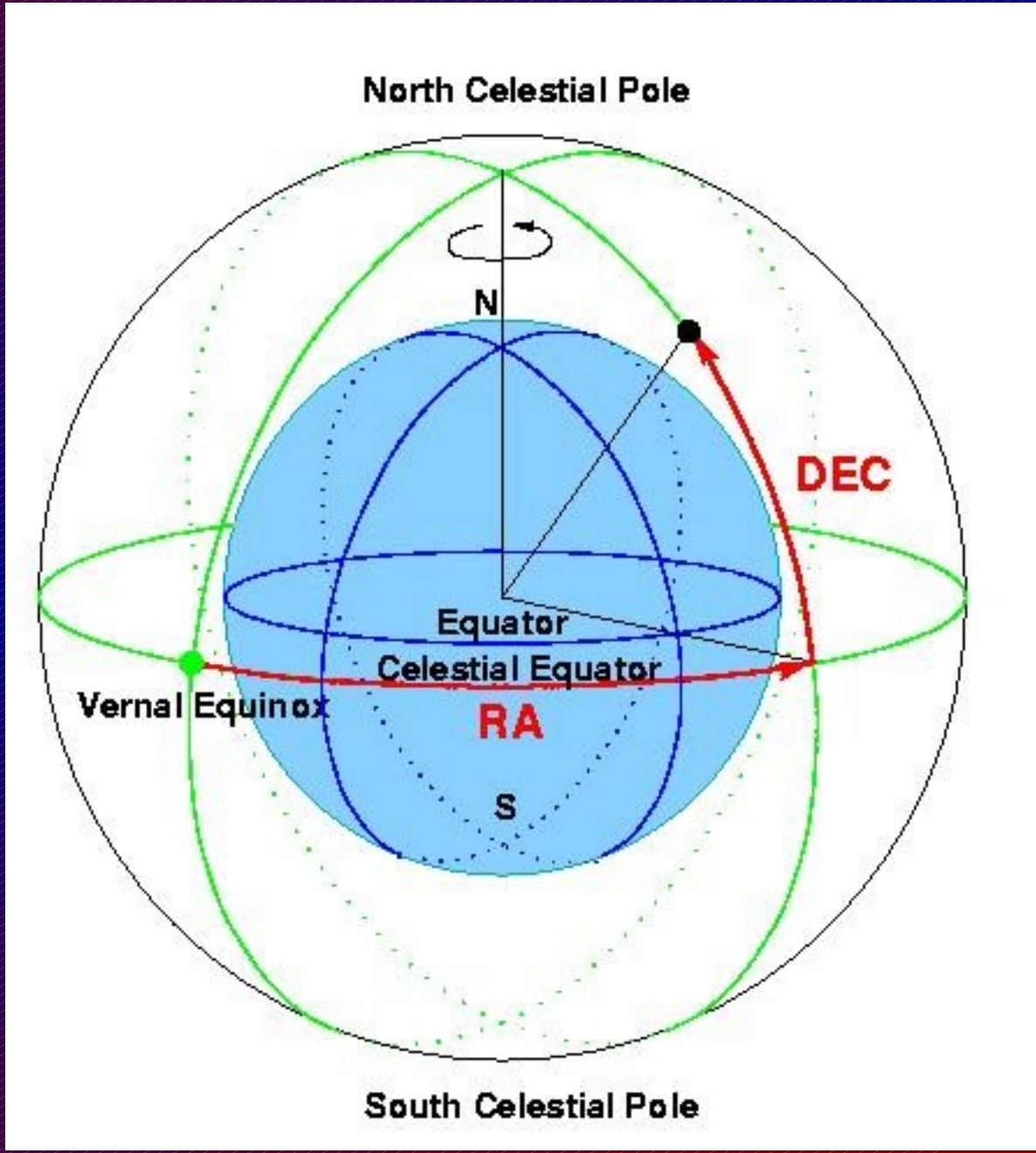
$z = 90^{o} - a$
= zenith distance



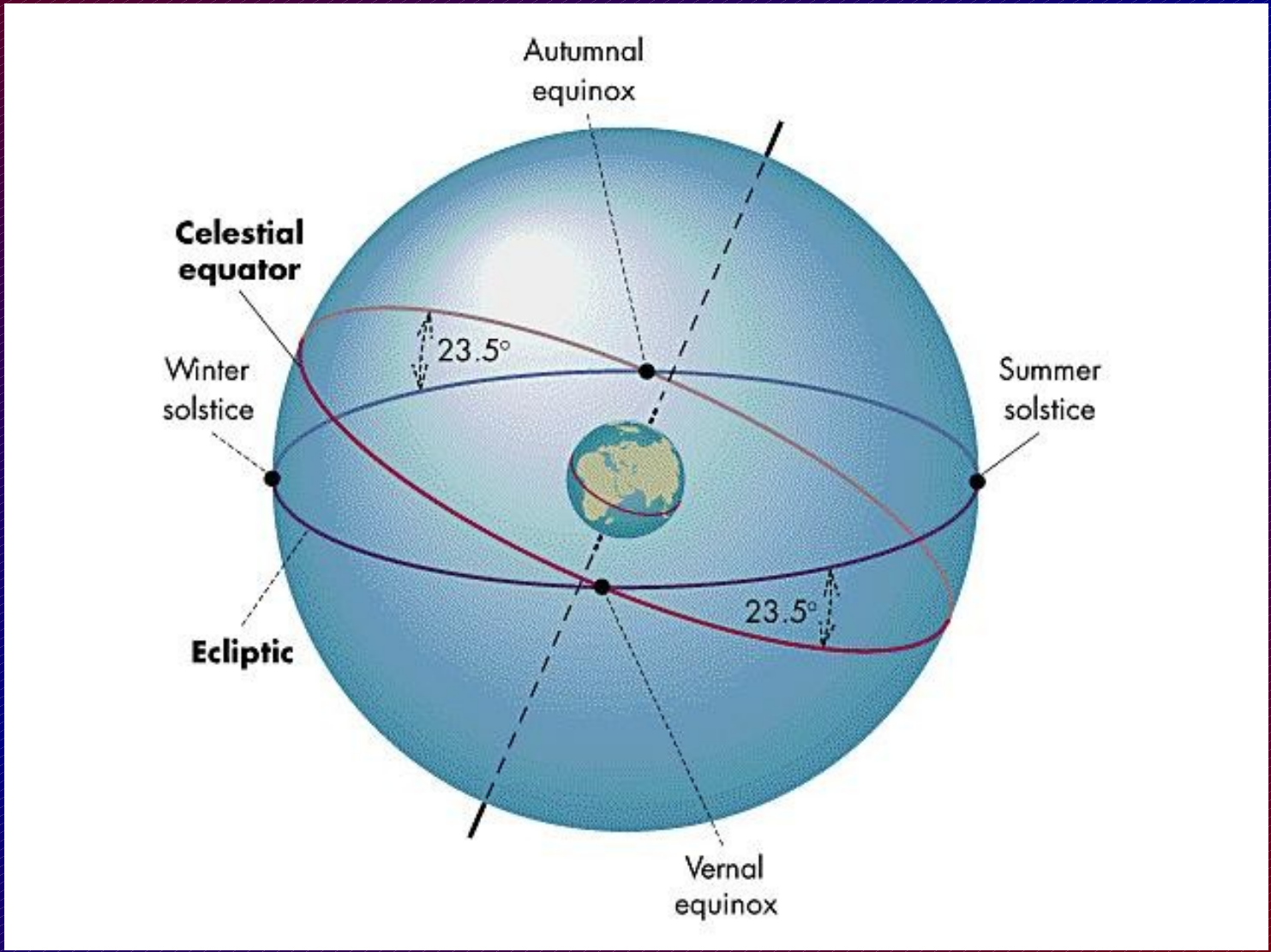
Equatorial Coordinate System

Declination
DEC or δ

Right Ascension
RA or α

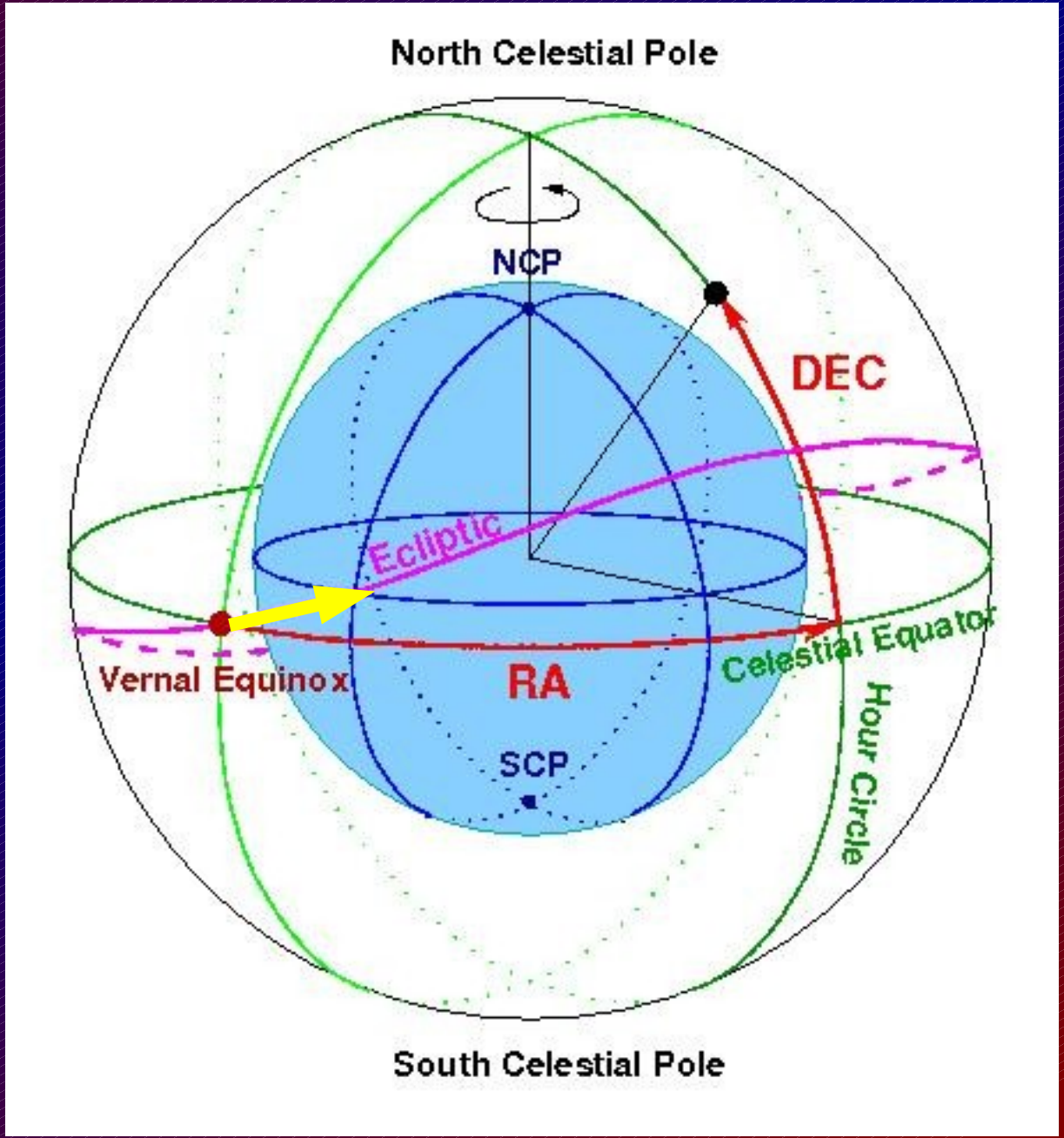


Ecliptic in Equatorial Coordinates

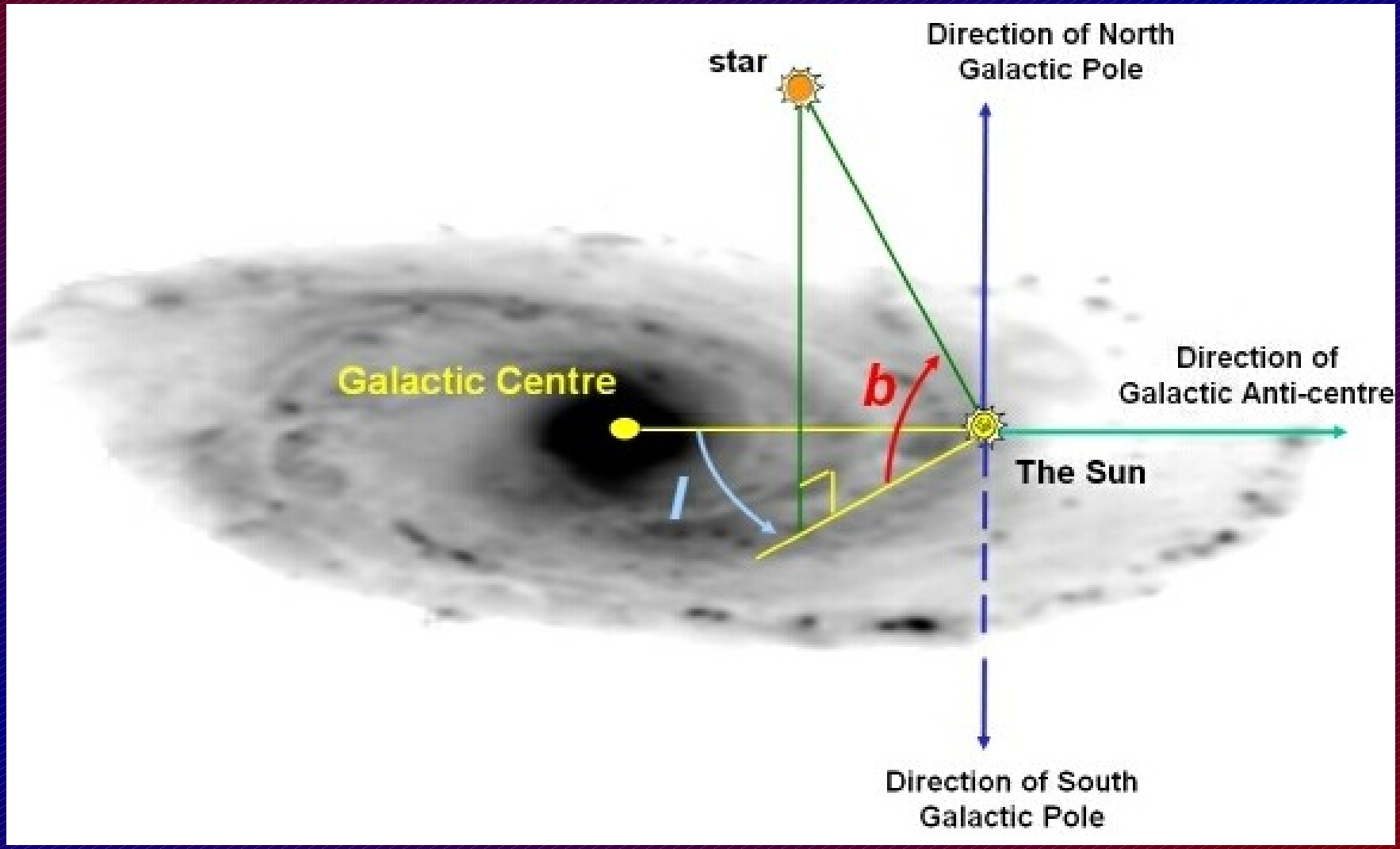


Does Sun move in the direction of increasing or decreasing RA?

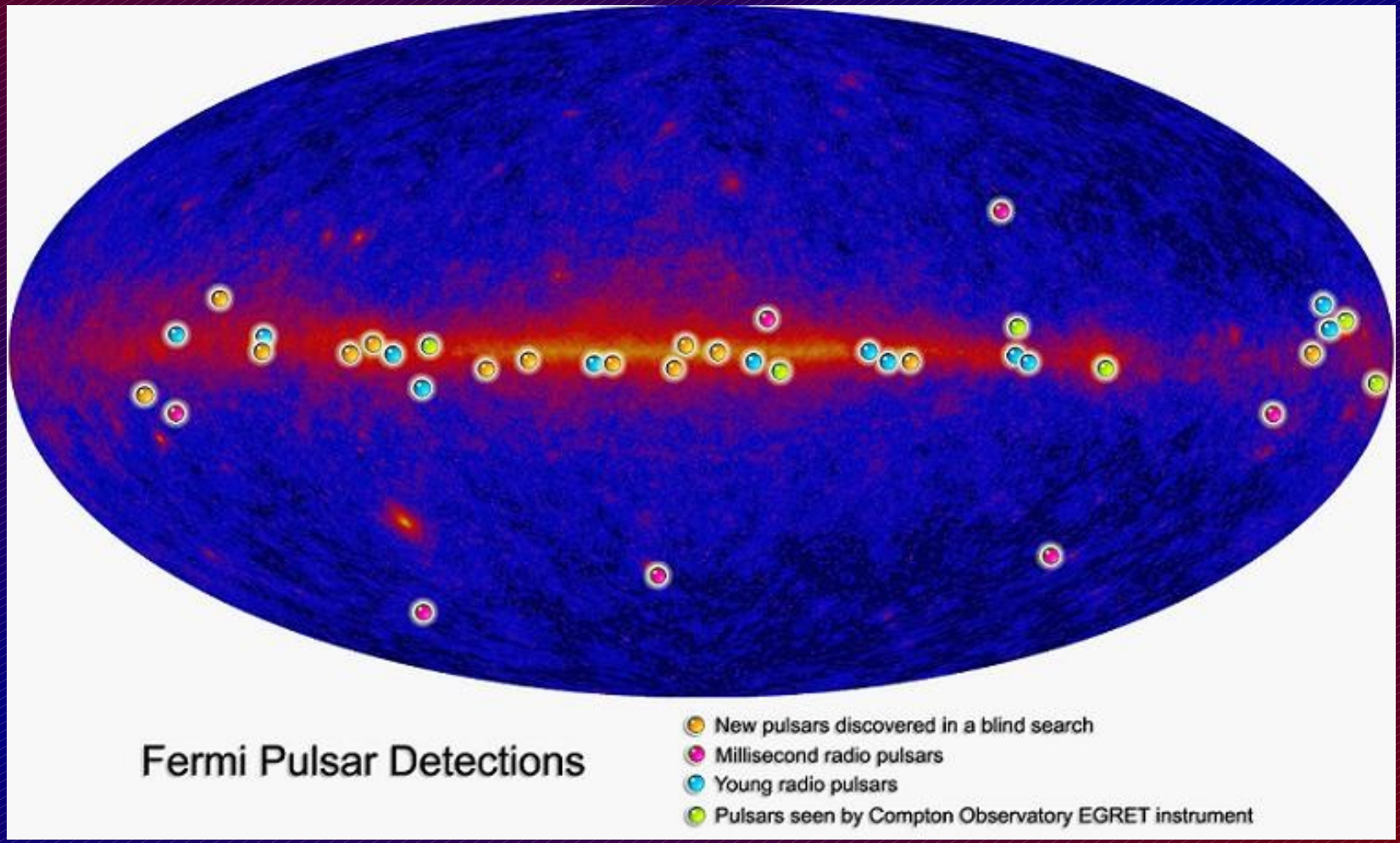
Increasing RA



Galactic Coordinate System



Galactic Coordinate System

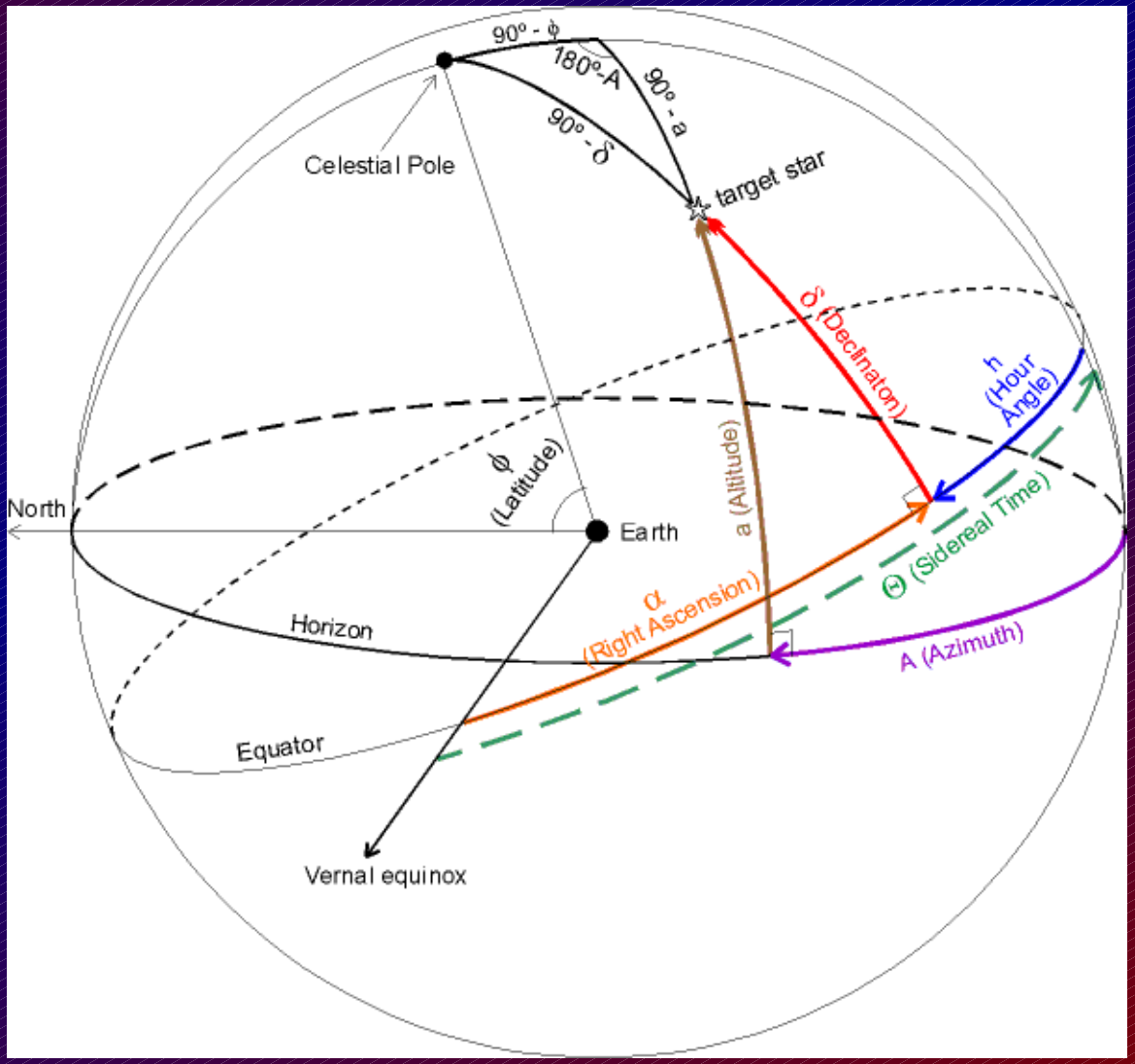


Hour Angle (HA) is measured westward from the observer's Meridian. It is analogous to RA.

HA = 0 on the meridian

HA < 0 E of meridian

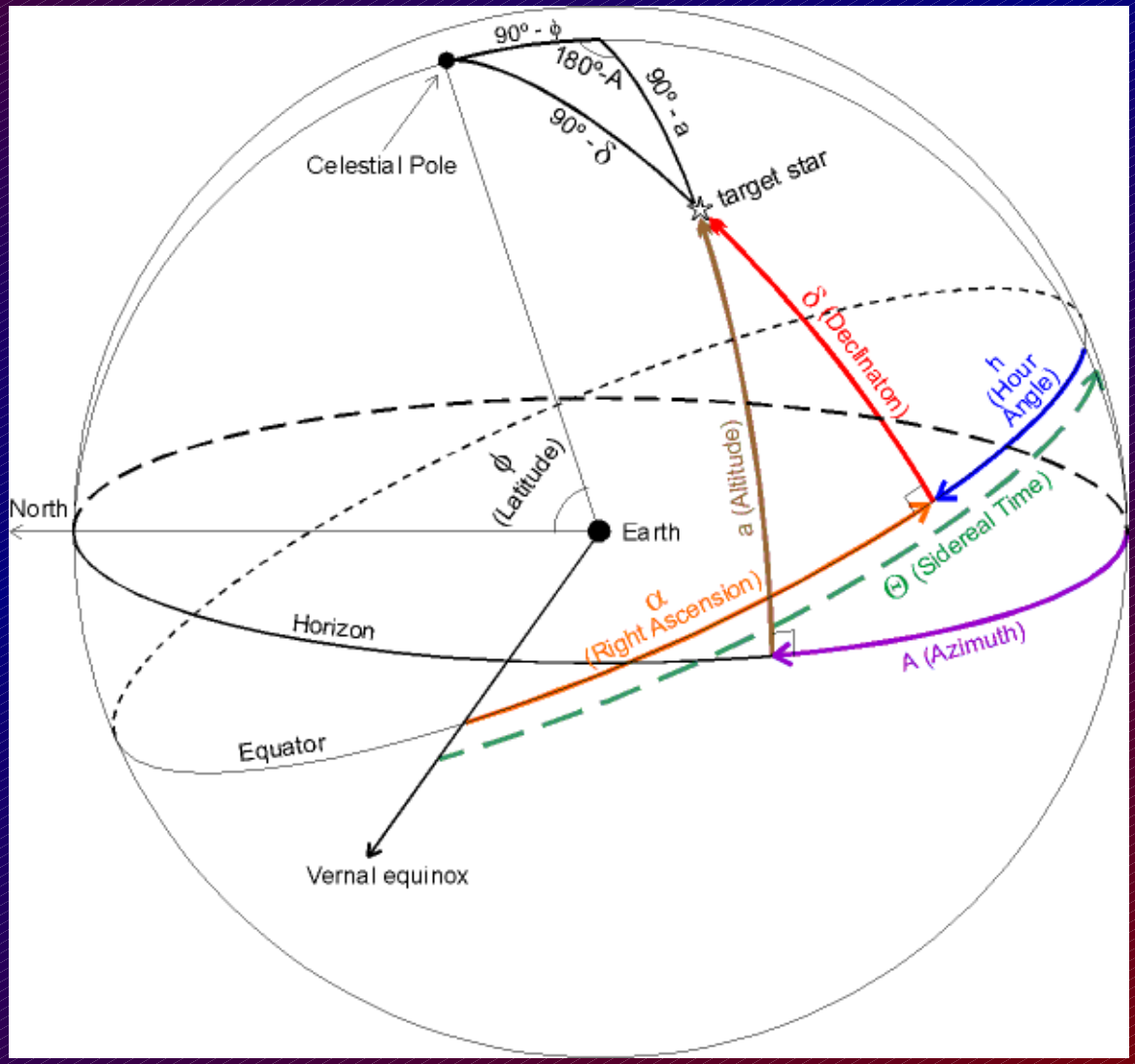
HA > 0 W of meridian



Horizon to Equatorial Coordinate Transformation

Equivalent to a rotation by angle $(90^o - \phi)$.

ϕ = latitude of observer



Ecliptic to Equatorial Coordinate Transformation

$$\cos DEC \cdot \sin HA = \cos alt \cdot \sin az$$

1. (alt, az) to (HA, DEC)

$$\cos DEC \cdot \cos HA = \cos\phi \cdot \sin alt + \sin\phi \cdot \cos alt \cdot \cos az$$

$$\sin DEC = \sin\phi \cdot \sin alt + \cos\phi \cdot \cos alt \cdot \cos az$$

2. (HA, DEC) to (alt, az)

$$\cos alt \cdot \cos az = -\cos\phi \cdot \sin DEC + \sin\phi \cdot \cos DEC \cdot \cos HA$$

$$\sin alt = \sin\phi \cdot \sin DEC + \cos\phi \cdot \cos DEC \cdot \cos HA$$

Galactic to Equatorial Coordinate Transformation

$$\cos b \cdot \cos(l - 33^o) = \cos DEC \cdot \cos(RA - 282.25^o)$$

1. (l, b) to (RA, DEC)

$$\cos DEC \cdot \sin(RA - 282.25^o) = \cos b \cdot \sin(l - 33^o) \cdot \cos 62.6^o - \sin b \cdot \sin 62.6^o$$

$$\sin DEC = \cos b \cdot \sin(l - 33^o) \cdot \sin 62.6^o + \sin b \cdot \cos 62.6^o$$

2. (RA, DEC) to (l, b)

$$\cos b \sin(l - 33^o) = \cos DEC \cdot \sin(RA - 282.5^o) \cdot \cos 62.6^o + \sin DEC \cdot \sin 62.6^o$$

$$\sin b = \sin DEC \cdot \cos 62.6^o - \cos DEC \cdot \sin(RA - 282.5^o) \cdot \sin 62.6^o$$

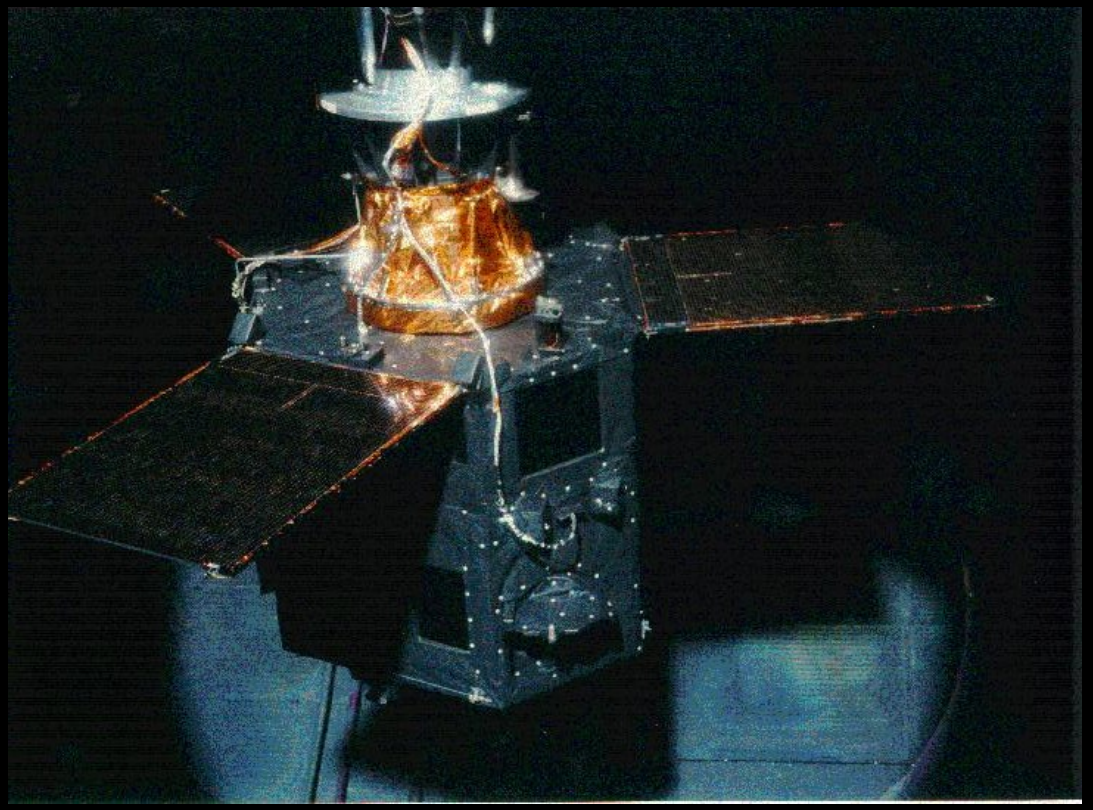
Hipparcos Space Astrometry Mission

Launch: August 1989
Terminated: August 1993

Hipparcos Catalog (1996):
120,000 stars
1 milliarcsec

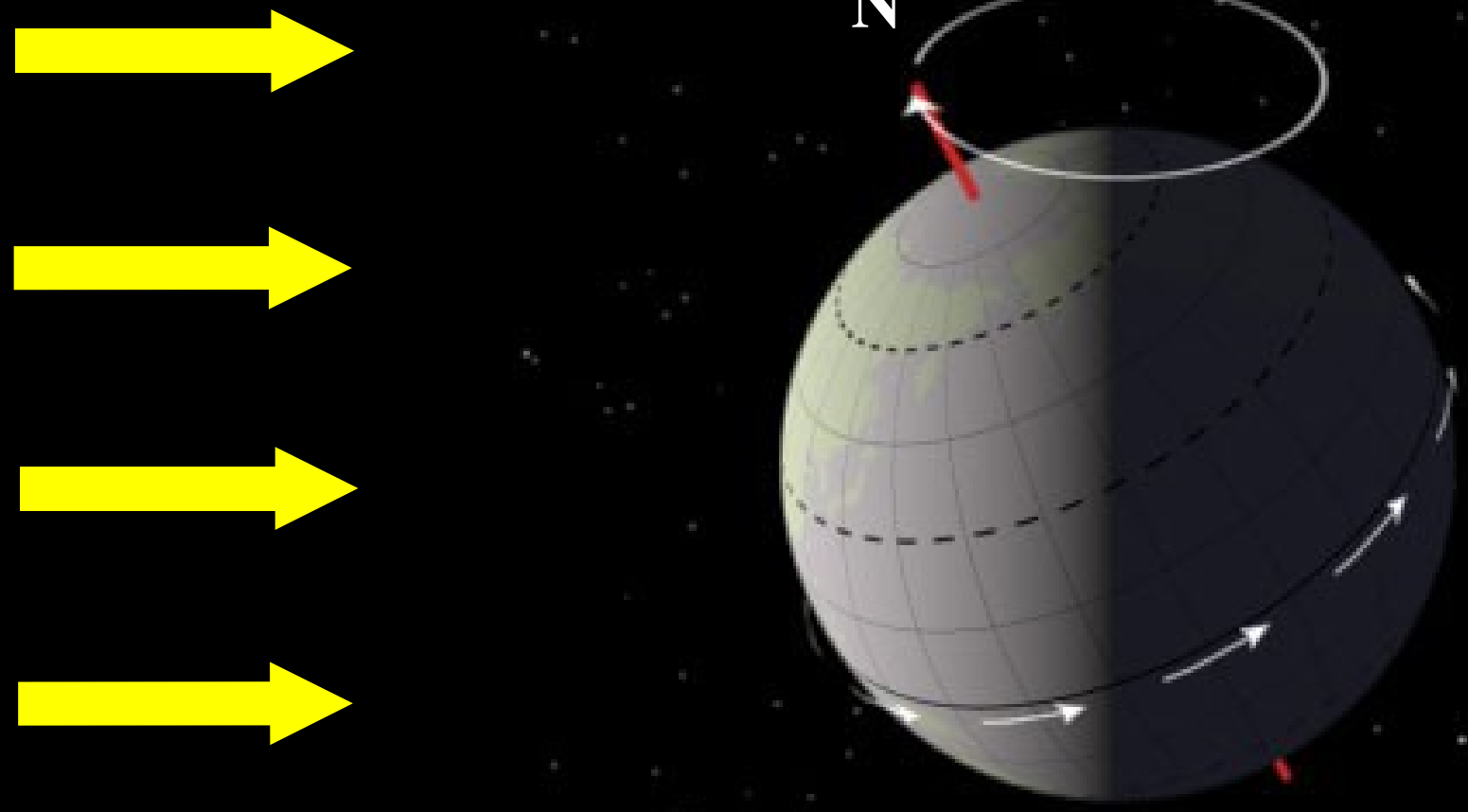
Tycho Catalog (1996):
1 million stars
20-30 milliarcsec
2 colors

Tycho-2 Catalog (2000):
2.5 million stars
2 colors



Precession

Sun



Period = 25,750 years

Correcting for Precession

$$\alpha = \alpha_0 + T\,\theta\,(\cos\epsilon + \sin\epsilon \sin\alpha_0 \tan\delta_0)$$

$$\delta = \delta_0 + T\,\theta \sin\epsilon \cos\alpha_0$$

(α_0, δ_0) are coordinates at some epoch E
(α, δ) are coordinates at epoch $E_0 + T$
T is measured in years
$\theta = 50.29'' \text{ yr}^{-1}$ is the precession rate
$\varepsilon = 23^\circ 27' 8''$ is the obliquity of the ecliptic

Atmospheric Refraction

Shift is less than 1" if $z<60^{o}$