ASTC02 - LECTURE 2 - PROF. HANNO REIN

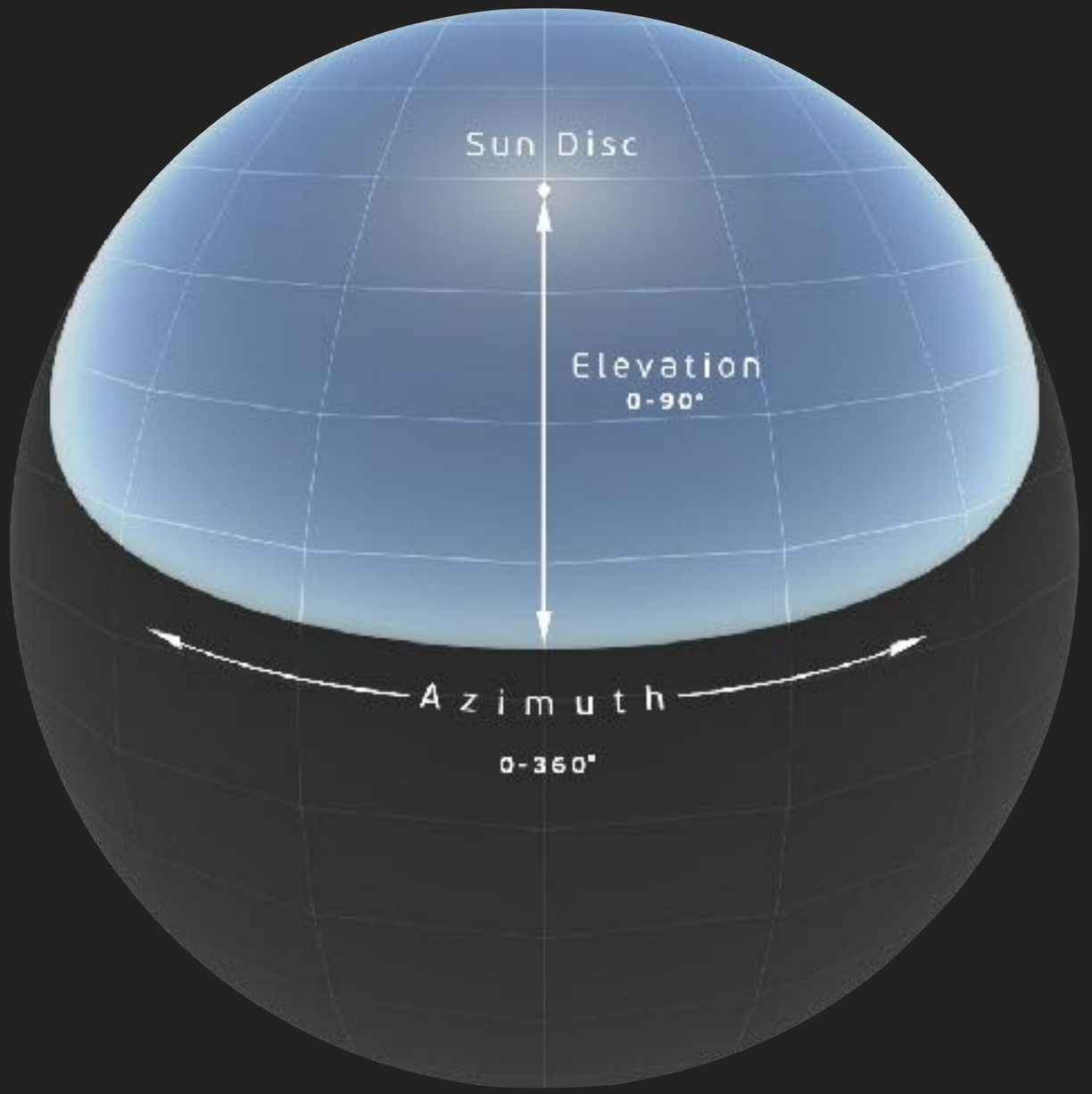
COORDINATE SYSTEMS

CELESTIAL COORDINATE SYSTEMS

- Need a way to specify the location of celestial objects
- Can be in 3D or in 2D
- Different coordinate systems exist for different purposes
- Spherical / cartesian, different origins, different orientation
- Can convert between them

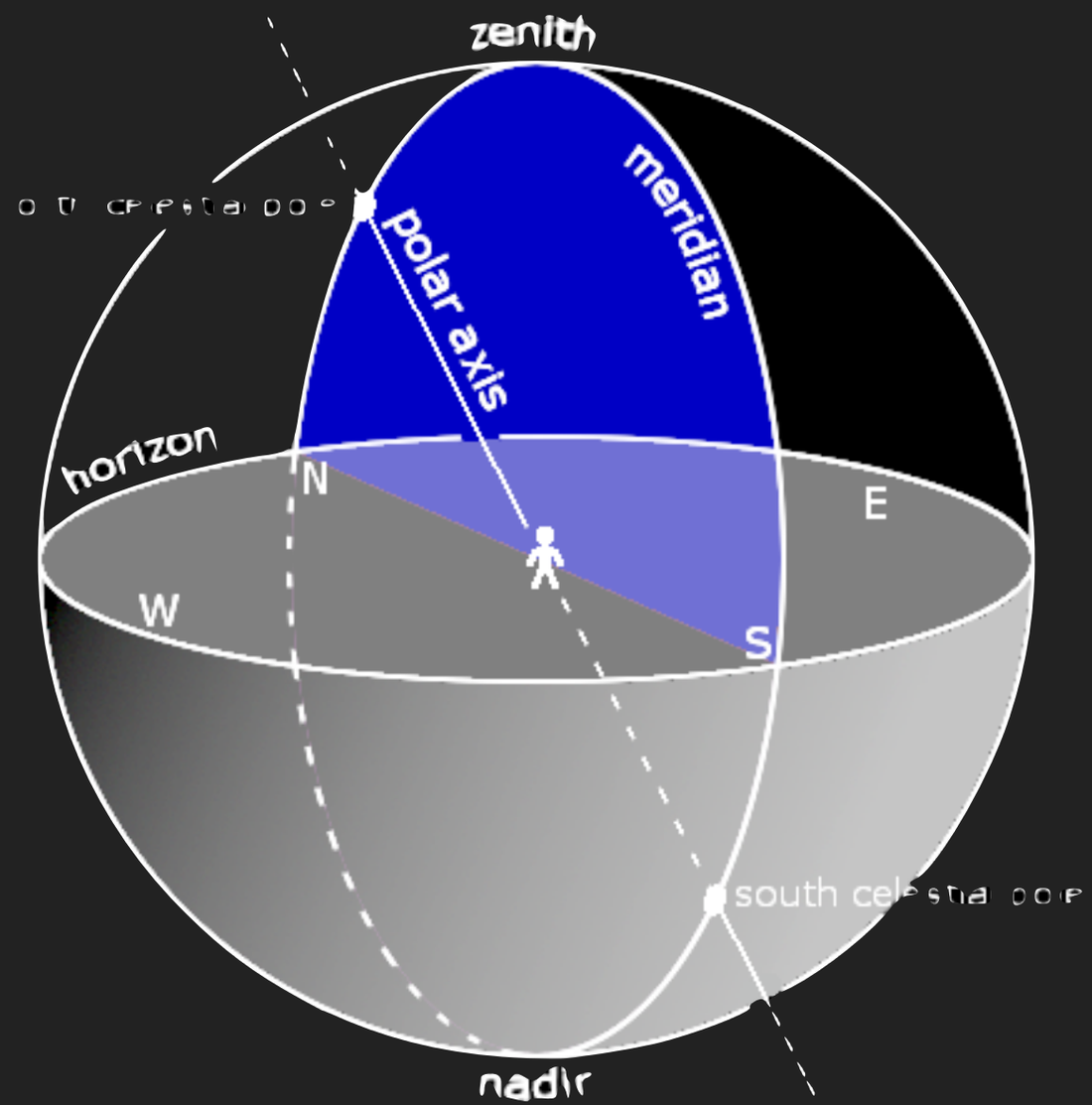
HORIZONTAL COORDINATE SYSTEM

- Local observer's horizon is the fundamental plane
- Altitude (alt) / Azimuth (az)
- Azimuth measured from north, increasing towards east
- Altitude from horizon upwards



HORIZONTAL COORDINATE SYSTEM

- Meridian is the line from North to the Zenith to South
- Azimuth 0 and 180



HORIZONTAL COORDINATE SYSTEM PROS

- Know exactly where to look

HORIZONTAL COORDINATE SYSTEM CONS

- Depends on time and location

EQUATORIAL COORDINATE SYSTEM

- Fundamental plane is the Earth's equator
- primary direction towards the vernal (spring) equinox
- Declination (dec) / Right Ascension (ra)

EQUATORIAL COORDINATE SYSTEM PROS

- Fixed stars have fixed coordinates
- Coordinates do not depend on time or date

EQUATORIAL COORDINATE SYSTEM CONS

- Harder to find objects for observers

ANGLES IN ASTRONOMY

- Both coordinate systems use angles
- Multiple way to specify angles:
  - Degrees 0° - 360°
  - Radians 0 - 2π
  - Hours 0h - 24h

DEGREES

- 1 full circle = 360°
- 1 degree = 60 arc minute = 60′
- 1′ = 60 arc seconds = 60″
- 1″ = 1000 milli arc seconds = 1000 mas
- 1 mas = 1000 micro arc seconds = 1000 μas

DEGREES

- Full moon
- 0.52 degrees
- GAIA
- 20 microarcseconds (μas)
- Factor of 100 000 000!

Venus

Type: planet
Magnitude: -4.03 (extincted to: -3.76)
Absolute Magnitude: 27.33
RA/Dec (J2000.0): 5h28m23.11s/+21°20'31.4"
RA/Dec (J2017.6): 5h29m26.19s/+21°21'18.9"
Hour angle/DE: 19h21m41.41s/+21°22'26.5" (apparent)
Az/Alt: +87°25'20.8"/+29°07'24.5" (apparent)
Ecliptic longitude/latitude (J2000.0): +82°38'14.4"/-1°53'43.7"
Ecliptic longitude/latitude (J2017.6): +82°52'57.5"/-1°53'35.5"
Galactic longitude/latitude: -175°38'54.7"/-7°20'58.3"
Obliquity (of date, for Earth): +23°26'13.2"
Distance: 1.101AU (164.681 Mio km)
Apparent diameter: +0°00'15.2"
Sidereal period: 224.70 days (0.615 a)
Sidereal day: 5832h28m47.1s
Mean solar day: 2802h0m52.2s
Phase Angle: +63°45'25"
Elongation: +39°49'08"
Phase: 0.72
Illuminated: 72.1%

Venus

N

Sun

E

Earth, Toronto, 0m FOV 140° 30 FPS 2017-07-25 05:55:30 UTC-04:00

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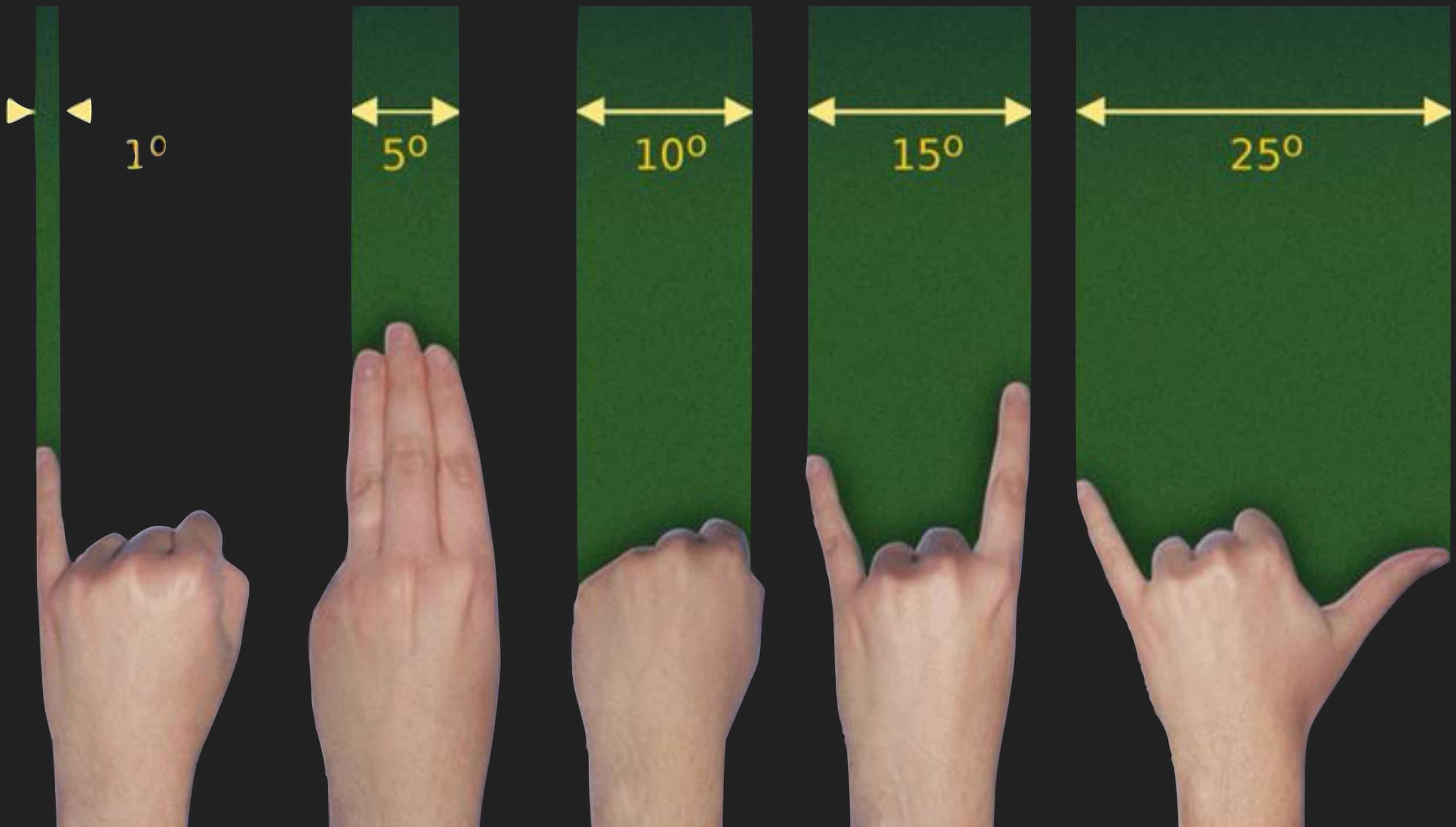
DEGREES, MEASURED BY HAND



HOURS

- 1 full circle = 24h
- 1h = 60 minutes = 60 m
- 1m = 60 seconds = 60 s

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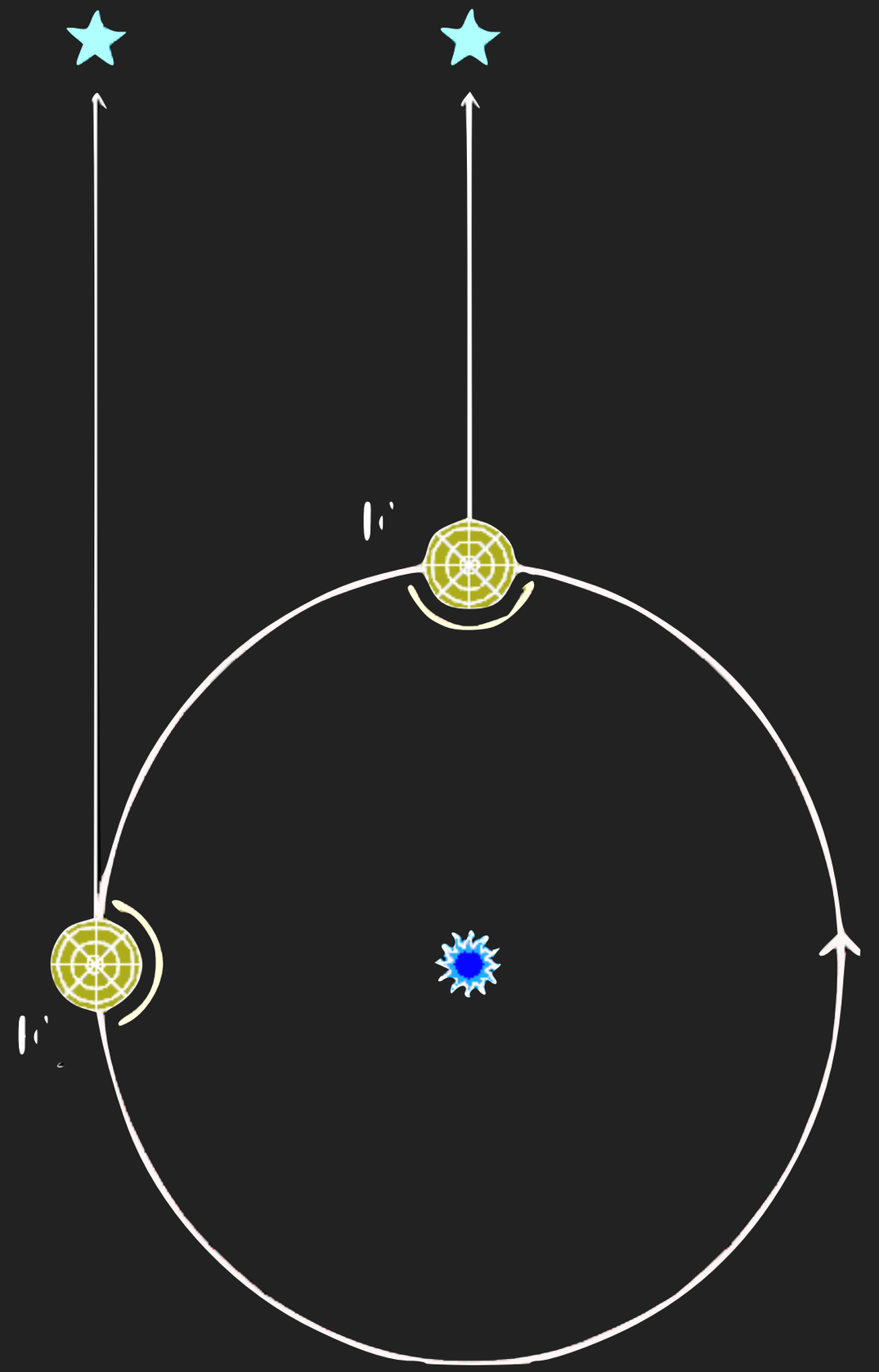
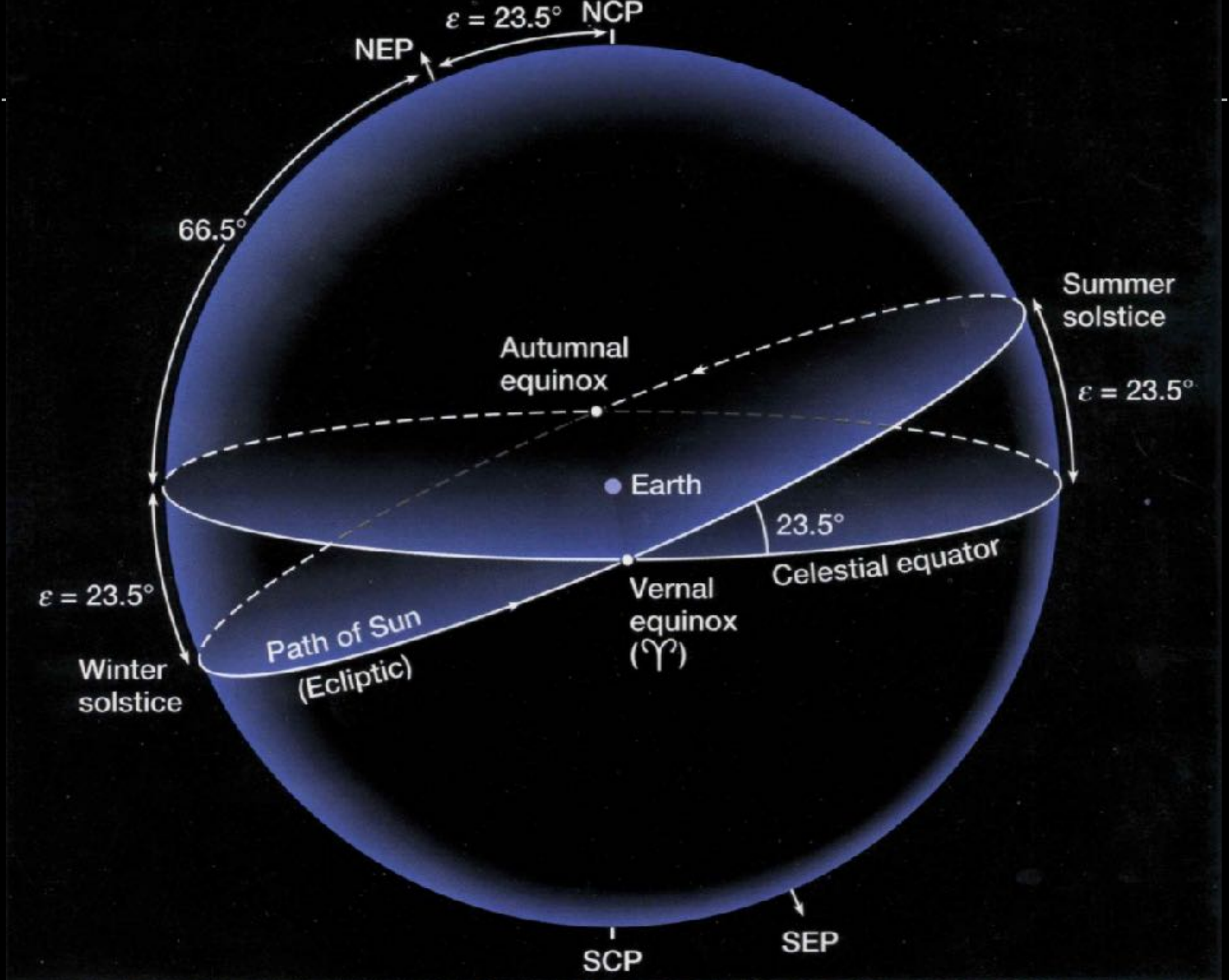
CONVERSION BETWEEN COORDINATE SYSTEMS

- Not difficult, just two rotations
- Do not remember formula, but do look at it and try to understand it
- To go between RA/DEC and AZ/ALT one also needs
  - Time
  - Location
- How to specify time? Sidereal time

SIDEREAL TIME

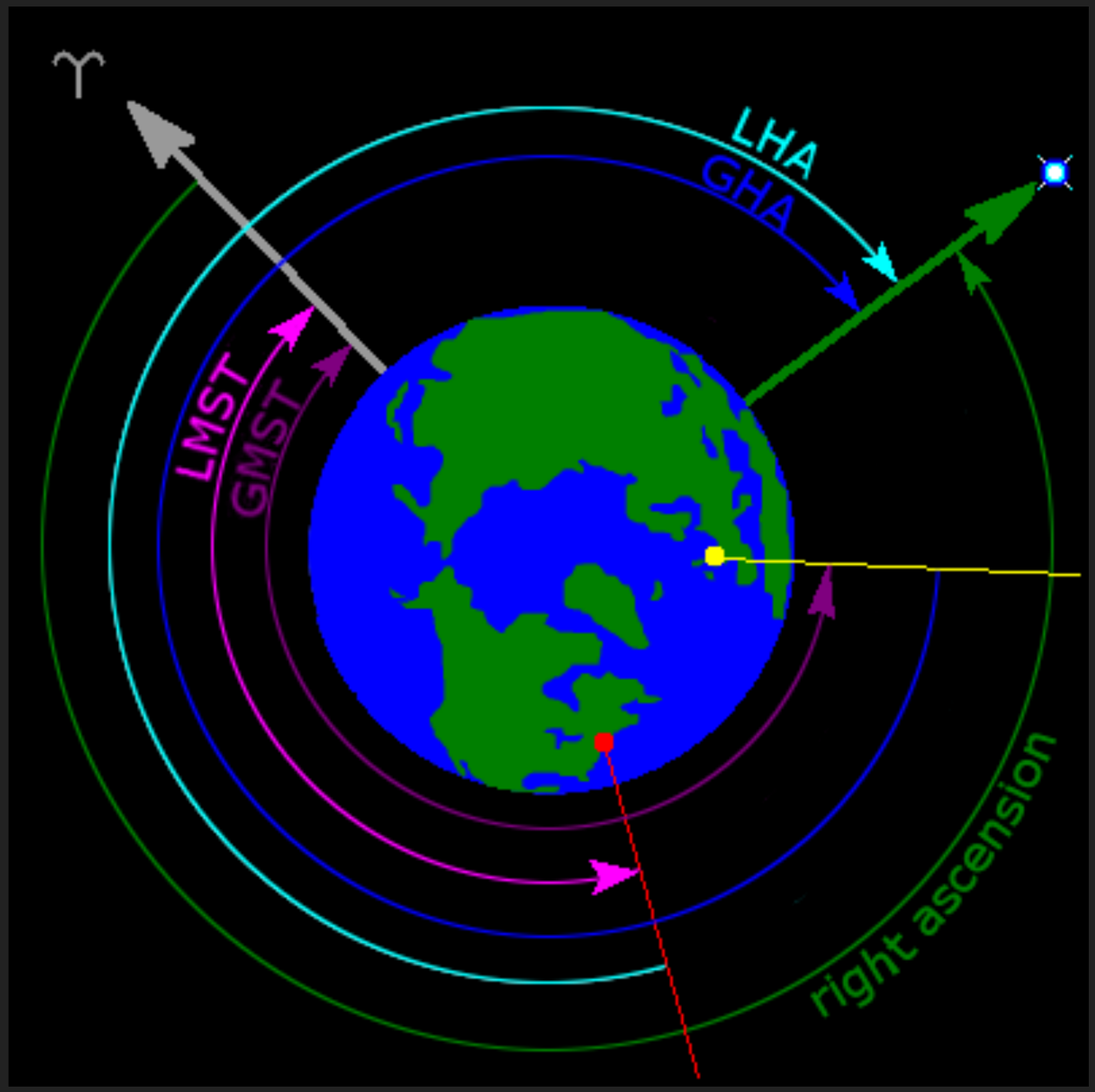
- Which star is on our local meridian?
- Depends on time and date
- Our normal clocks use solar time
- Astronomers are interested in sidereal time
- Local Sidereal Time (LST) is 0 hours when the vernal equinox (RA=0) is on local meridian




ε = 23.5°
NCP
NEP
66.5°
Summer
solstice
Autumnal
equinox
ε = 23.5°
Earth
23.5°
Celestial equator
Vernal
equinox
(♈)
Path of Sun
(Ecliptic)
ε = 23.5°
Winter
solstice
SCP
SEP

SIDEREAL TIME

- Hour angle
  HA = LST - RA
- Tells you where your object is with respect to the meridian.
- |HA|> 6 hours hard to observe (but depends on declination)



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EXAMPLE (WITHOUT THE CELESTIAL SPHERE)

At midnight on 1998 February 4th, LST
at St. Andrews was 8h45m.

St. Andrews has longitude 2°48'W.

What was the Local Hour Angle of
Betelgeuse (RA = 5h55m) at midnight?

At what time was Betelgeuse on the
meridian at St.Andrews?

At what time was Betelgeuse on the
meridian at Greenwich?

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SOLUTIONS

2h 50m

21h 10m

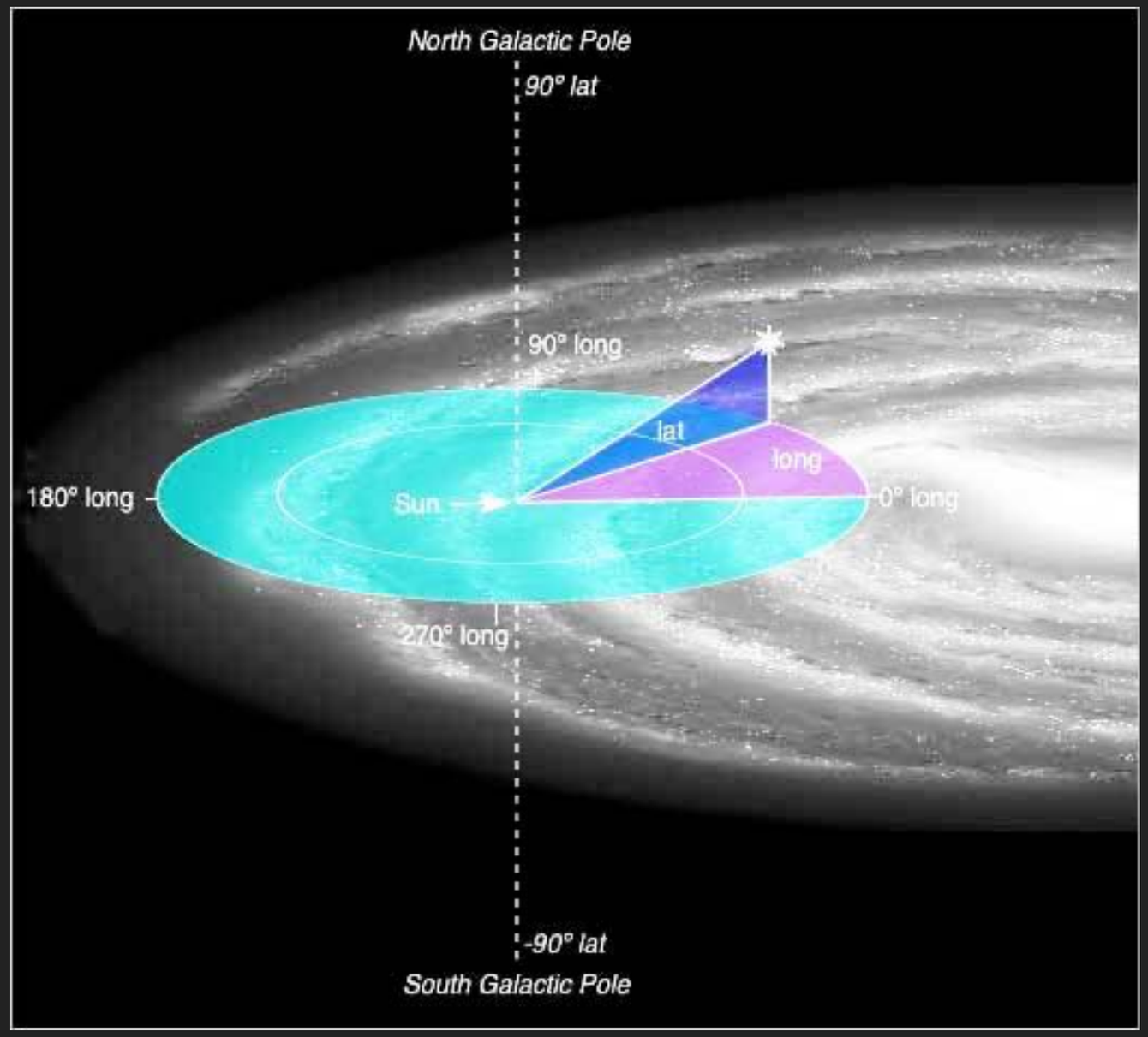
20h 59m

COMPLICATIONS WITH THE EQUATORIAL SYSTEM

- Equatorial coordinates change slowly
- Timescale 25770 years
- This is because Earth's rotation axis precesses around the orbital plane
- Must also specify Epoch, the standard nowadays is J2000

GALACTIC COORDINATE SYSTEM

- Earth at centre
- Latitude and longitude
- 0 towards galactic centre



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CELESTIAL SPHERES