ASTC02 - LECTURE 1 - PROF. HANNO REIN

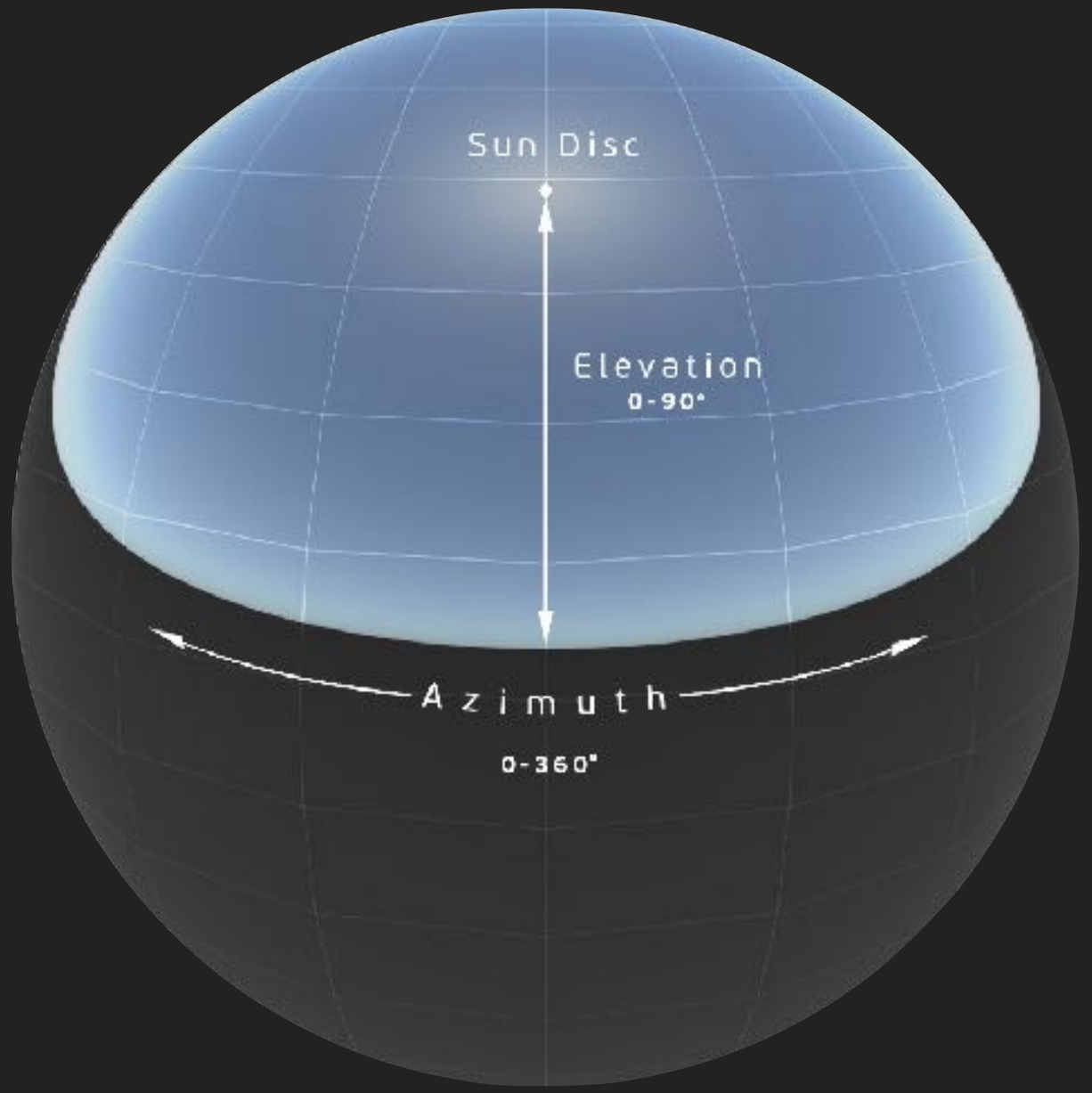
COORDINATE SYSTEMS

CELESTIAL COORDINATE SYSTEMS

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

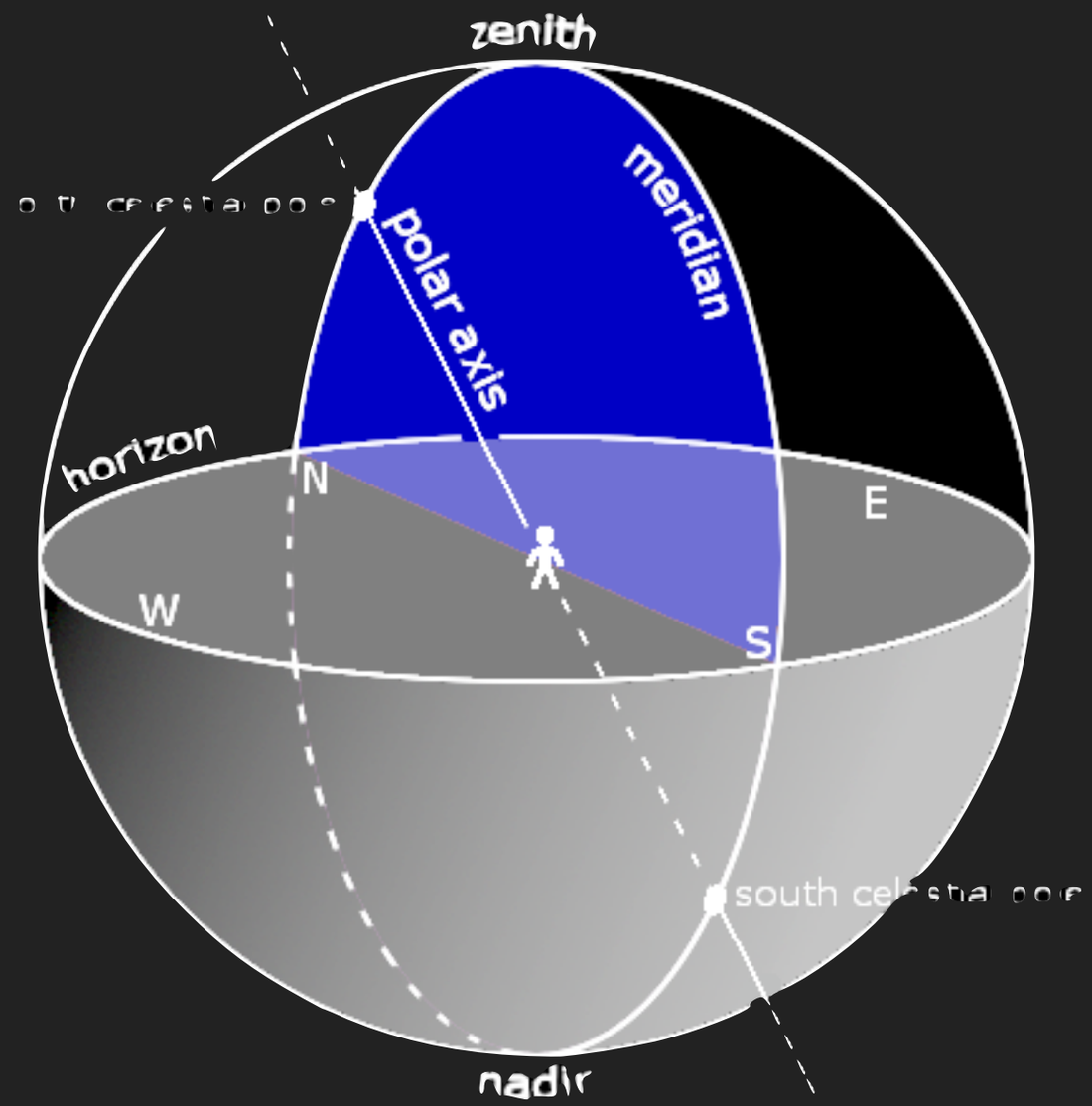
HORIZONTAL COORDINATE SYSTEM

- 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 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

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

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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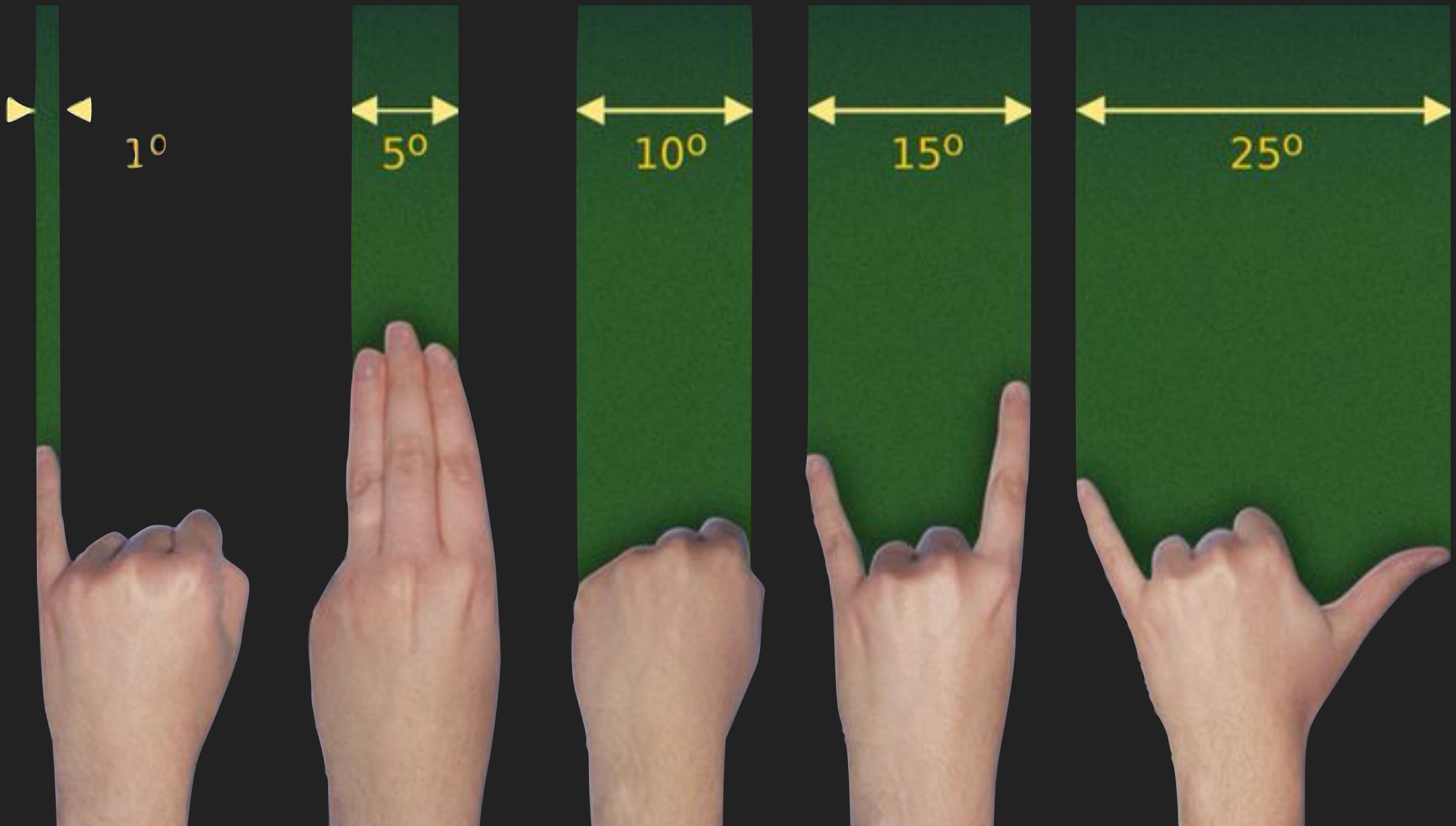
N

DEGREES, MEASURED BY HAND



HOURS

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

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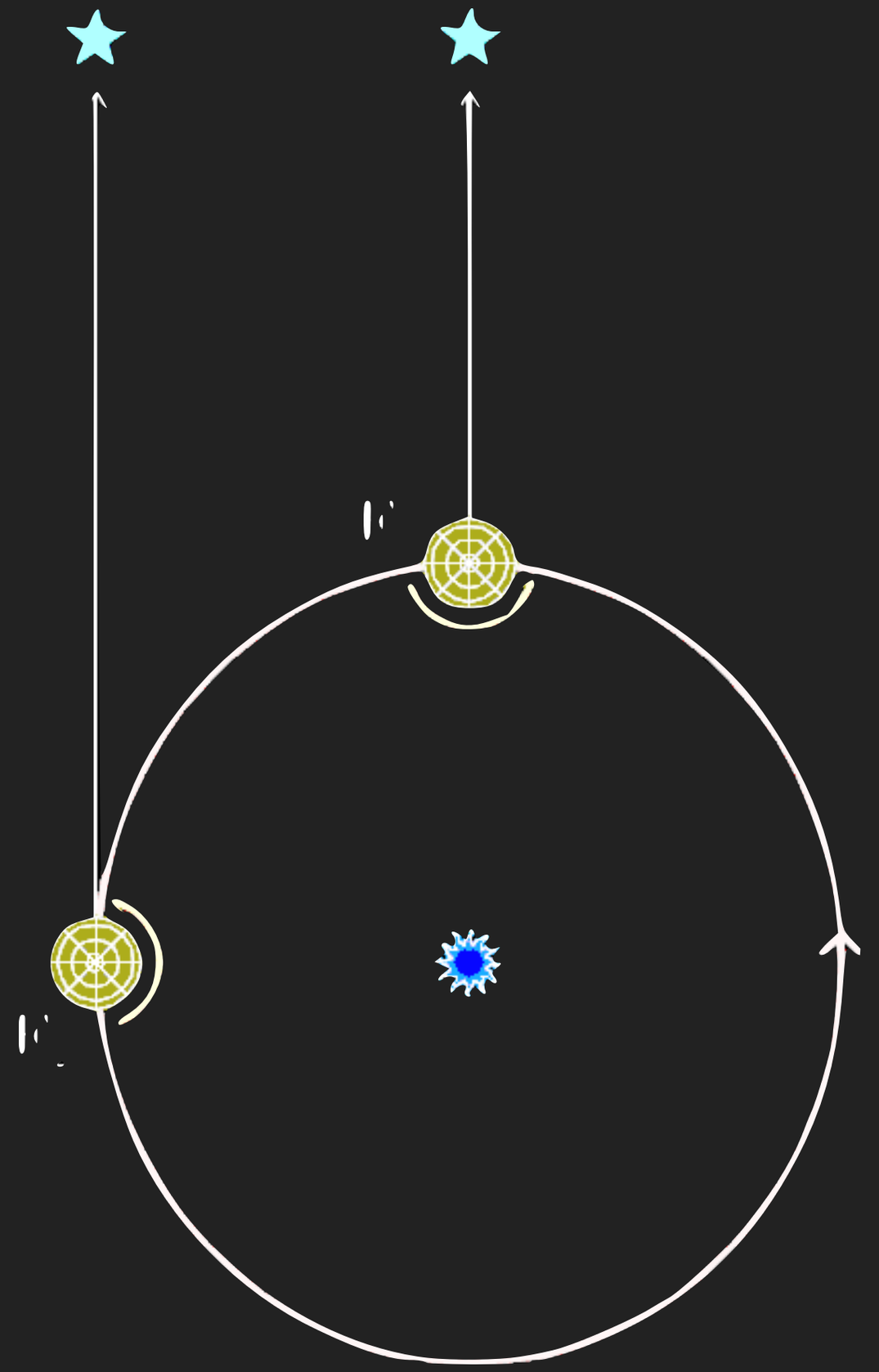
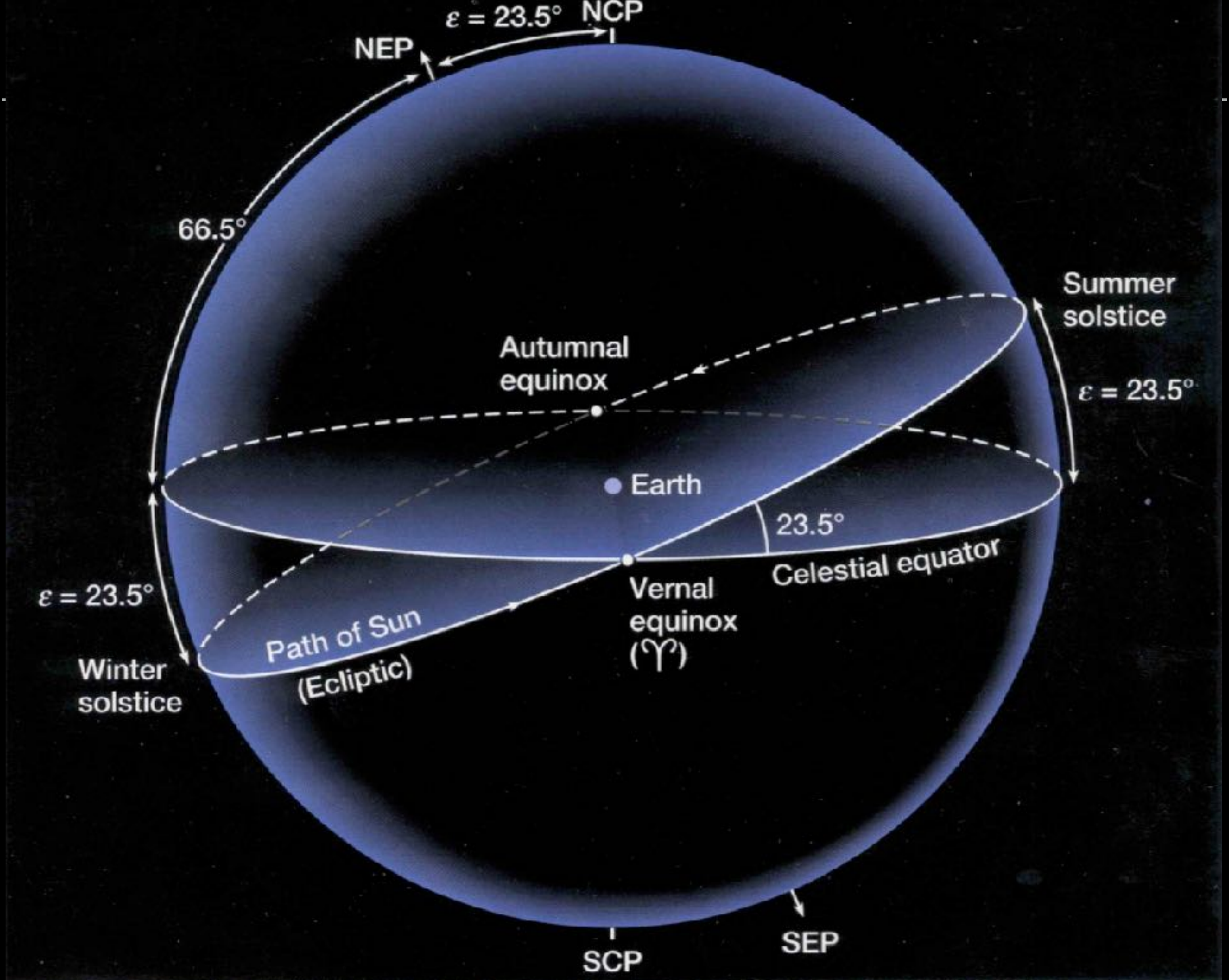
CONVERSION BETWEEN COORDINATE SYSTEMS

- 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

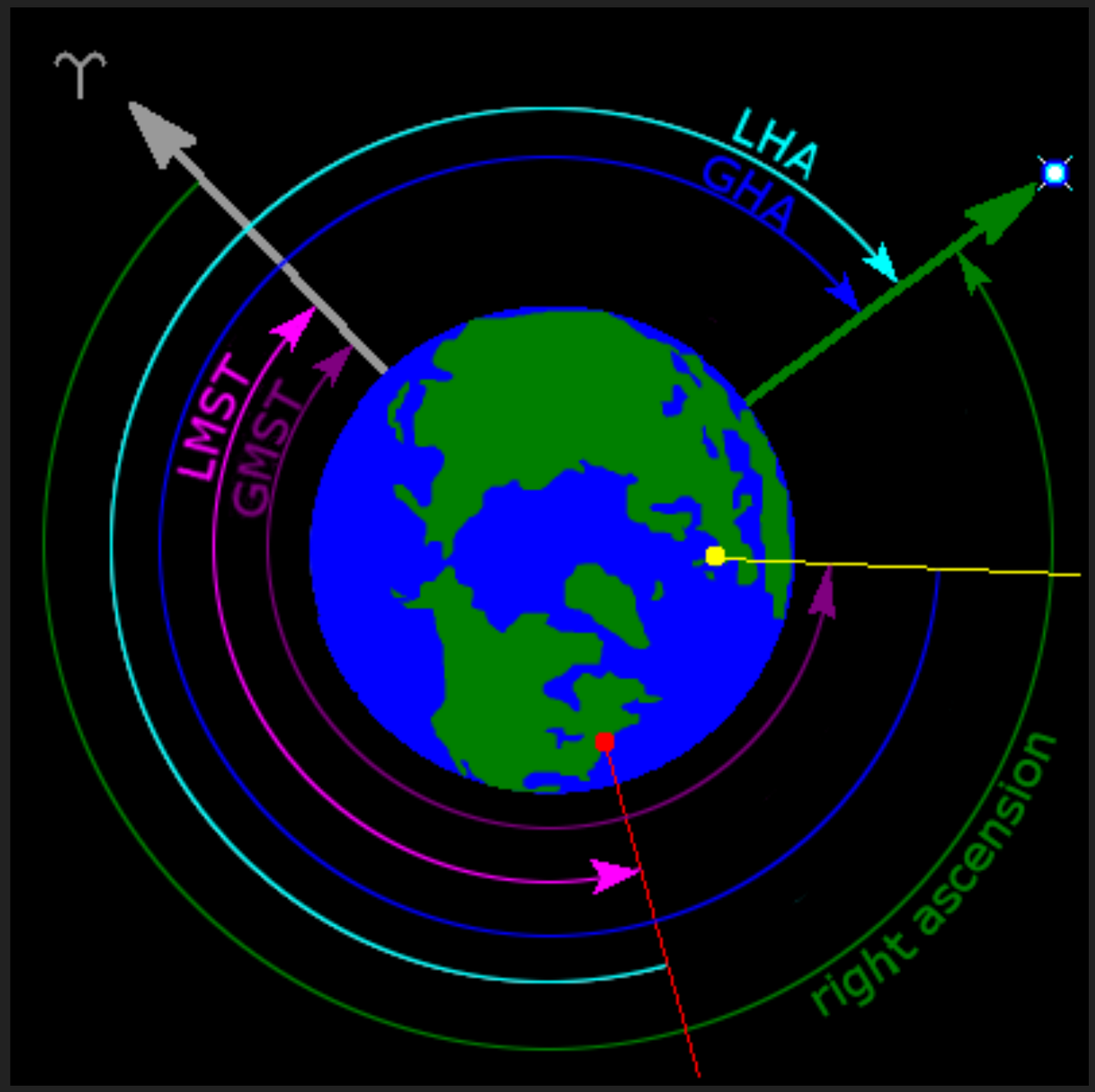
- Which star is on our local meridian?
- Depends on time and date
- Our normal clocks use solar time
- Astronomers are interested in sidereal time
- Local Sidereal Time (LST) is 0 hours when the vernal equinox (RA=0) is on local meridian




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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COORDINATE SYSTEMS

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?

EXAMPLE

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

St. Andrews has longitude 2°48'W.

SOLUTIONS

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

2h 50m

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

21h 10m

At what time was Betelgeuse on the meridian at Greenwich?

20h 59m

PROBLEMS 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