AGA5802
Astrofísica Observacional

Astronomical coordinates and planning observations I

Bibliography: Any book (or chapter) on coordinates.

Some basic astrometry in slides from Prof. Roberto Boczko + myself (Elementos de Astronomia):

http://www.astro.iag.usp.br/~jorge/aga205_2011/

Prof. Jorge Meléndez

Points to discuss

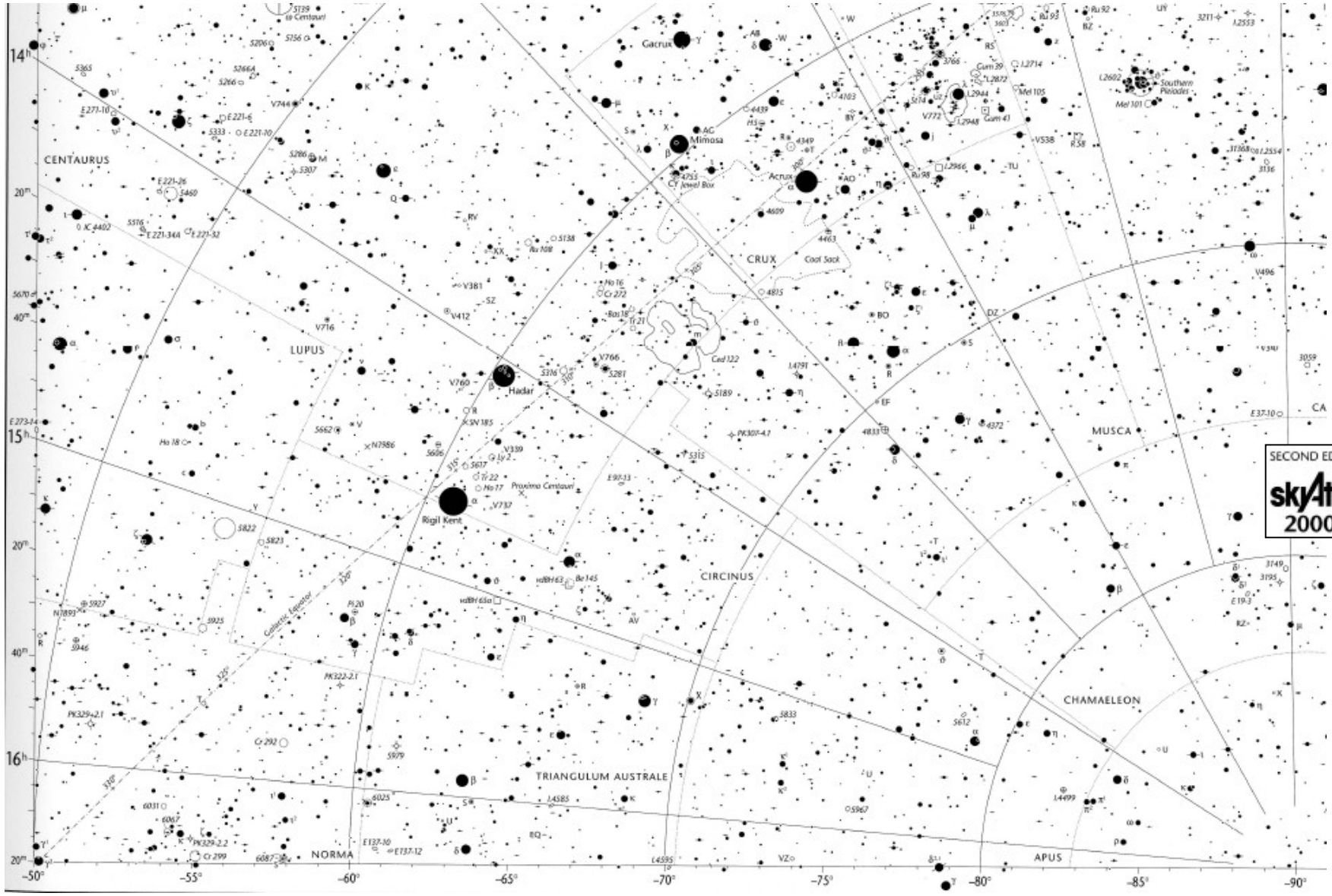
- Local coordinates: celestial sphere, horizon, zenith, vertical, local meridian
- Altazimutal system: azimuth, altitude, zenital distance. Reference points?
- Geographic system
- Equatorial system: R.A., Dec, ecliptic, γ
- Hour angle
- Sidereal time

Iguazu falls

http://www.twanight.org

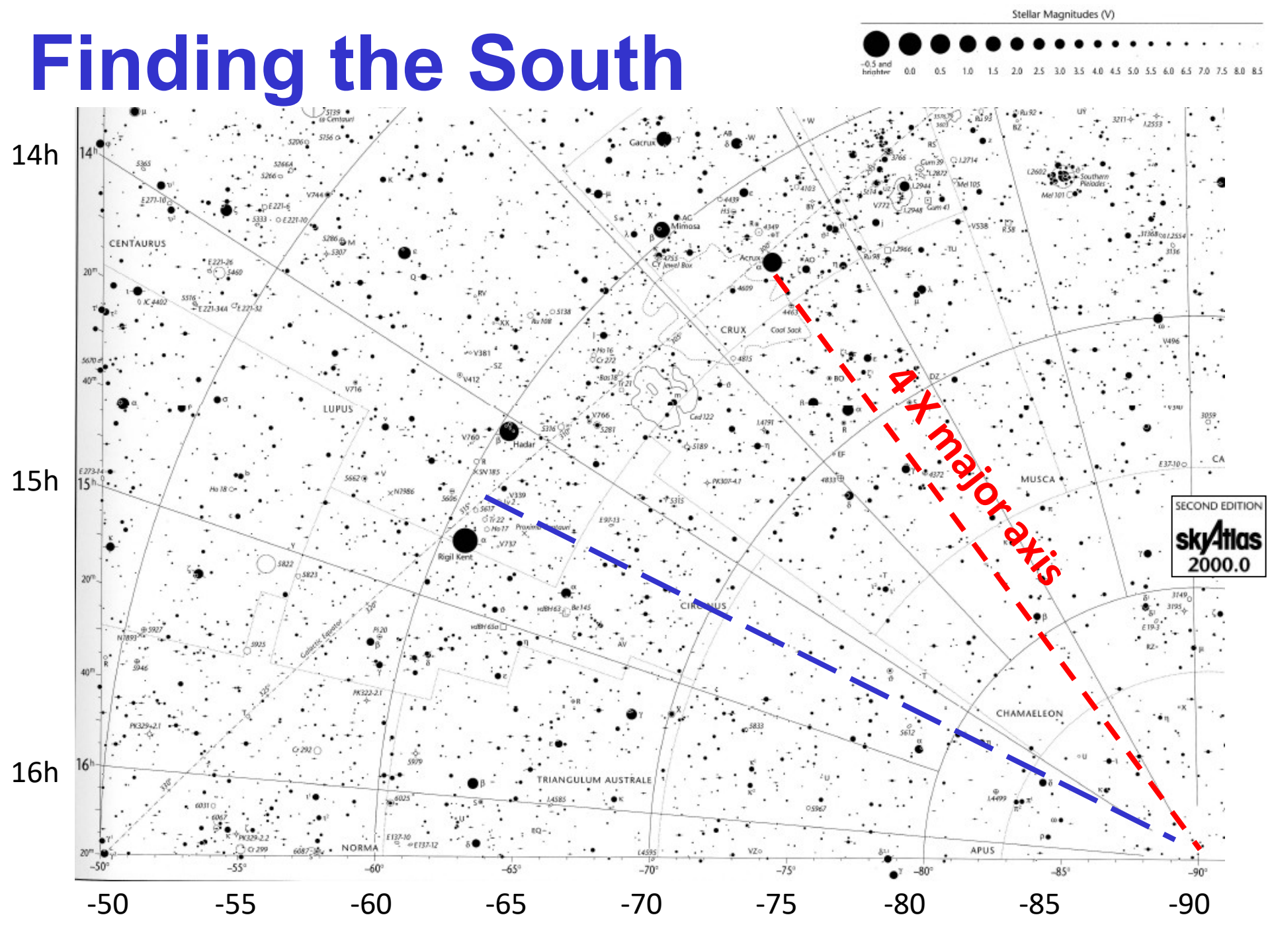
http://apod.nasa.gov/apod/ap100514.html

Finding the South

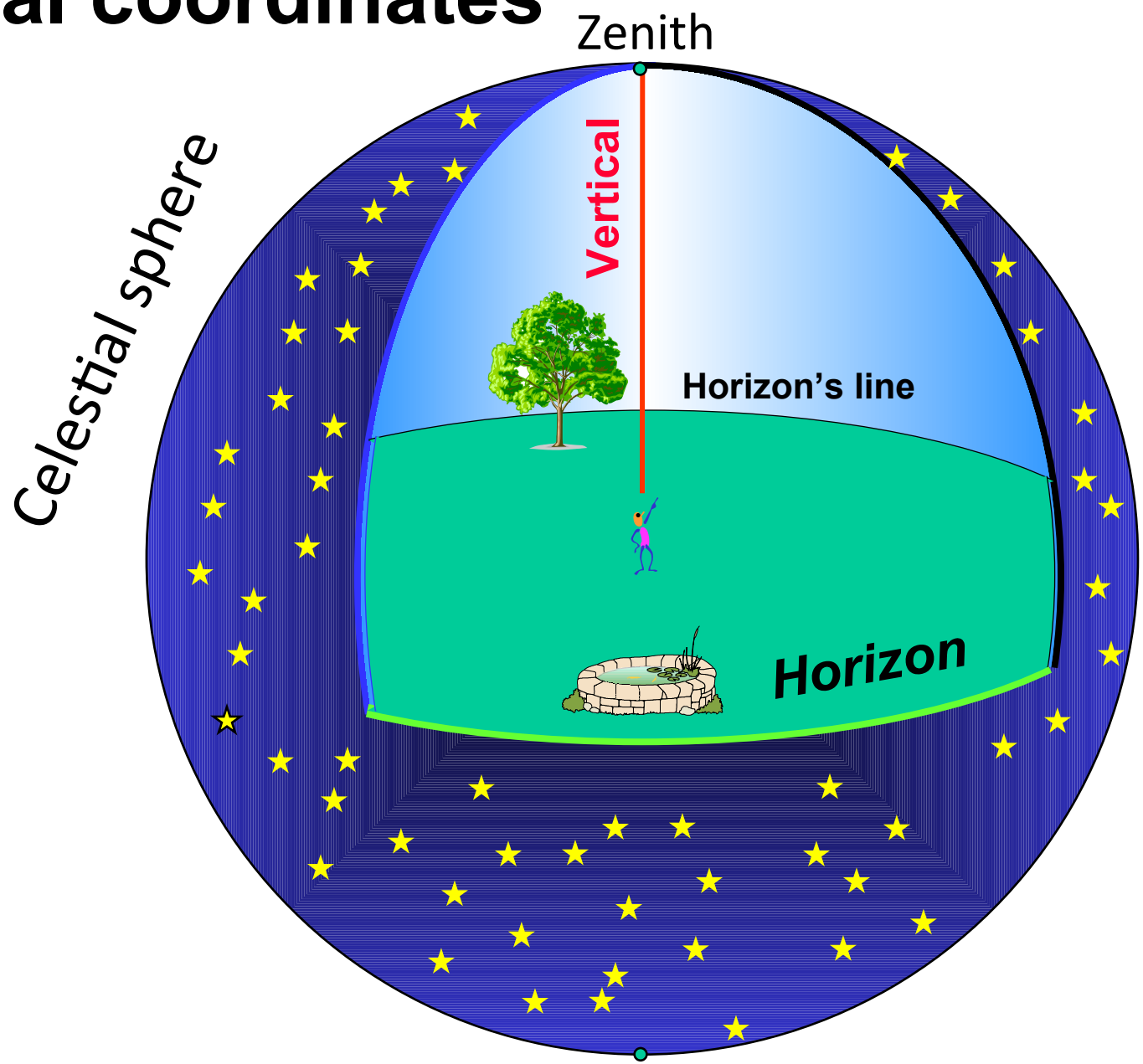


SECOND EDITION
skyAtlas 2000.0

Finding the South



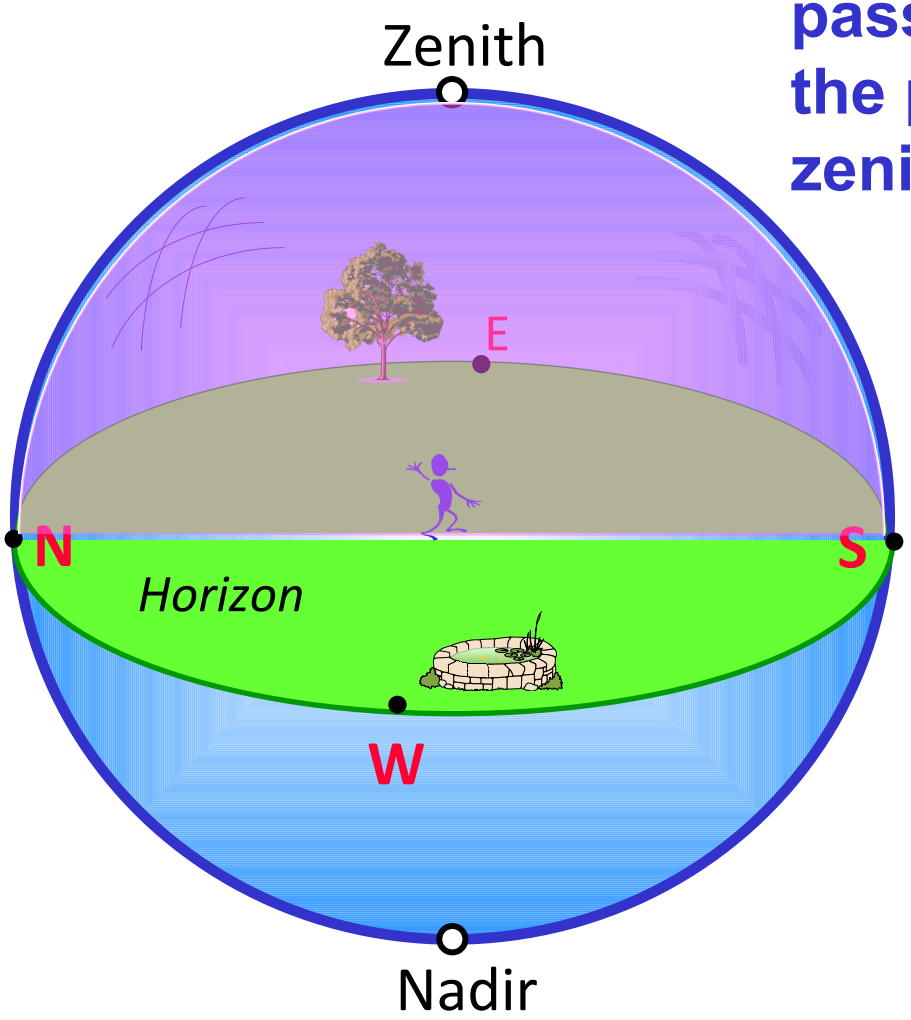
Local coordinates



Slide adapted from Prof. Boczko

Local Meridian

Is the semicircle passing through the points zenith, N and S.



Slide adapted from Prof. Boczko

Altazimutal System

Azimuth (A): N E S O(W)

Altitude (h):
-90º a +90º

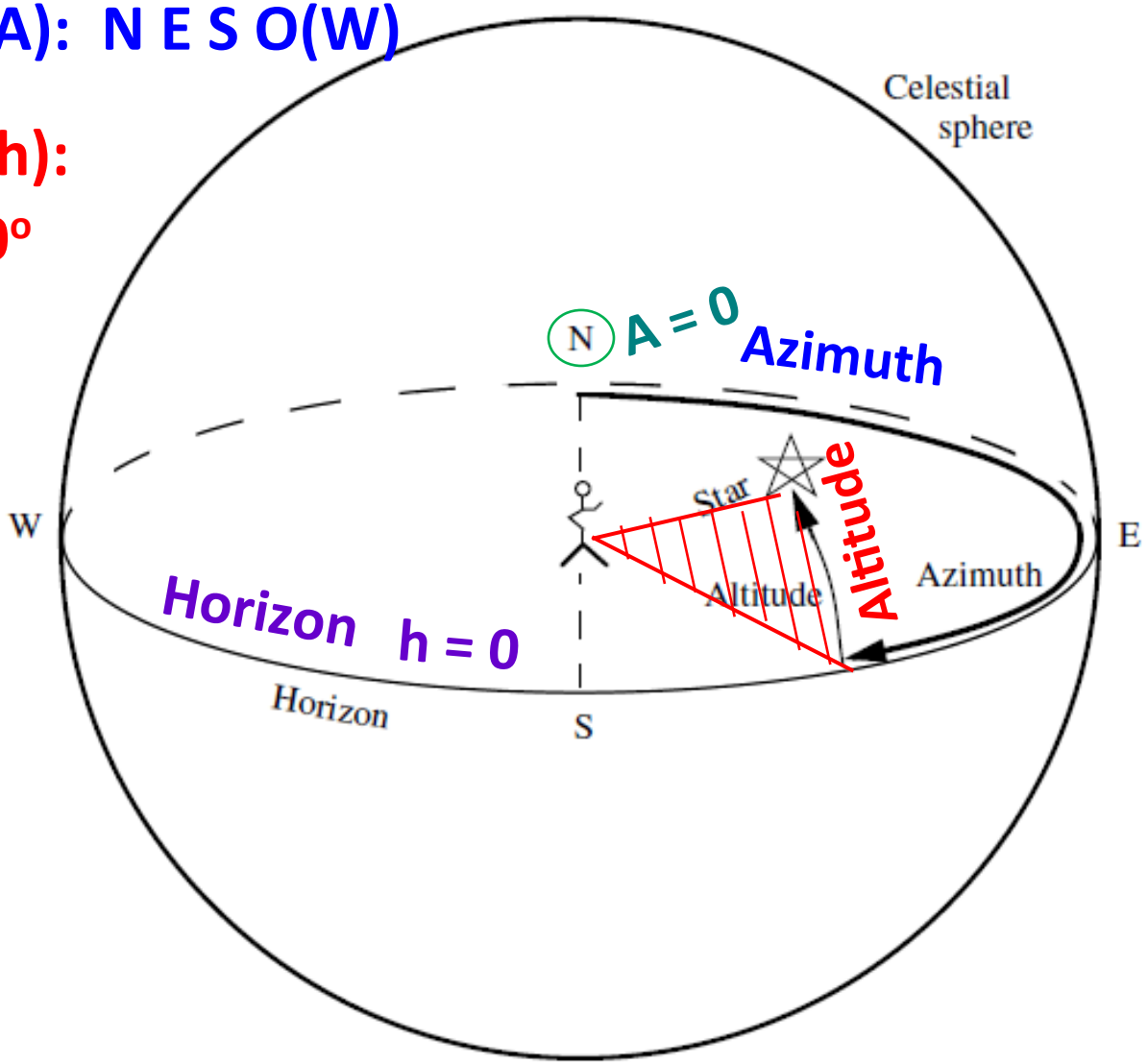
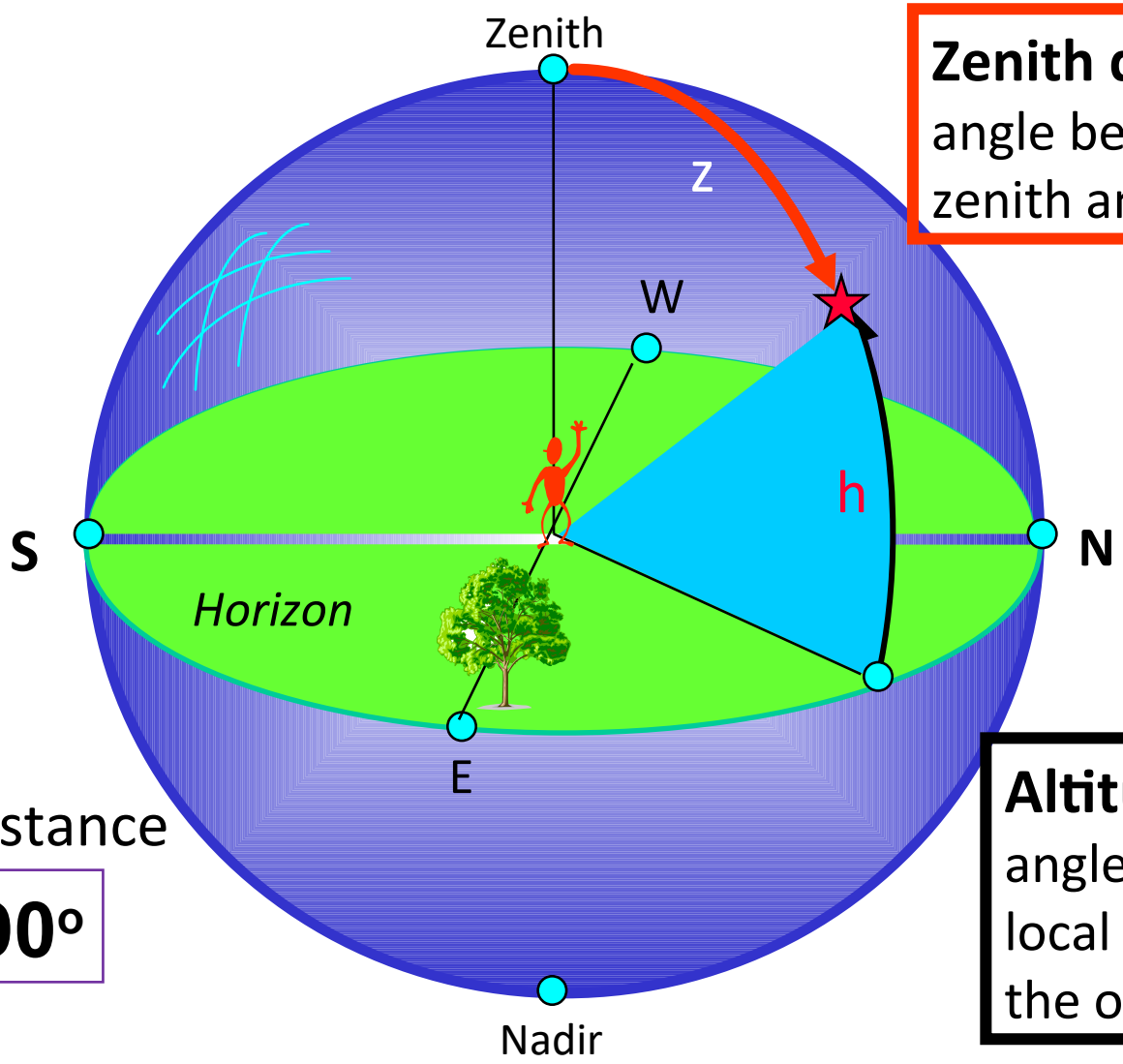


Fig. 3.2 from Astronomy Methods

Altitude & zenith distance



Zenith distance is the angle between the zenith and the object

h = altitude

z = zenith distance

h + z = 90°

Altitude is the angle between the local horizon and the object

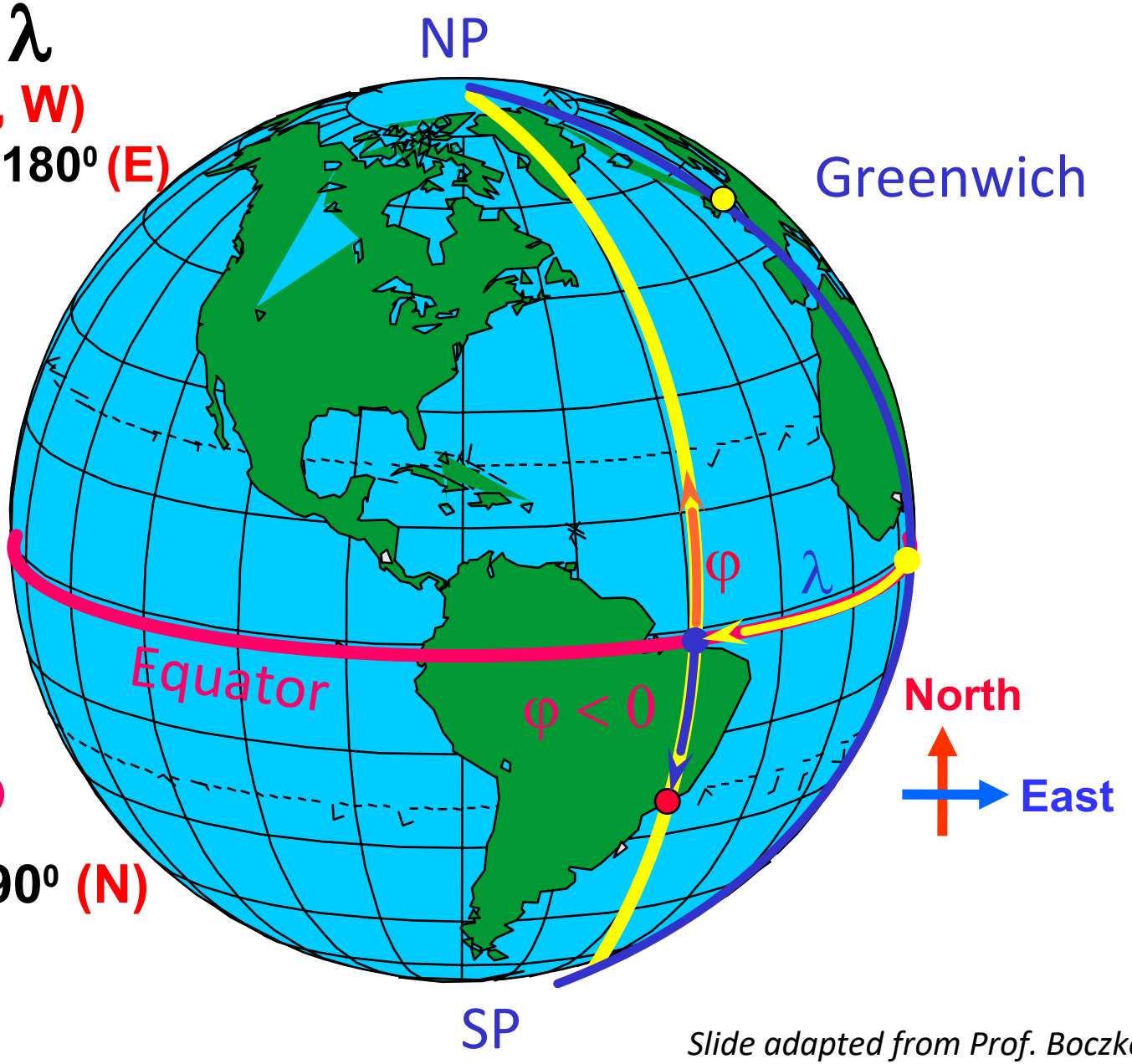
Slide adapted from Prof. Boczko

Geographic system

Longitude λ

$0 \leq \lambda \leq +180^0$ (E, W)

(W) $-180^0 \leq \lambda \leq +180^0$ (E)



Sampa:

23.55° S

46.63° W

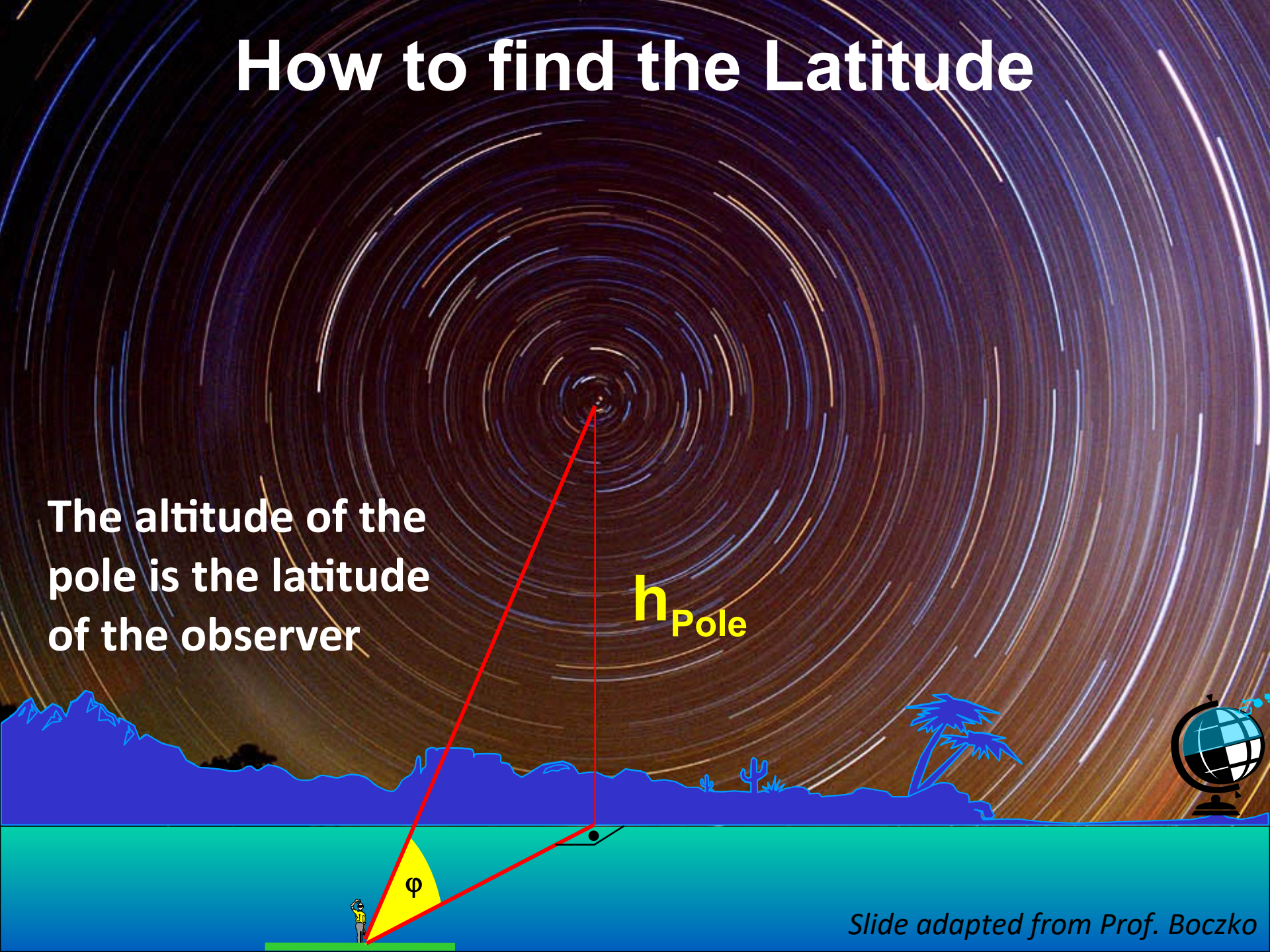
Latitude φ

(S) $-90^0 \leq \varphi \leq +90^0$ (N)

Slide adapted from Prof. Boczko

How to find the Latitude

The altitude of the pole is the latitude of the observer



Slide adapted from Prof. Boczko

La Silla/ESO (3,6m telescope) 29.2612° S, 70.7313° W
on 2014/01/12 © Jorge Meléndez

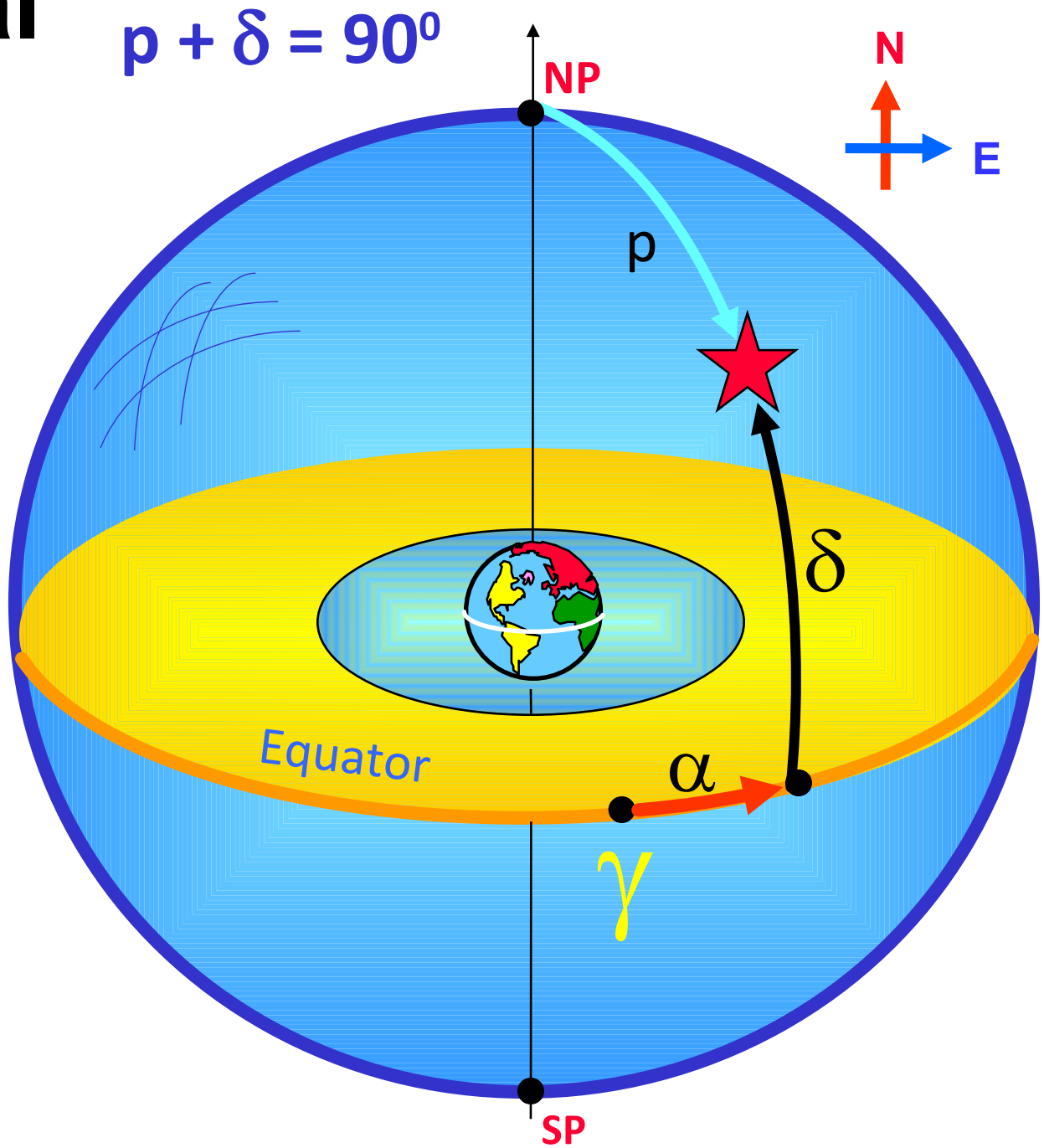
Equatorial system

(α , δ)

α = right ascension

δ = declination

p = polar distance



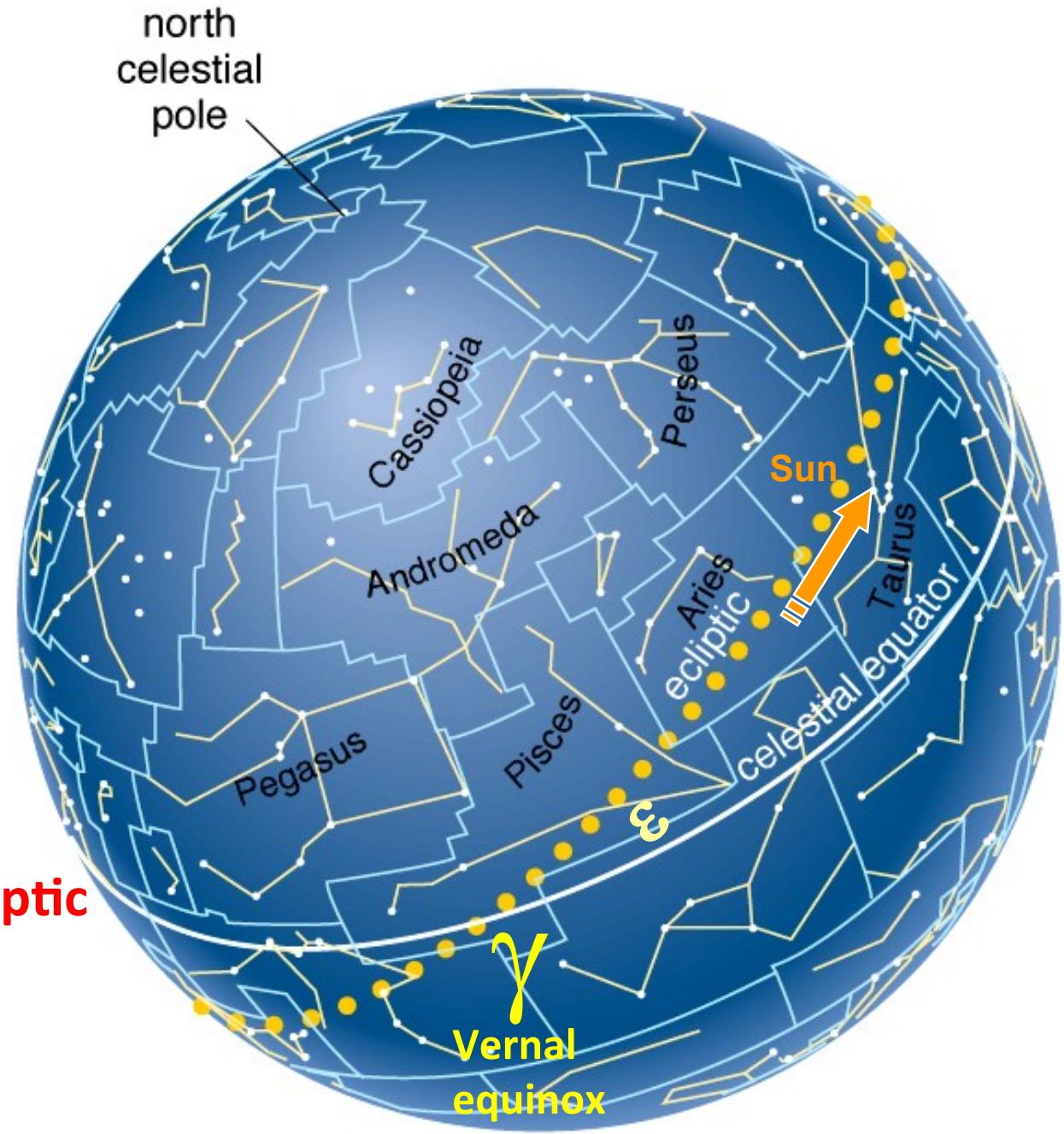
Slide adapted from Prof. Boczko

Equatorial system

Zero point for R.A. : intersection of ecliptic & equator

Obliquity of the ecliptic

$\varepsilon \cong 23^{o}\ 27'\ 08''$



Equatorial coordinates

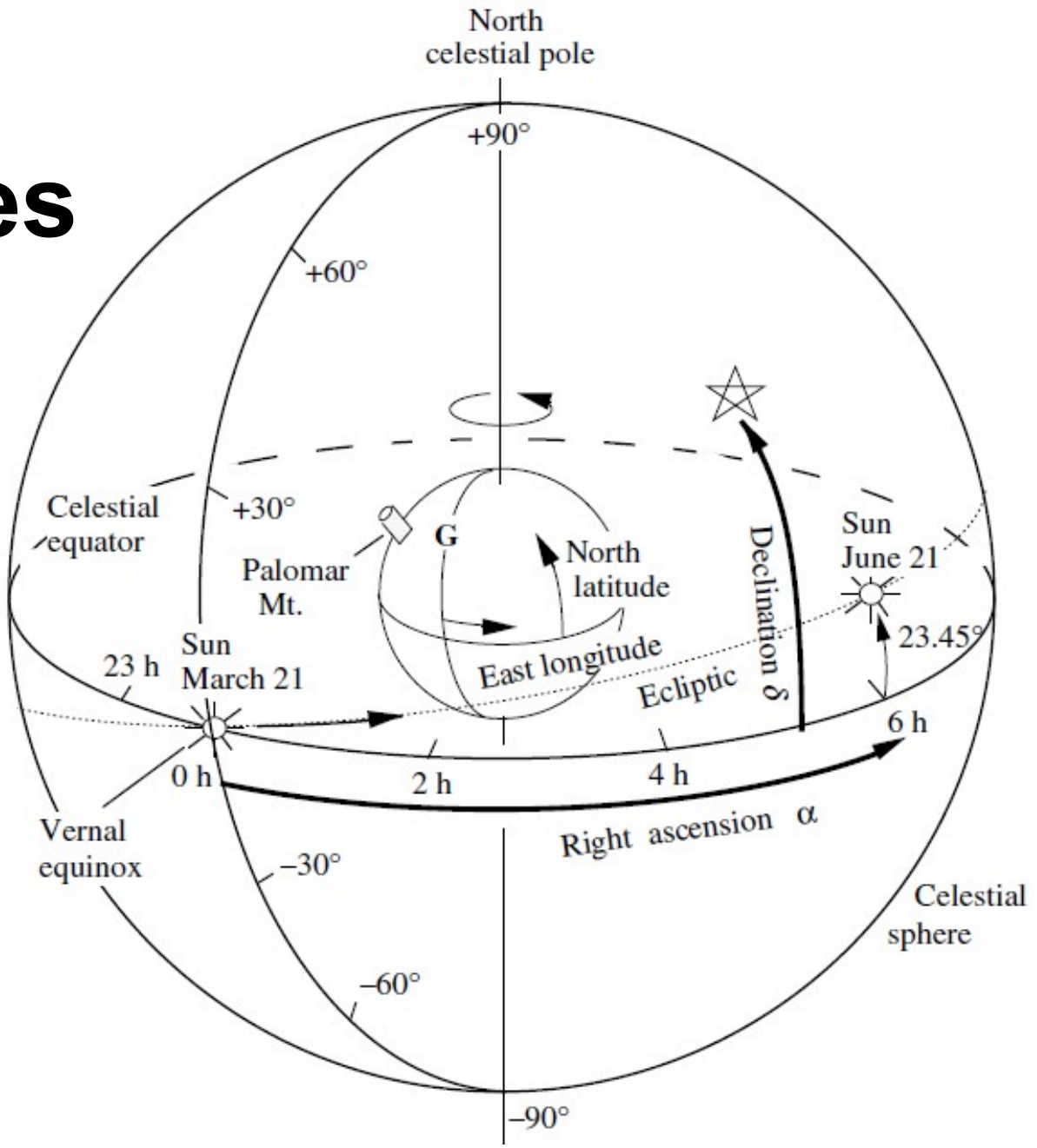


Fig. 3.1 from Astronomy Methods

Units

Right Ascension

$0^0 \leq \alpha < 360^0$

o ‘ “ (degrees, arc minutes, arc seconds)

Declination

(S) $-90^0 \leq \delta \leq +90^0$ (N)

Polar distance

(N) $0^0 \leq p \leq +180^0$ (S)

$0^h \leq \alpha < 24^h$

hh, mm, ss (hours, minutes, seconds)

$24\ h = 360^0 \rightarrow 1\ hour = 15^0$

1 m = 15' 1 s = 15"

Slide adapted from Prof. Boczko

Coordinates for astronomical objects: SIMBAD

http://simbad.u-strasbg.fr/simbad/sim-fid

Simbad

HD 75302 -- High proper-motion Star

Other object types: * (HD,AG,ASCC,BD,GSC,HIC,HIP,PPM,SAO,SKY#,SPOCS,TYC,USNO,u
IR (2MASS) ,X (1RXS)

ICRS coord. (ep=J2000) : 08 49 12.53044 +03 29 05.1266 (Optical) [7.11 4.22 84]

Epoch 2000

R.A. (α) dec (δ)

HD 75302 -- High proper-motion Star

query around with radius 2 arcm

Other object types: * (HD,AG,ASCC,BD,GSC,HIC,HIP,PPM,SAO,SKY#,SPOCS,TYC,USNO,uvby98,YZ) ,PM* (LSPM) ,
IR (2MASS) ,X (1RXS)

ICRS coord. (ep=J2000) : 08 49 12.53044 +03 29 05.1266 (Optical) [7.11 4.22 84] A 2007A&A...474..653V

FK5 coord. (ep=J2000 eq=2000) : 08 49 12.530 +03 29 05.13 (Optical) [7.11 4.22 84] A 2007A&A...474..653V

FK4 coord. (ep=B1950 eq=1950) : 08 46 36.17 +03 40 12.4 (Optical) [40.72 25.02 0] A 2007A&A...474..653V

Gal coord. (ep=J2000) : 223.9743 +27.6703 (Optical) [7.11 4.22 84] A 2007A&A...474..653V

Proper motions *mas/yr* [error ellipse]: -146.56 60.17 [0.81 0.48 0] A 2007A&A...474..653V

Radial velocity / Redshift / cz : V(km/s) 10.32 [0.45] / z(~) 0.000034 [0.000002] / cz 10.32 [0.45] (~) A 2007AJ....133.2524W

Parallaxes *mas*: 32.26 [0.71] A 2007A&A...474..653V

Spectral type: G5V C 2007AJ....133.2524W

Fluxes (12) :

B 8.128 [0.016] D 2000A&A...355L..27H
V 7.43 [0.01] D 2000A&A...355L..27H
R 7.0 [~] E 2003AJ....125..984M
I 6.7 [~] E 2003AJ....125..984M
J 6.238 [0.021] C 2003yCat.2246....0C
H 5.952 [0.049] C 2003yCat.2246....0C
K 5.840 [0.020] C 2003yCat.2246....0C
u (AB) 12.871 [0.006] C 2009yCat.2294....0A
g (AB) 11.846 [0.005] C 2009yCat.2294....0A
r (AB) 11.318 [0.006] C 2009yCat.2294....0A
i (AB) 10.117 [0.006] C 2009yCat.2294....0A
z (AB) 8.515 [0.001] C 2009yCat.2294....0A

magnitudes

HD 75302

BD+04 2050

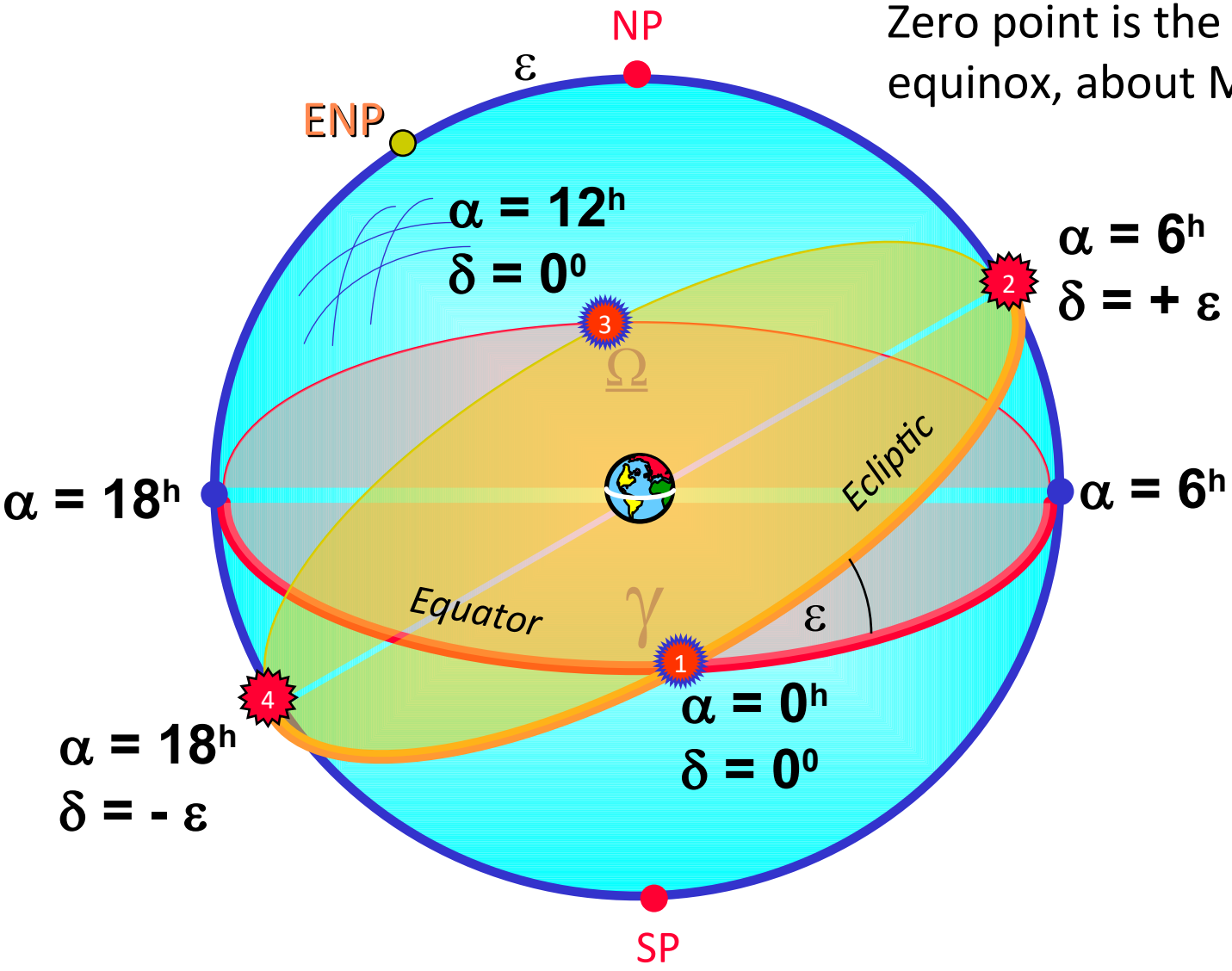
HIP 43297

LSPM J0849+0329E

2MASS J08491252+0329052

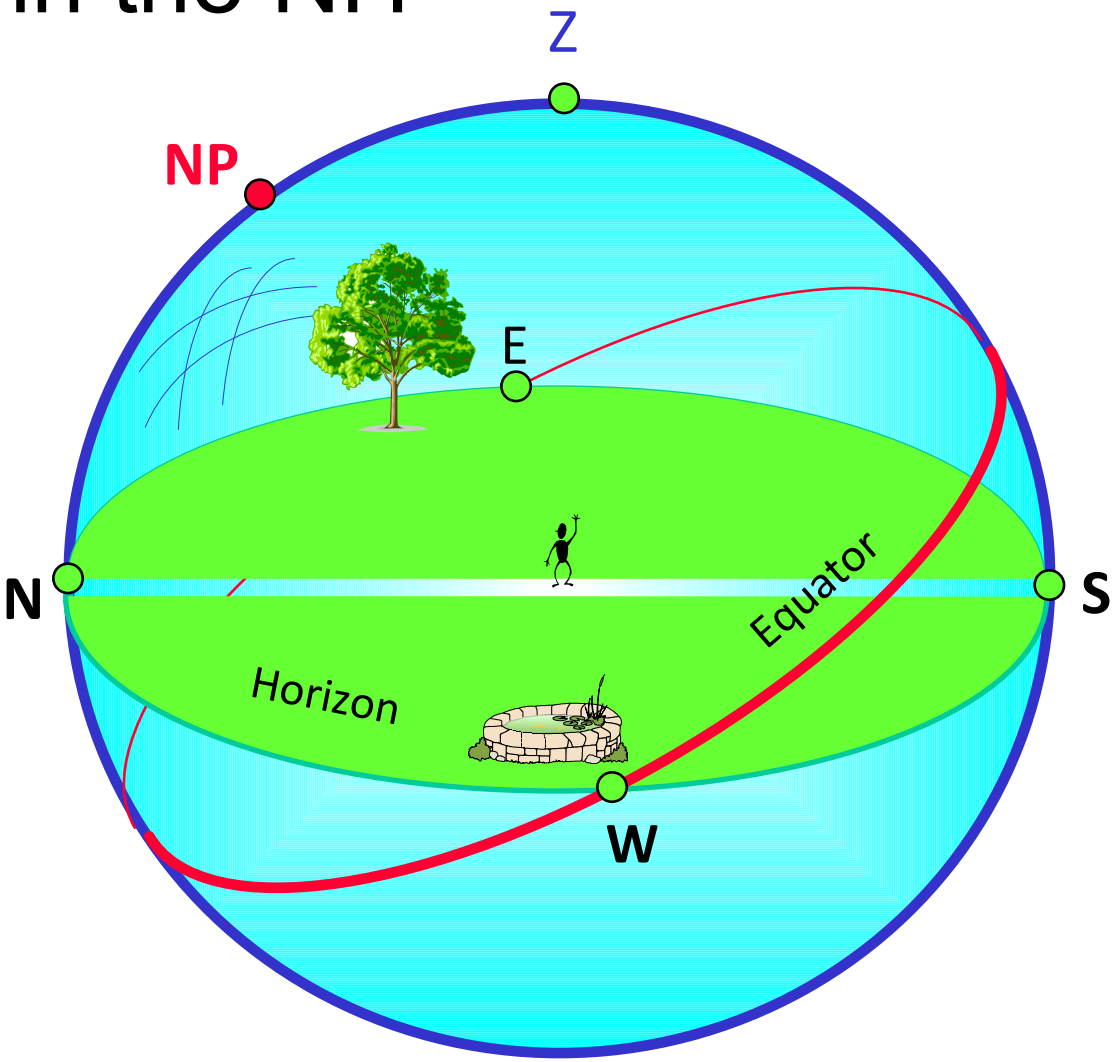
Example: equatorial coordinates for the Sun

Zero point is the Vernal equinox, about March 21



Slide adapted from Prof. Boczko

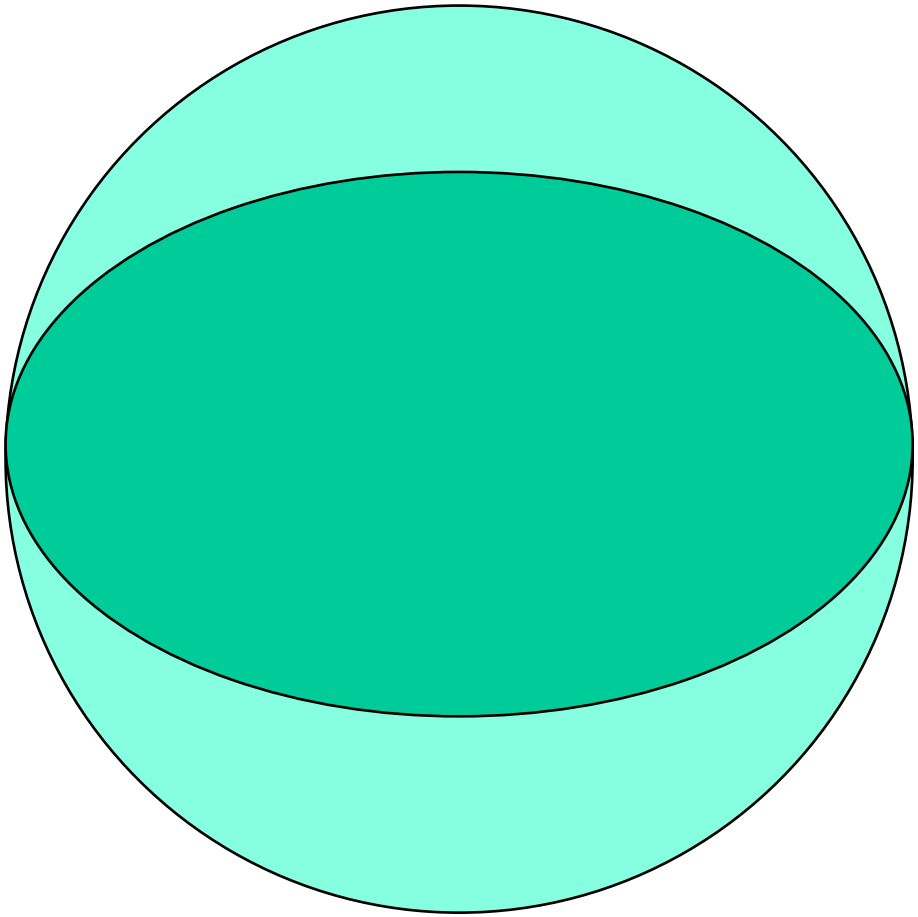
Horizontal & Equatorial system for observer in the NH



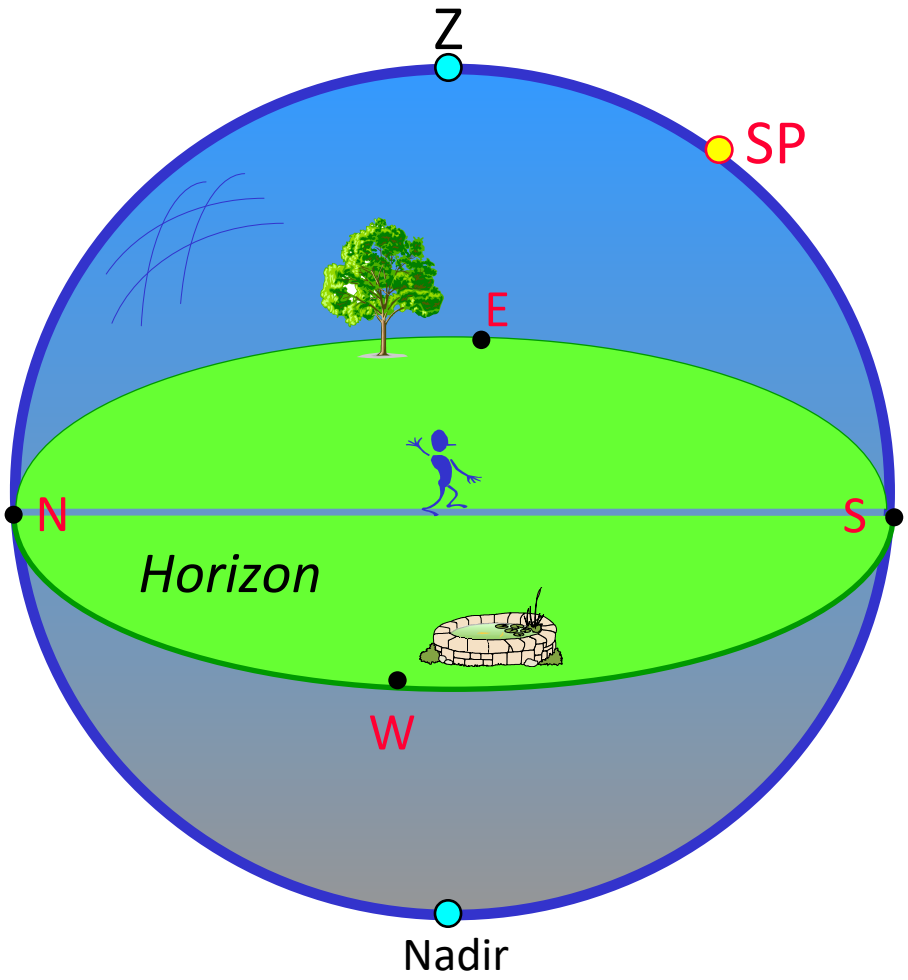
Slide adapted from Prof. Boczko

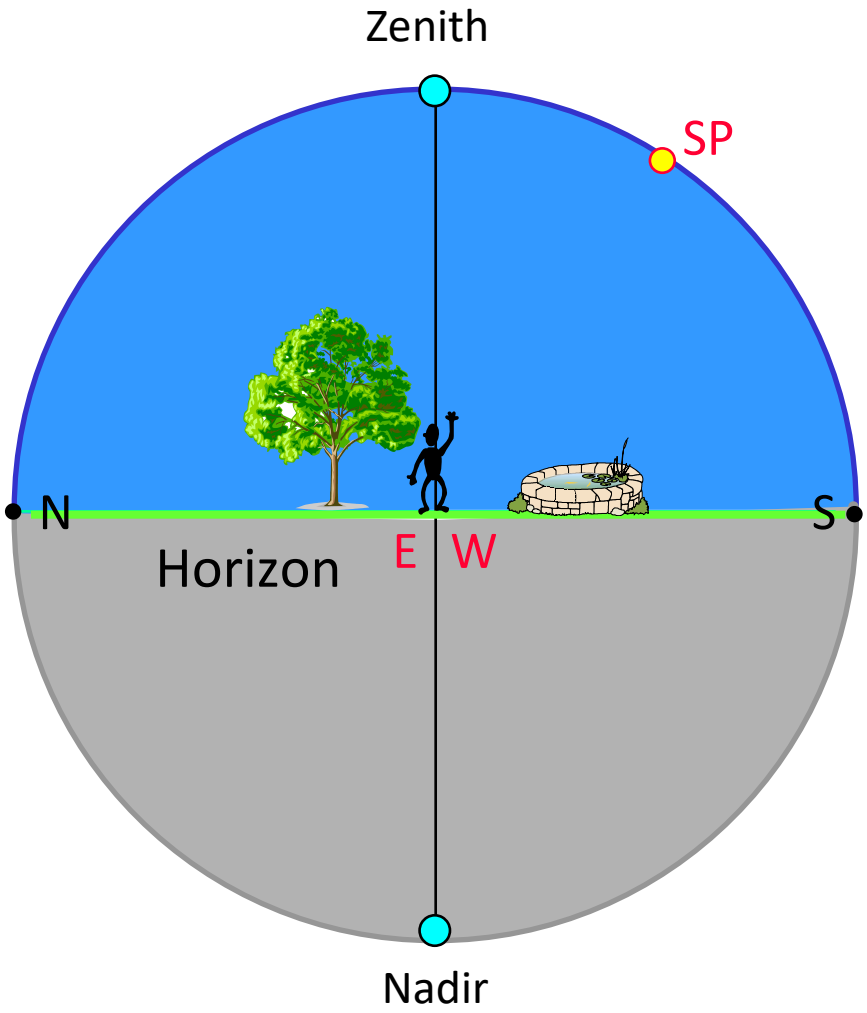
Provinha 1.

1) Plot both horizontal + equatorial system for an observer in São Paulo (latitude 23.55° S, long. 46.63° W). Show the horizontal & equatorial planes, the zenith, the cardinal points and the position of the Celestial South Pole



Local Meridian and Projection





Projection on the meridian plane

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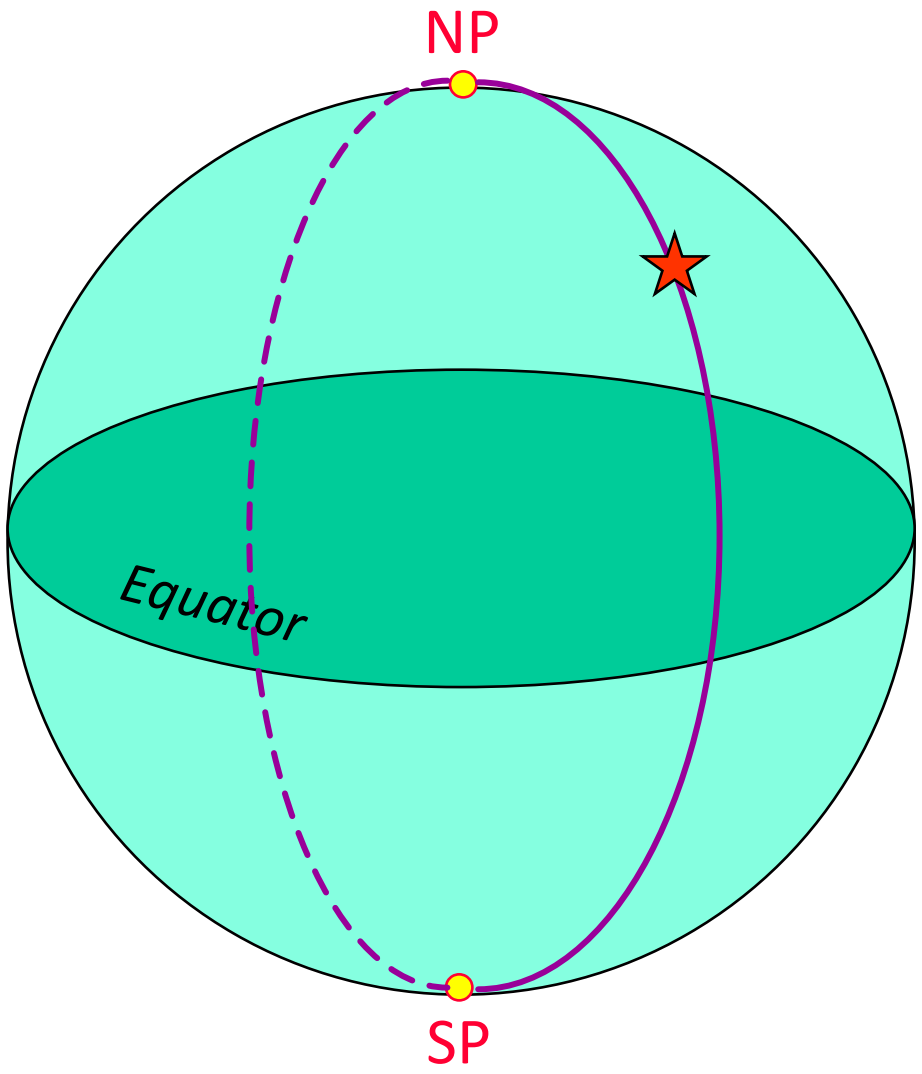
Hour circle: the great circle passing through the object and the celestial poles



Hour angle H: the angle on the equator's plane, from the local meridian to the object's hour circle

→ H = 0 at meridian

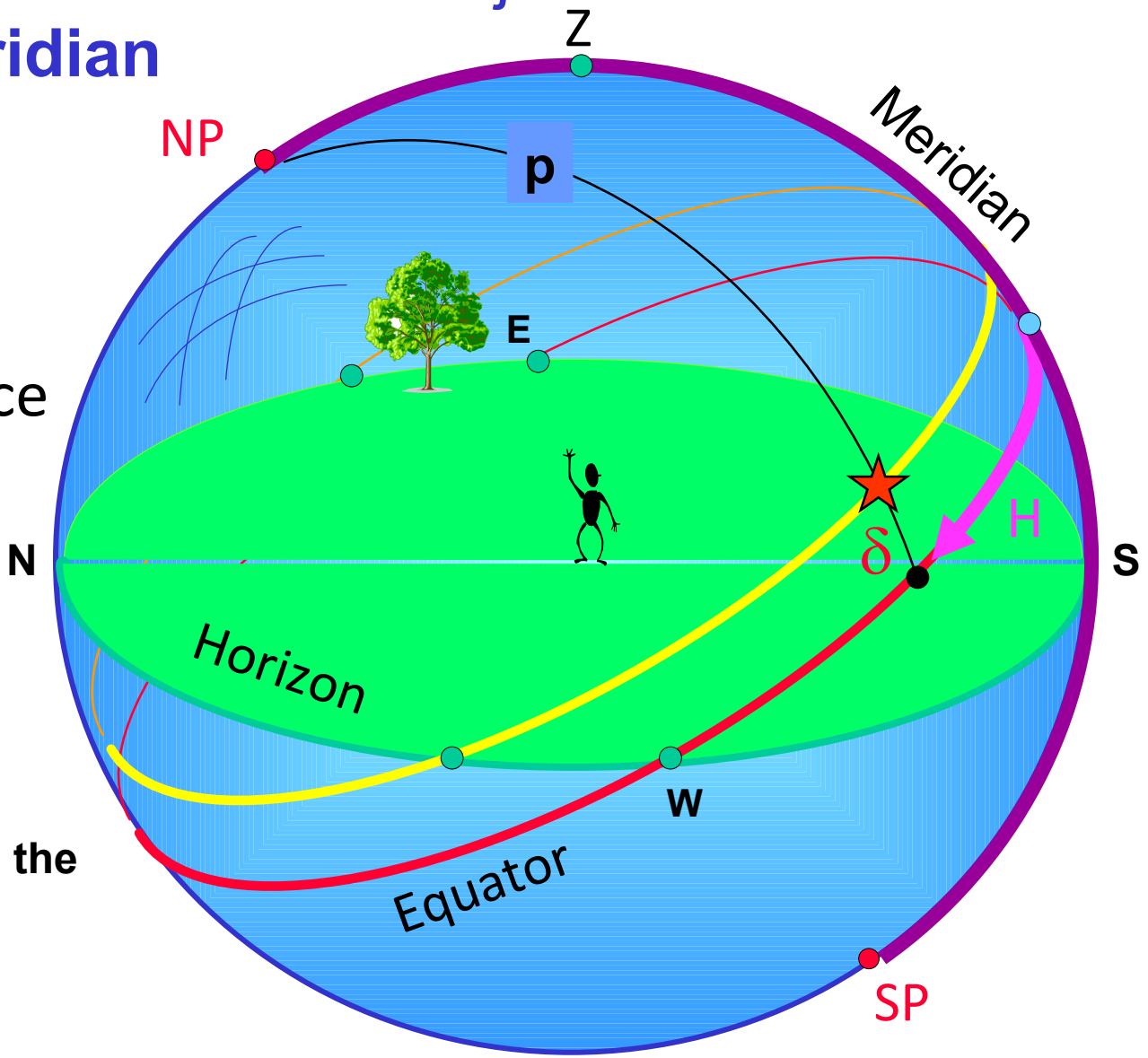
H = hour angle

δ = declination

p = polar distance

★ (H , δ)

Observer in the Northern H.



Slide adapted from Prof. Boczko

Units

Hour angle

(E) $-180^0 \leq H \leq +180^0$ **(W)**

Positive on the West side

1 hour ≡ 15^0

(E) $-12^h \leq H \leq +12^h$ **(W)**

Declination

(S) $-90^0 \leq \delta \leq +90^0$ **(N)**

$0^0 \leq p \leq +180^0$

1 h = 15°

1 m = 15'

1 s = 15"

Do it yourself

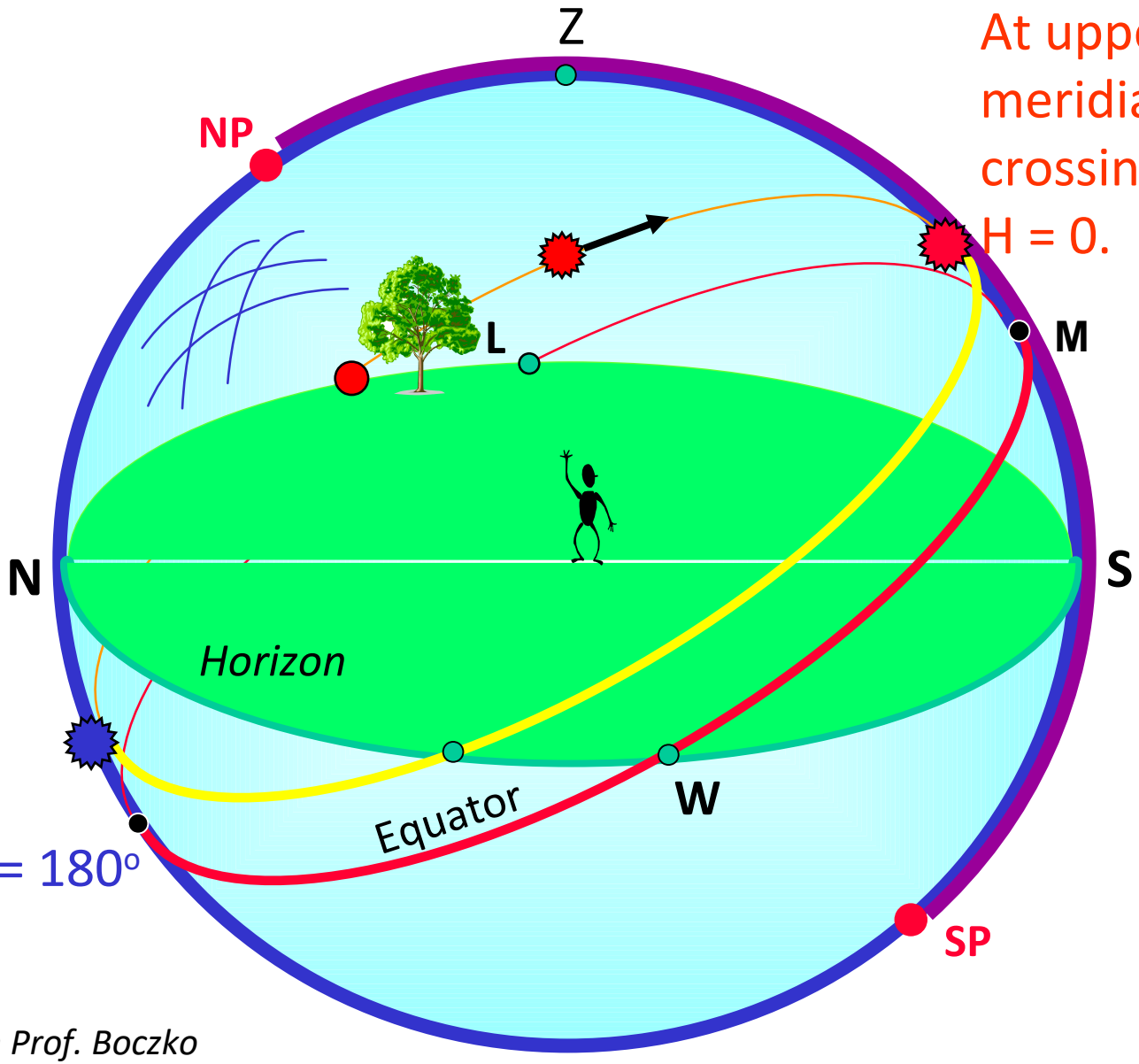
3h 20m 0s = ^{0} ‘ “?

$-30^{0},5$ = h m s ?

Provinha 1

2. Converter **-0h 30m 0s** em fração de grau
3. Converter **15^{0} 30‘00“** em (h,m,s)

Culmination or Meridian crossing

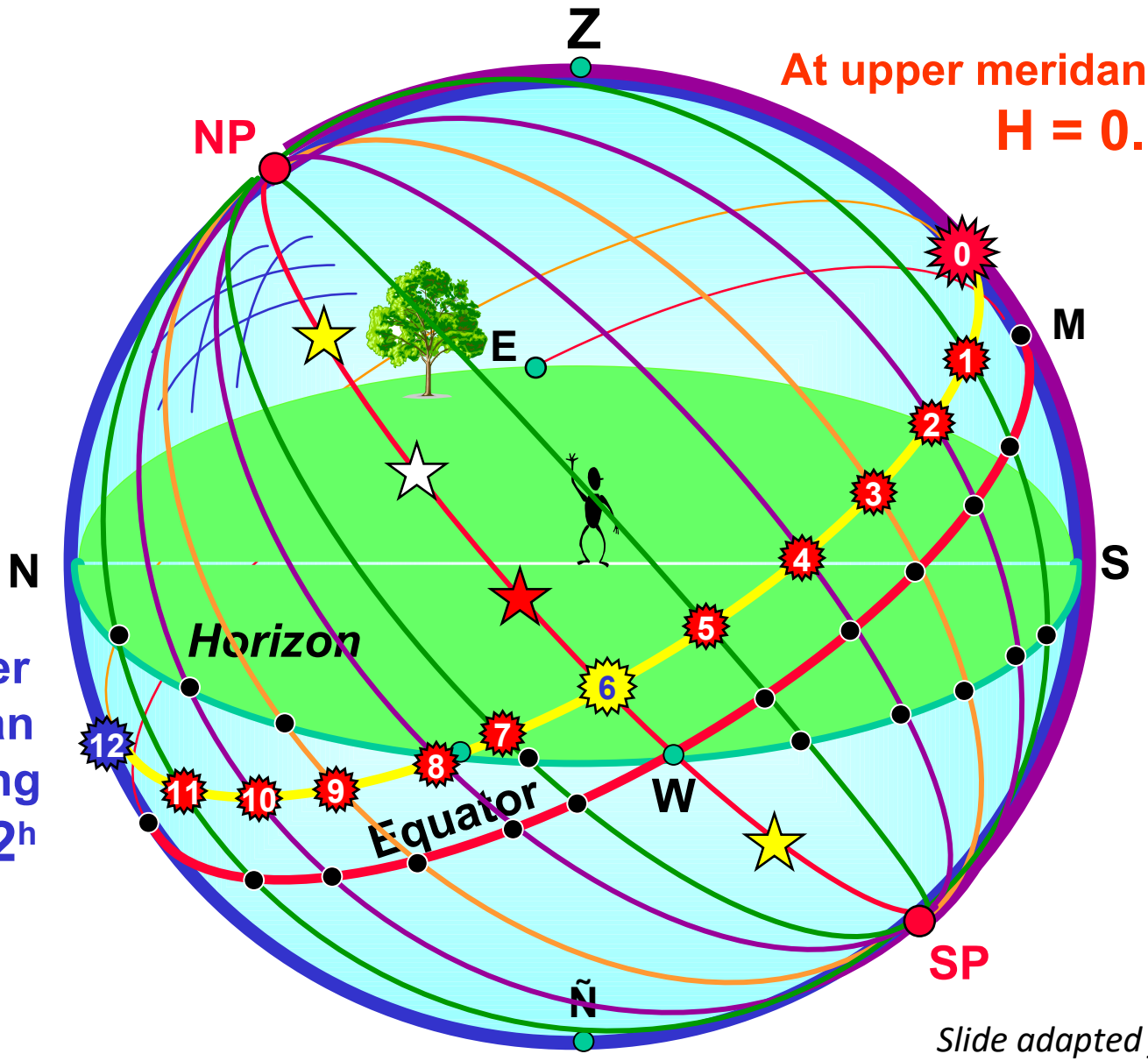


At upper meridian crossing H = 0.

At lower meridian crossing: H = 180°

Slide adapted from Prof. Boczko

Example of hour angles



At upper meridan crossing:

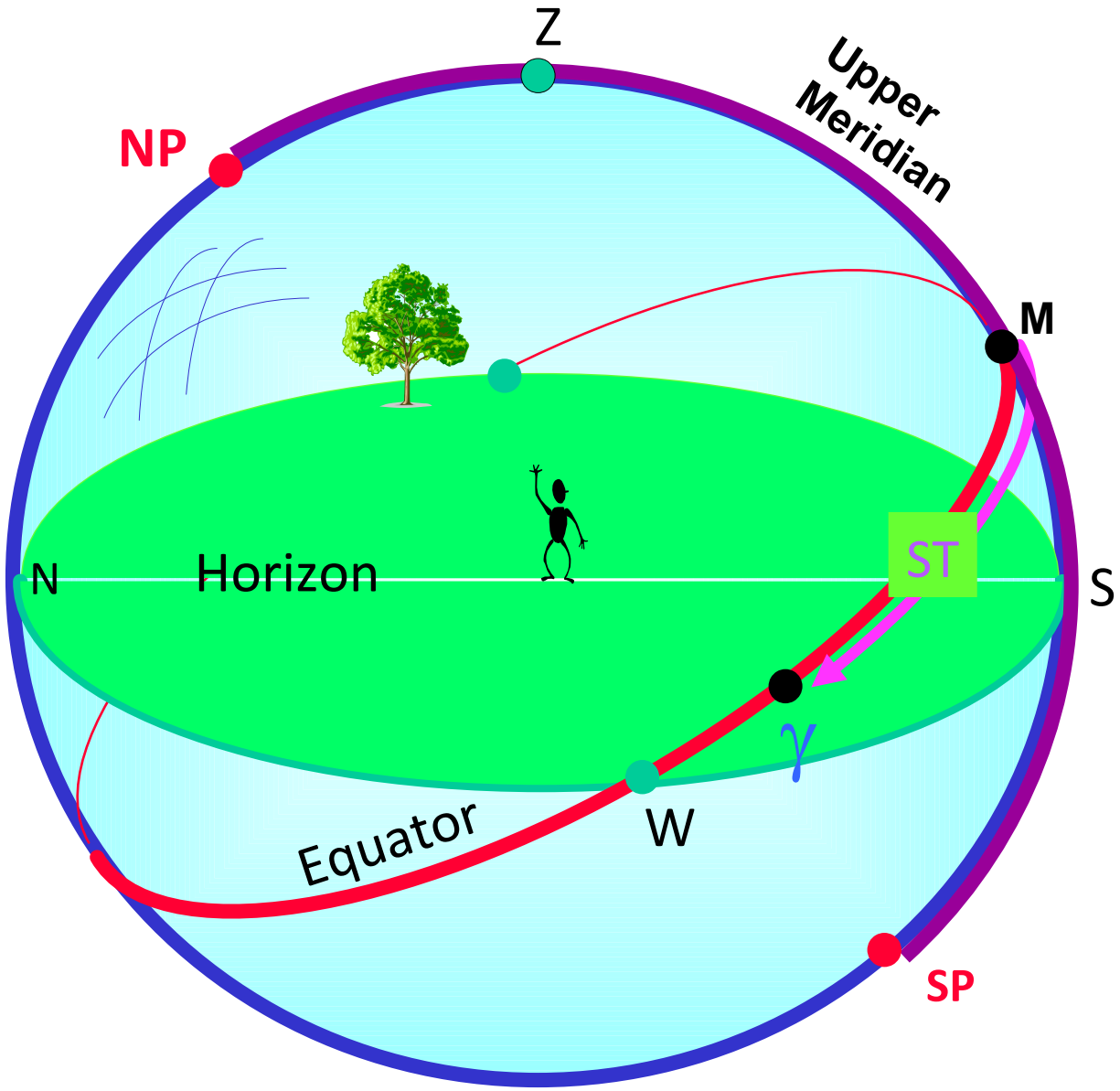
H = 0.

At lower meridian crossing

H = 12h

Slide adapted from Prof. Boczko

Sidereal time: the hour angle of γ

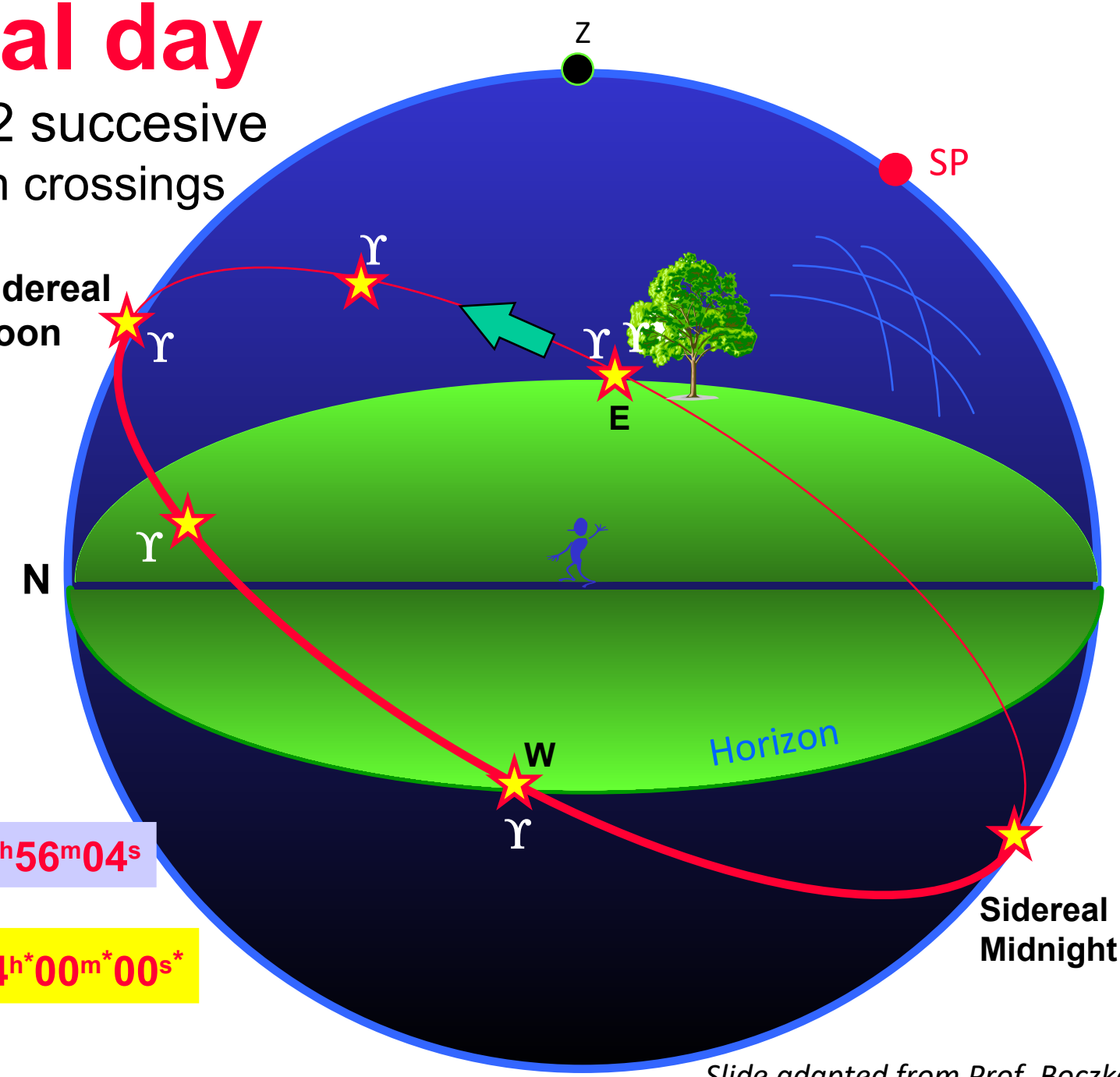


$$ST \equiv H_{\gamma}$$

Slide adapted from Prof. Boczko

Sidereal day

Interval for 2 succesive local meridian crossings of γ



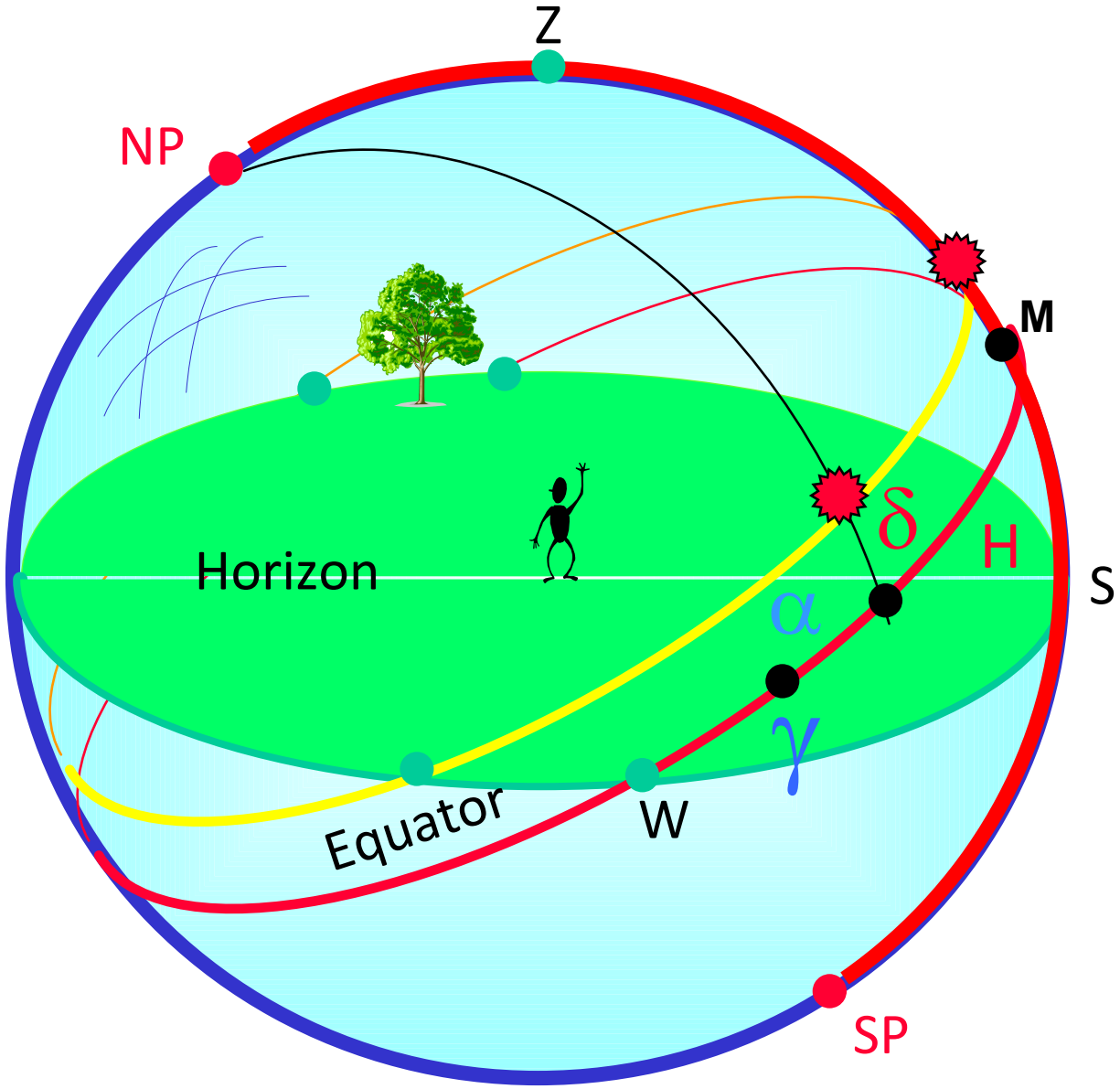
Sidereal day ≅ $23^h56^m04^s$

Sidereal day ≡ $24^{h*}00^{m*}00^{s*}$

*** : sidereals**

Slide adapted from Prof. Boczko

Measuring the right ascension at meridian crossing



$ST = H_{\gamma}$

$ST = \alpha + H$

At upper meridian crossing: H = 0

Then:

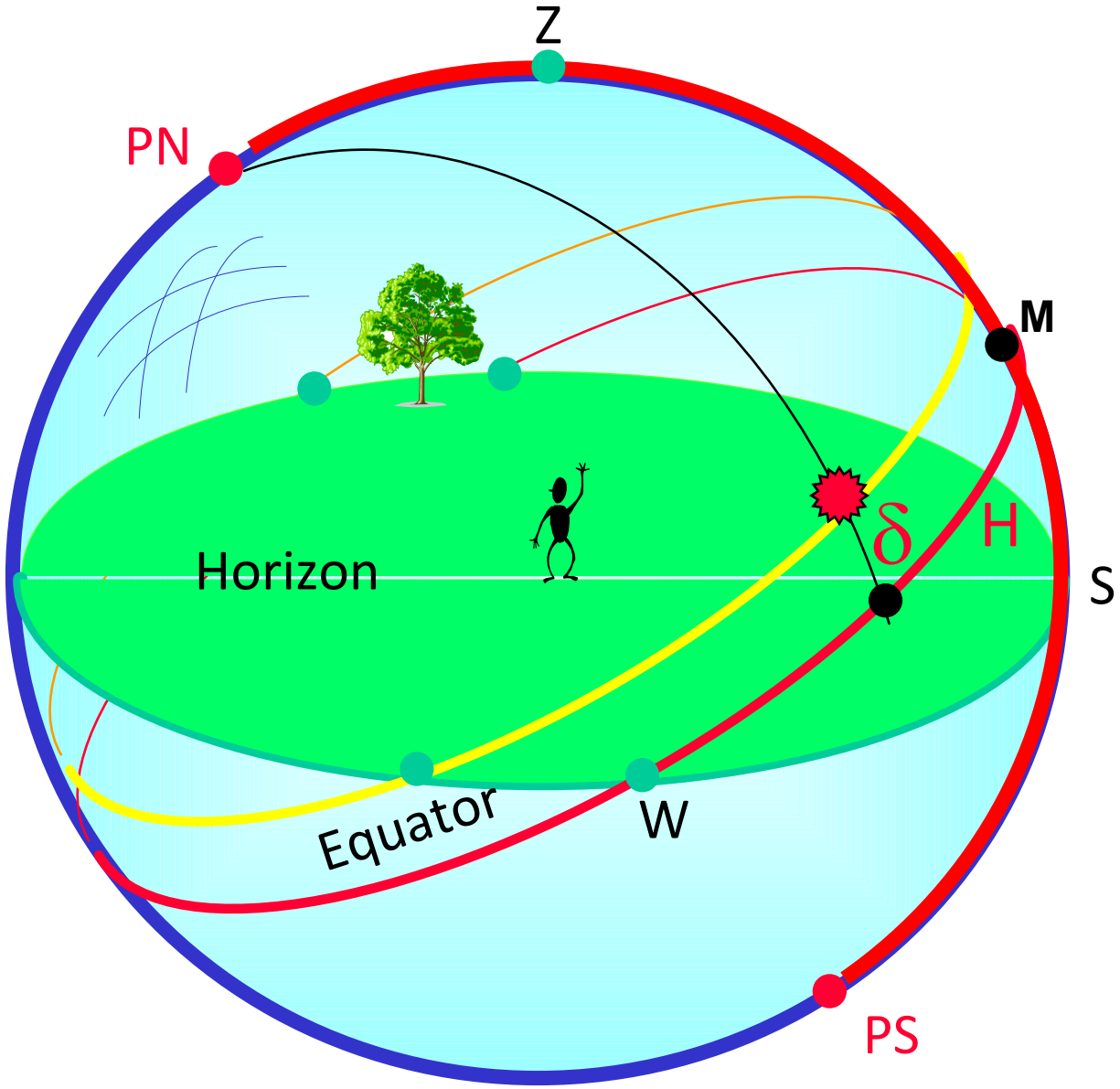
$\alpha = ST_{Mer.crossing}$

Slide adapted from Prof. Boczko

Meridian Circle at Valinhos

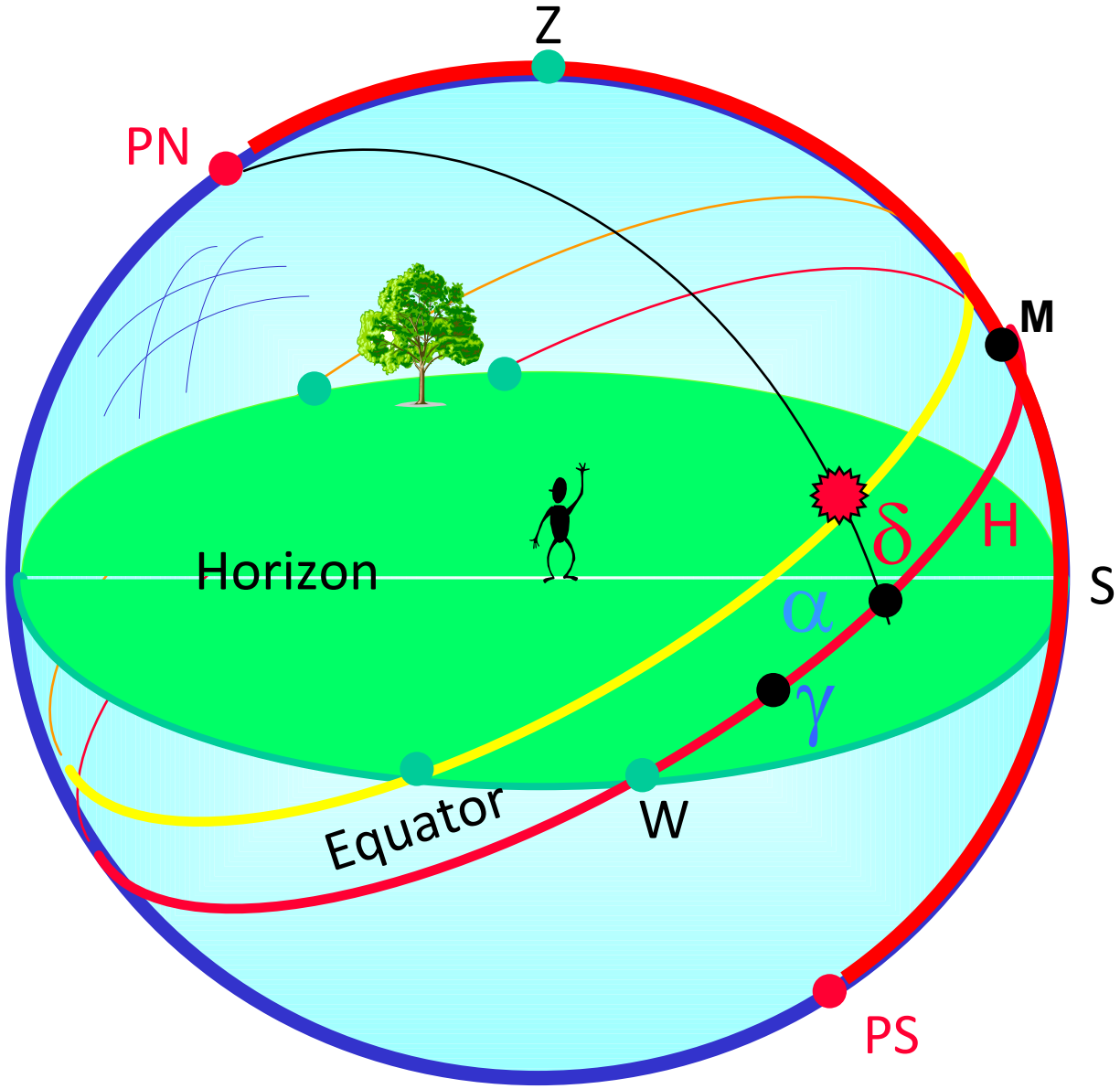
Prof. Rama

Do it yourself: star in London with hour angle H = 3h & declination $\delta = 15^{o}$?



Slide adapted from Prof. Boczko

Do it yourself: star in London with H=3h, δ=15° & α=1h30m, draw α



What is the sidereal time ST?

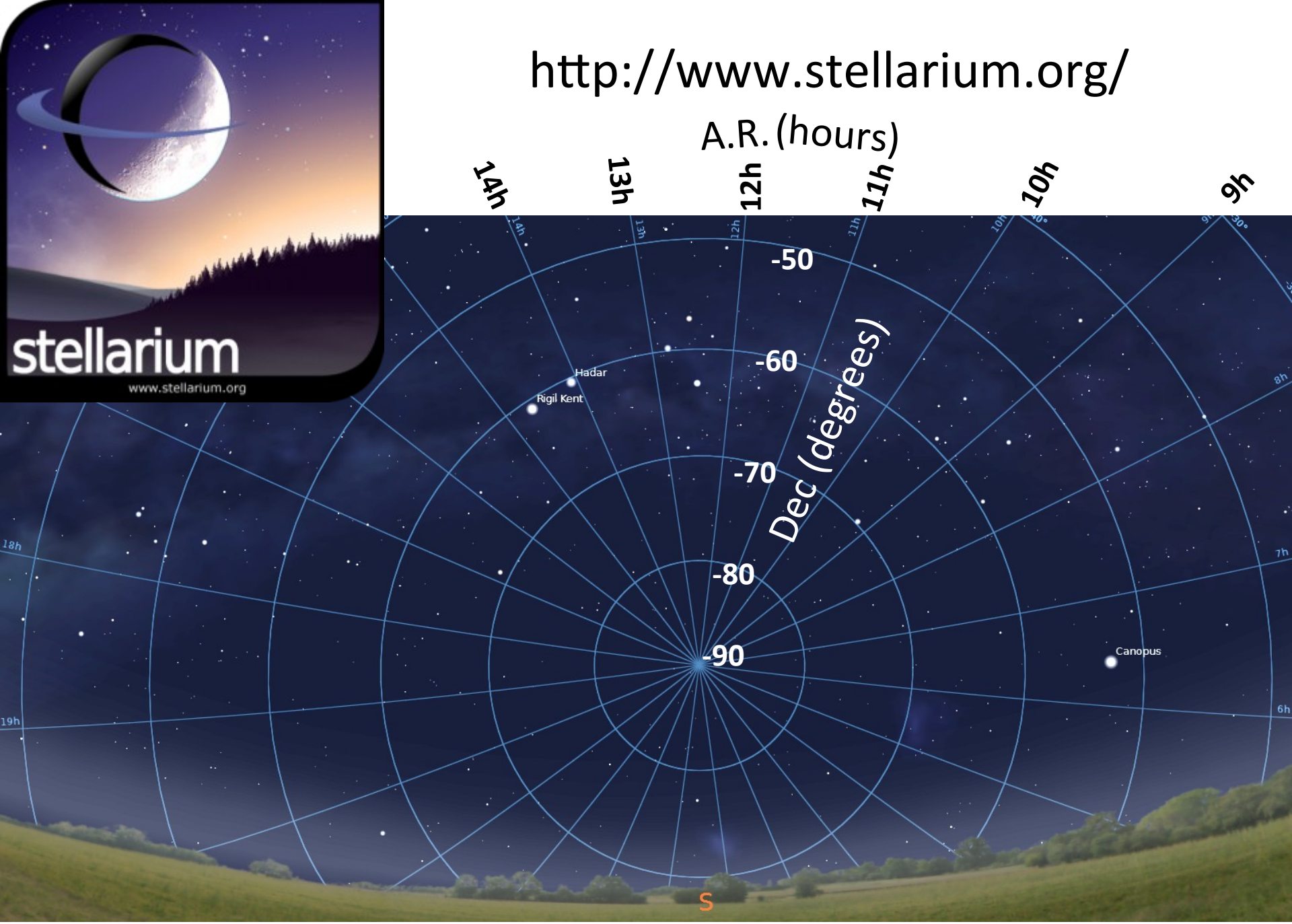
ST = 4h30m

Slide adapted from Prof. Boczko

Provinha:

4. Draw Orion as seen from São Paulo (23.5° S, 46.6° W) at the meridian passage

http://www.stellarium.org/



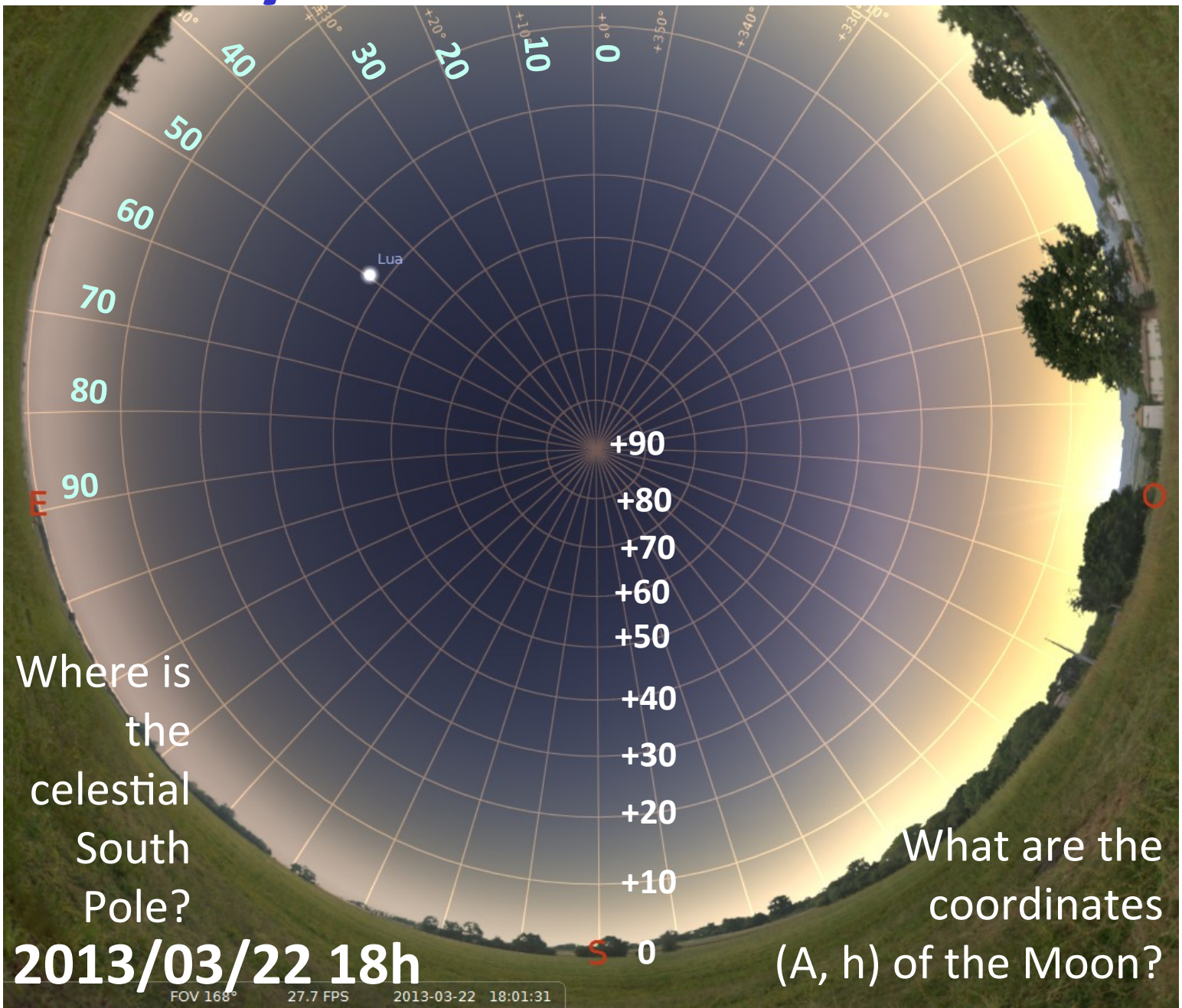
Provinha:

5. Choose your question.

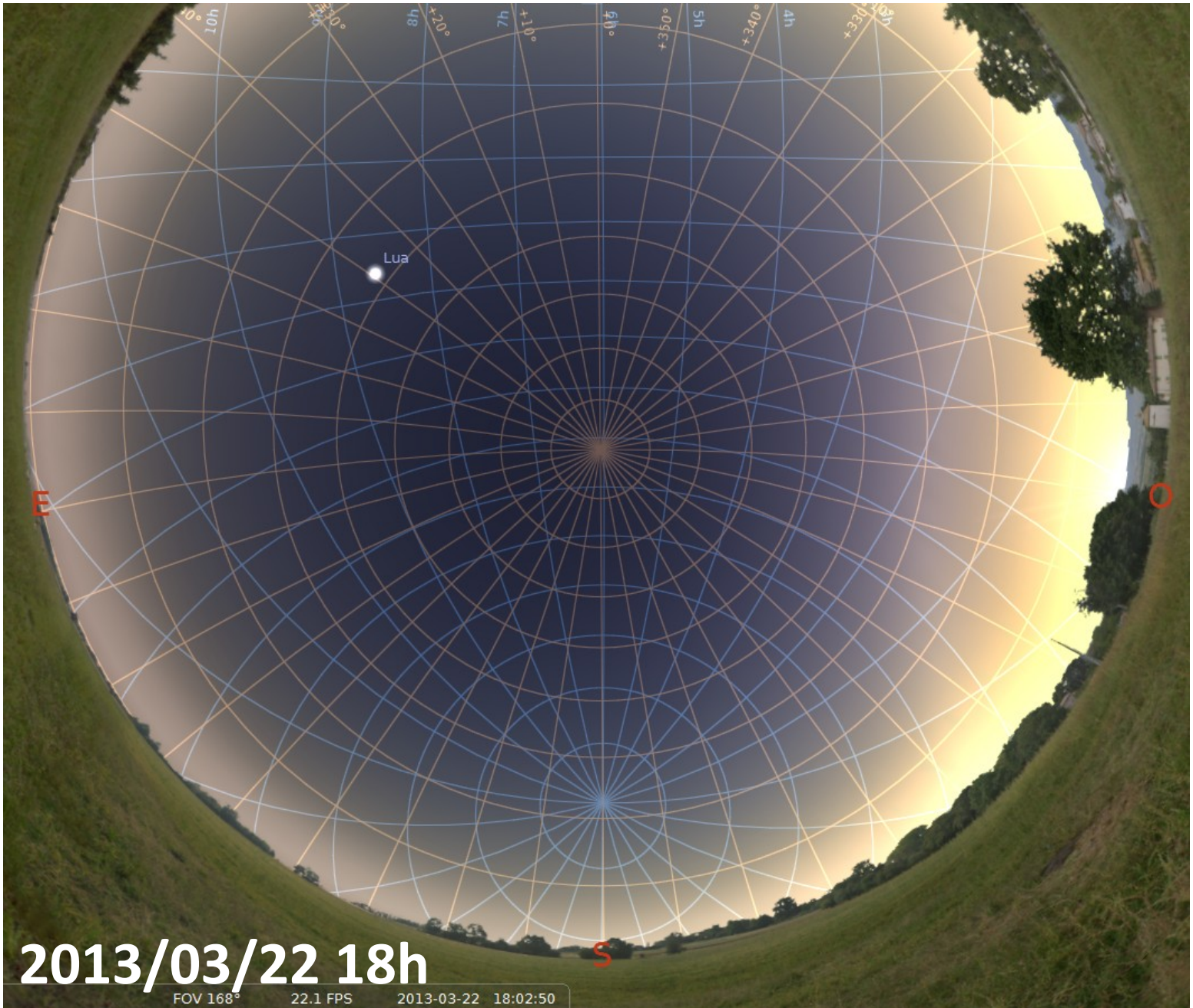
If correct, write 2 pts next to the question

The Sky at OPD observatory

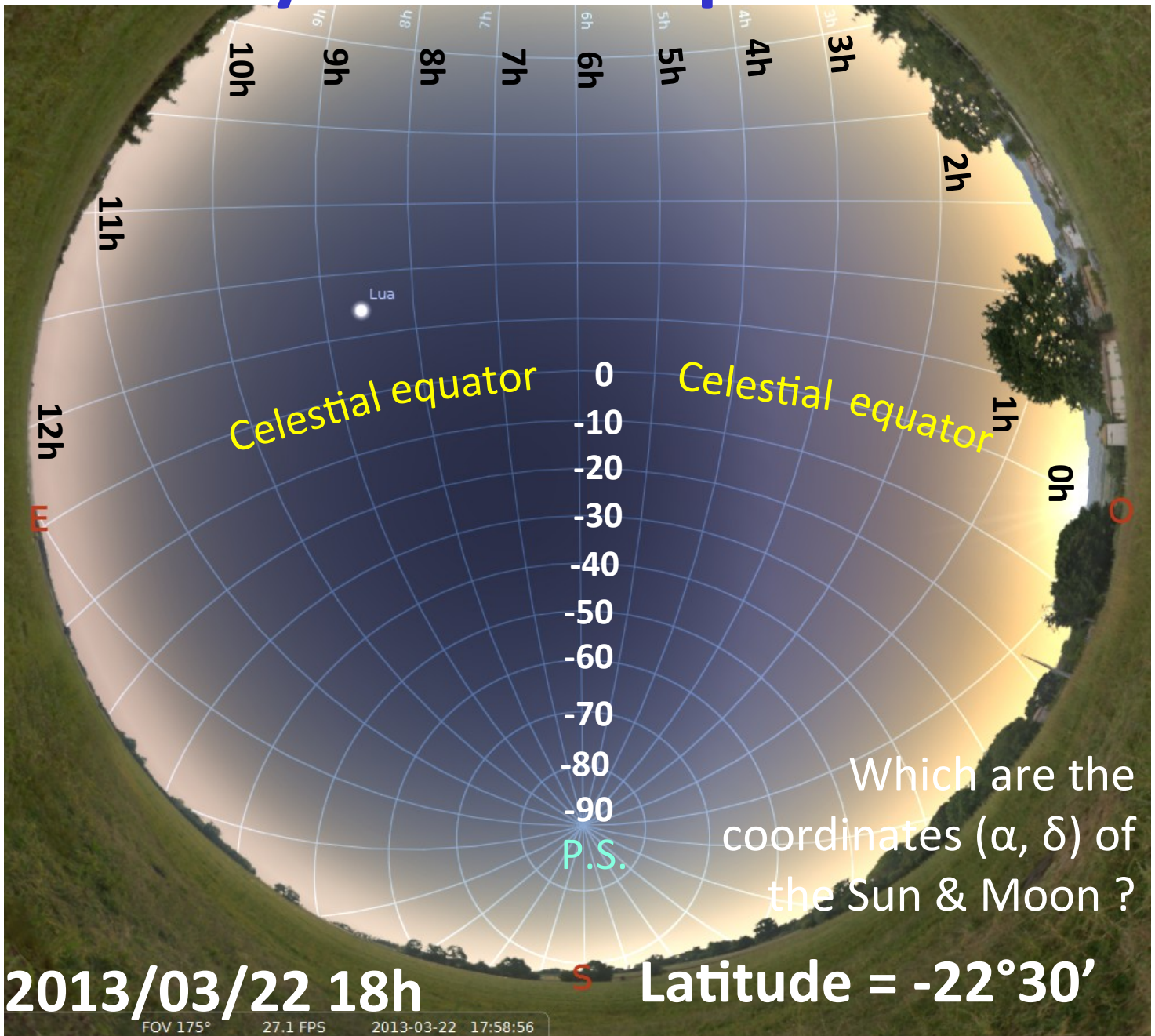
Sky at OPD: altazimutal

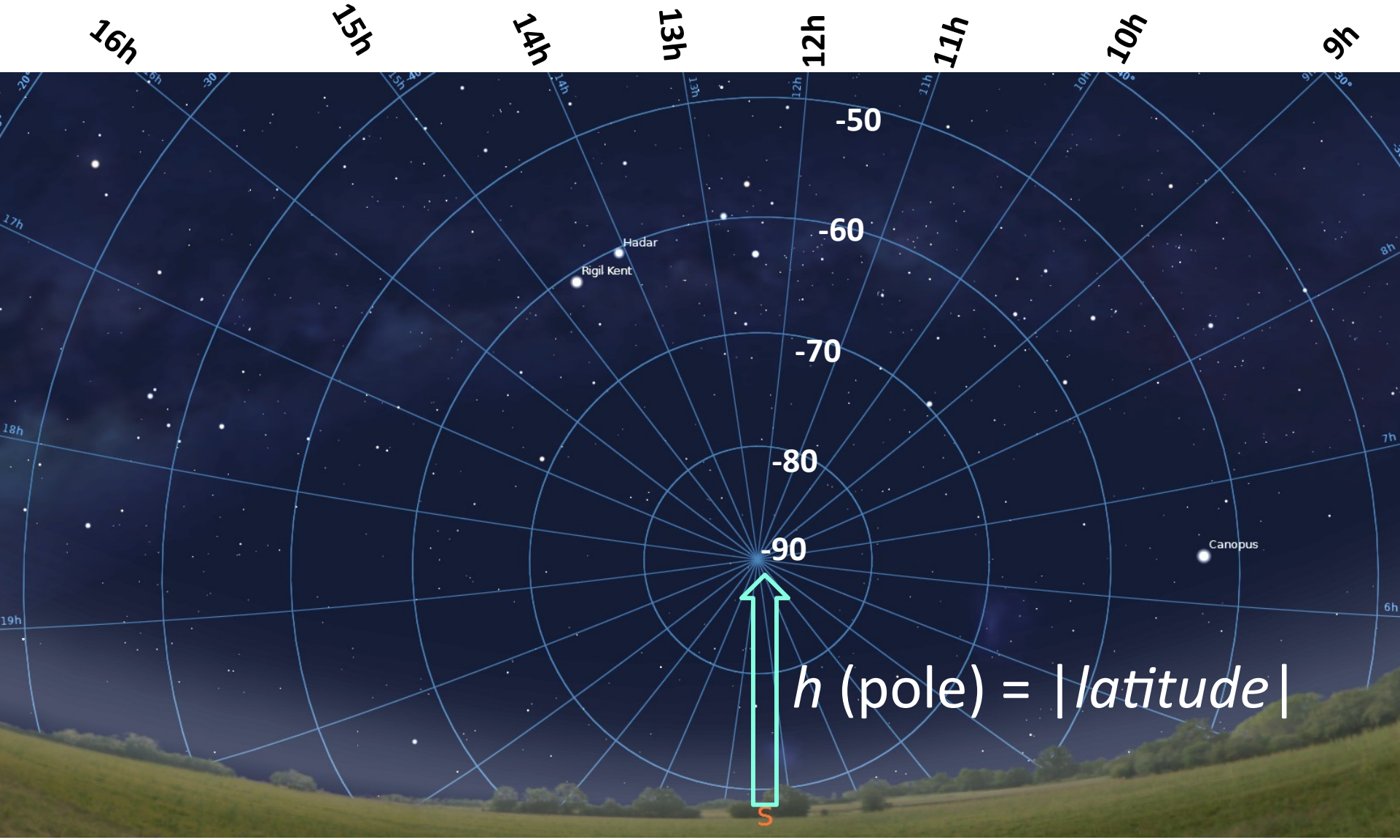


Sky at OPD: altazimutal + equatorial

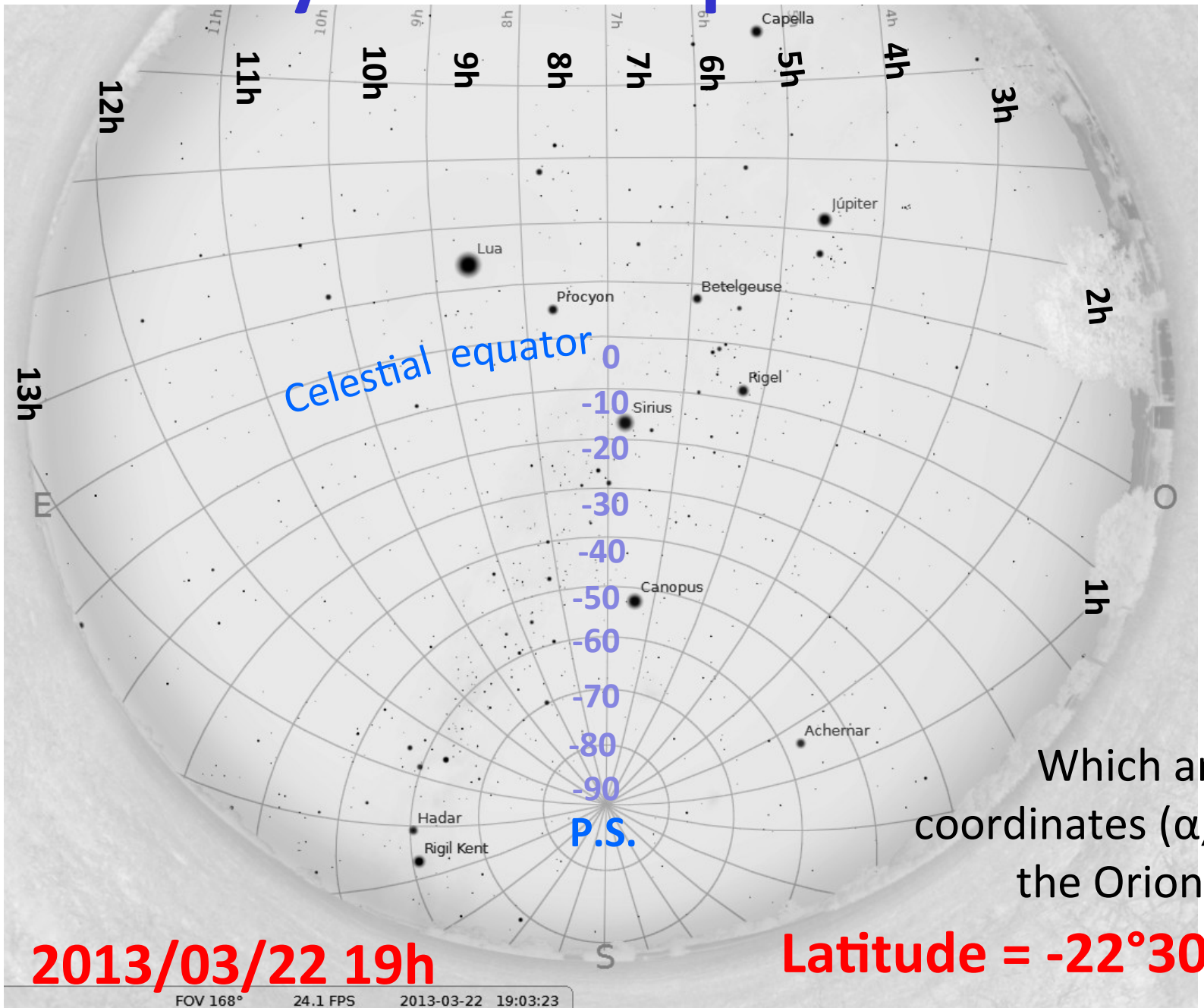


Sky at OPD: equatorial




16h
15h
14h
13h
12h
11h
10h
9h
-50
-60
-70
-80
-90
Hadar
Rigil Kent
Canopus
17h
18h
19h
8h
7h
6h
h (pole) = |latitude|
S

Sky at OPD: equatorial

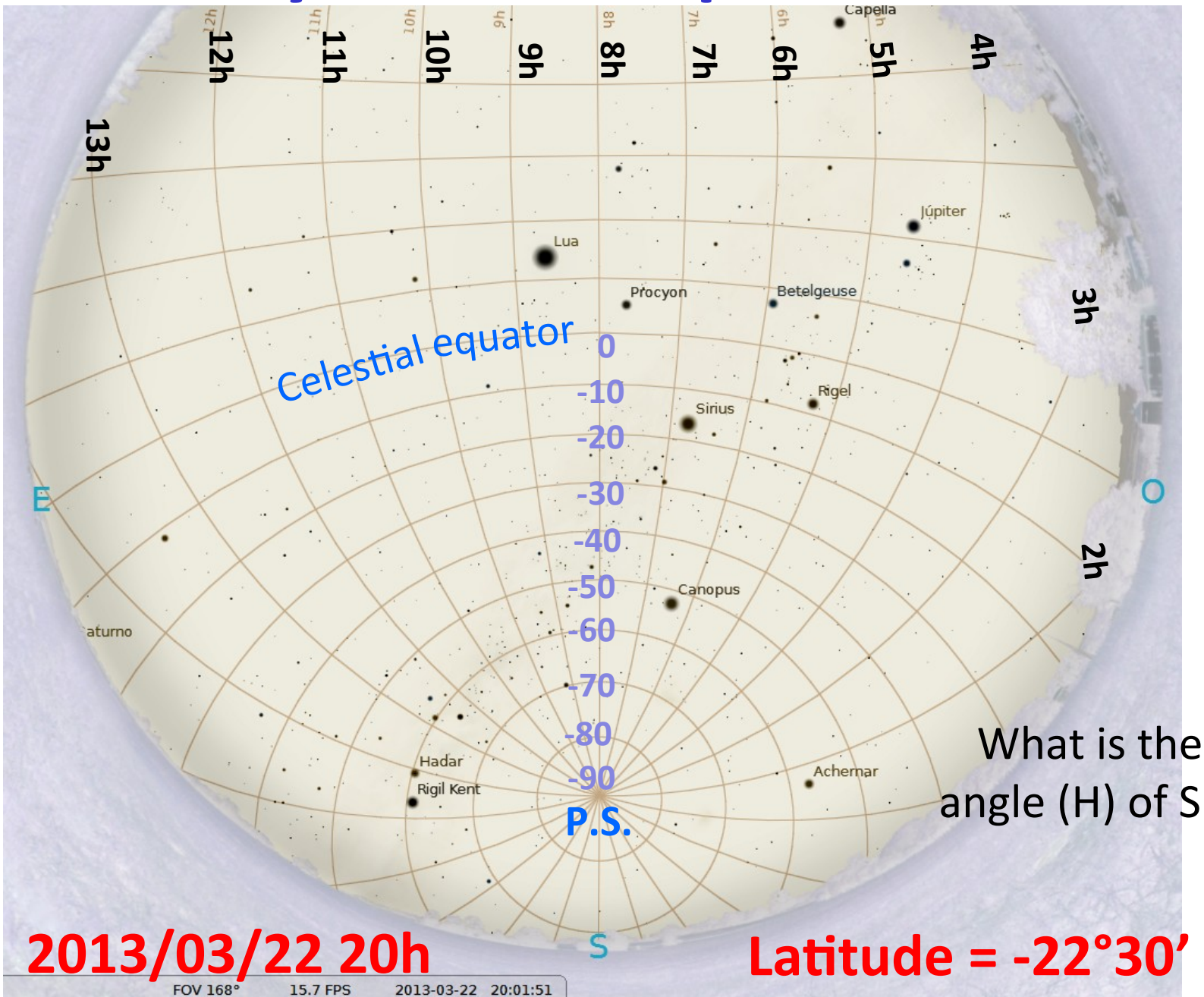


Which are the coordinates (α, δ) of the Orion belt?

2013/03/22 19h

Latitude = -22°30’

Sky at OPD: equatorial

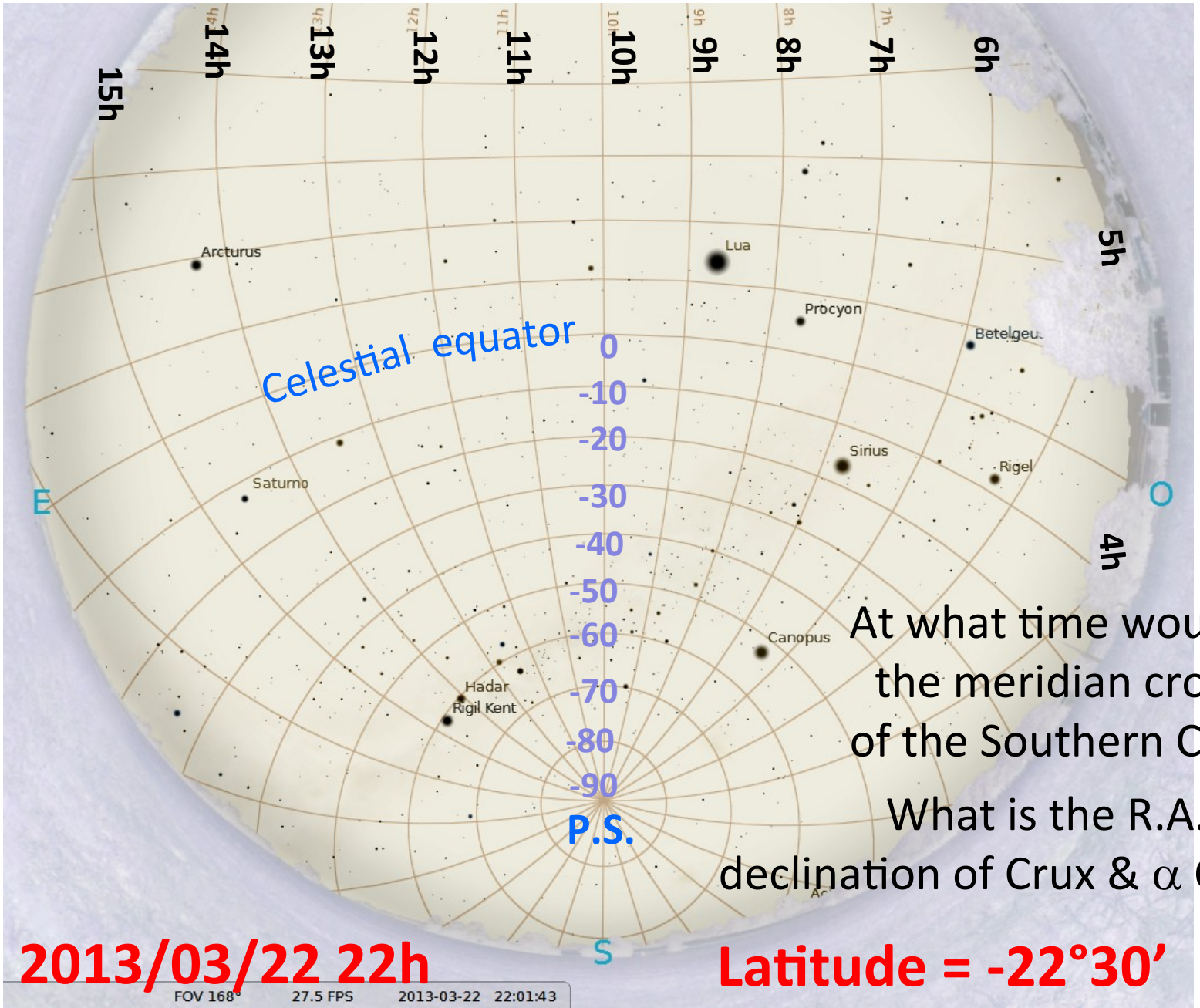


What is the hour angle (H) of Sirius?

2013/03/22 20h

Latitude = -22°30’

Sky at OPD: equatorial



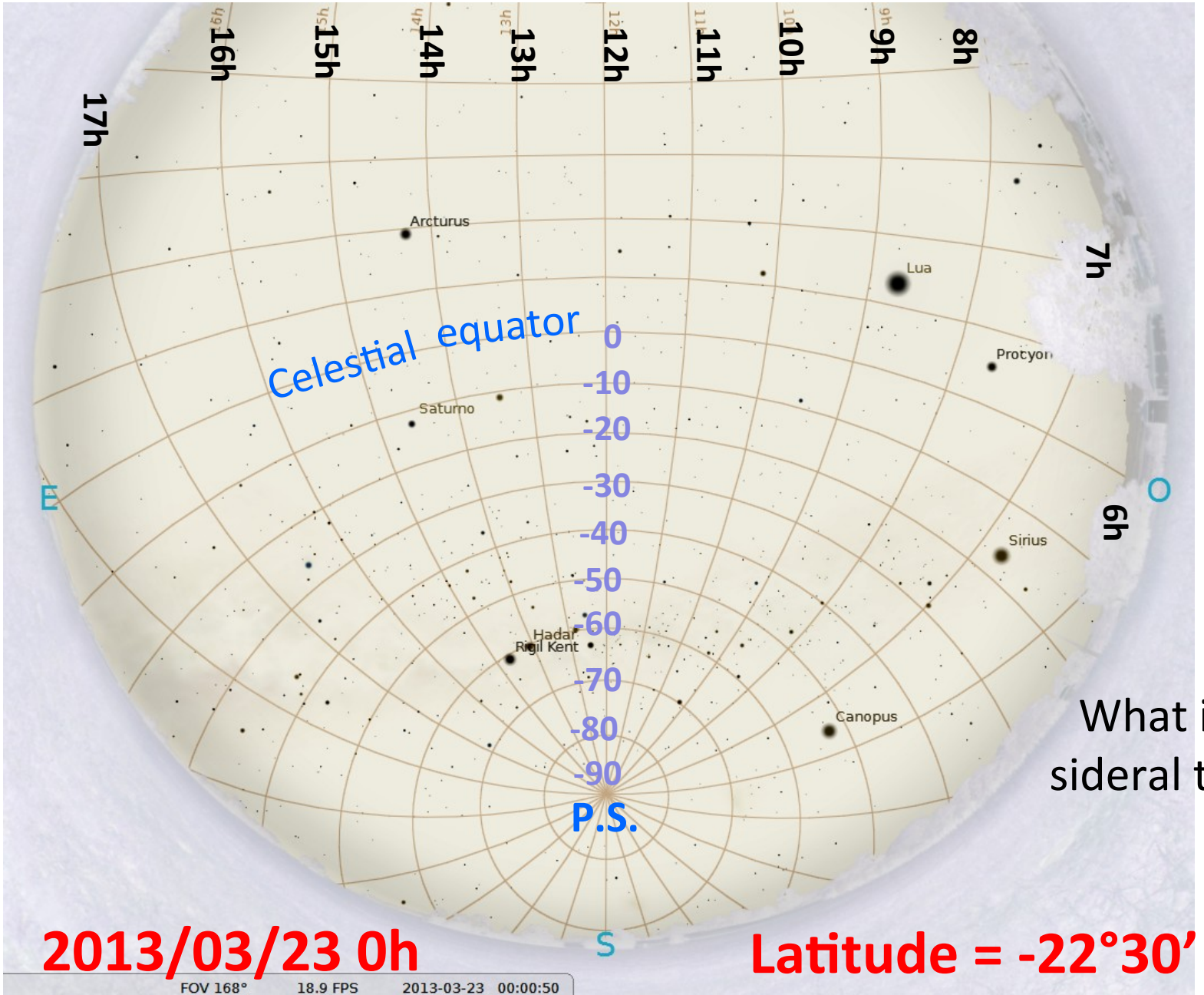
At what time would be the meridian crossing of the Southern Cross?

What is the R.A. and declination of Crux & α Cen?

2013/03/22 22h

Latitude = -22°30'

Sky at OPD: equatorial

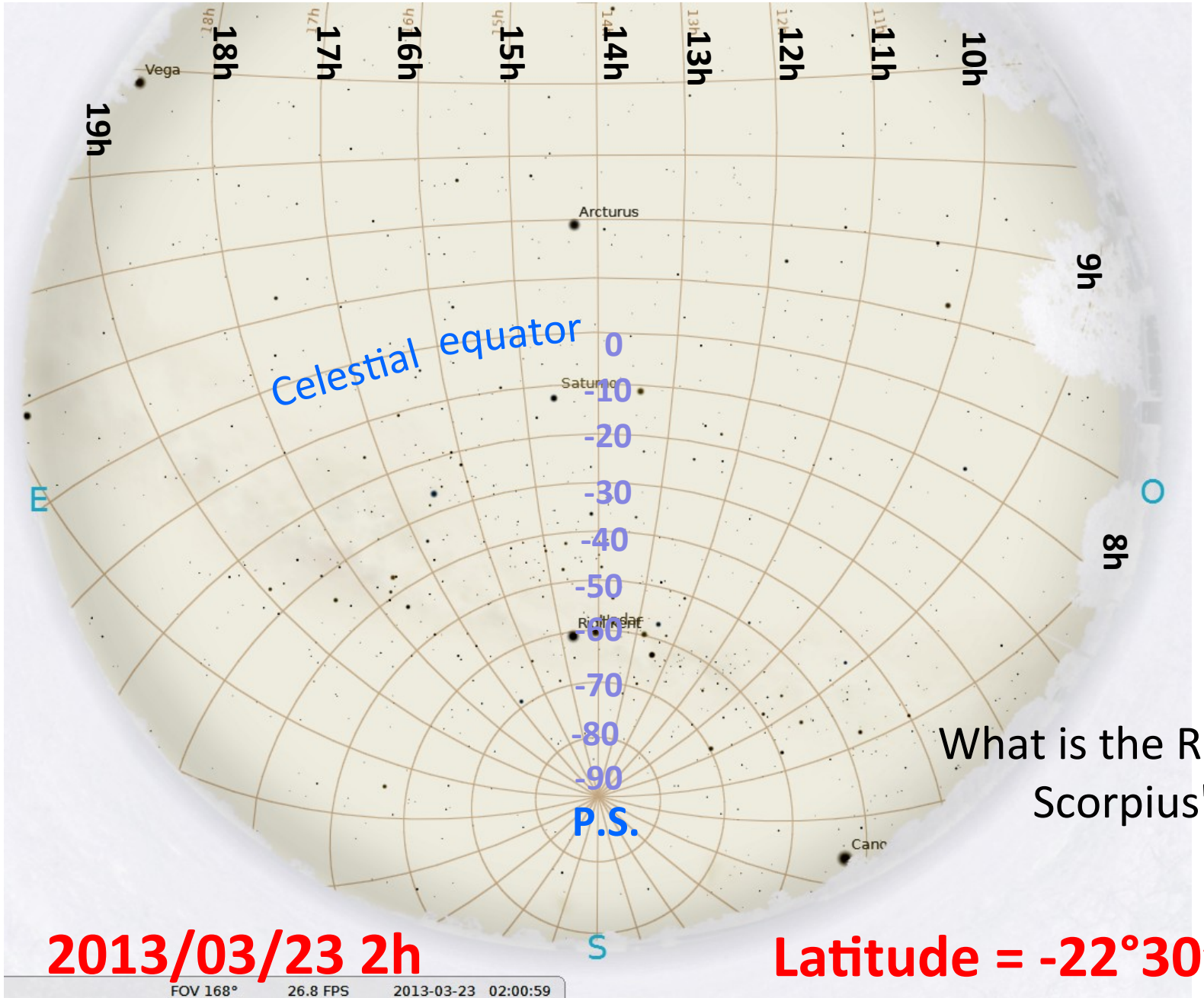


What is the sideral time?

2013/03/23 0h

Latitude = -22°30'

Sky at OPD: equatorial

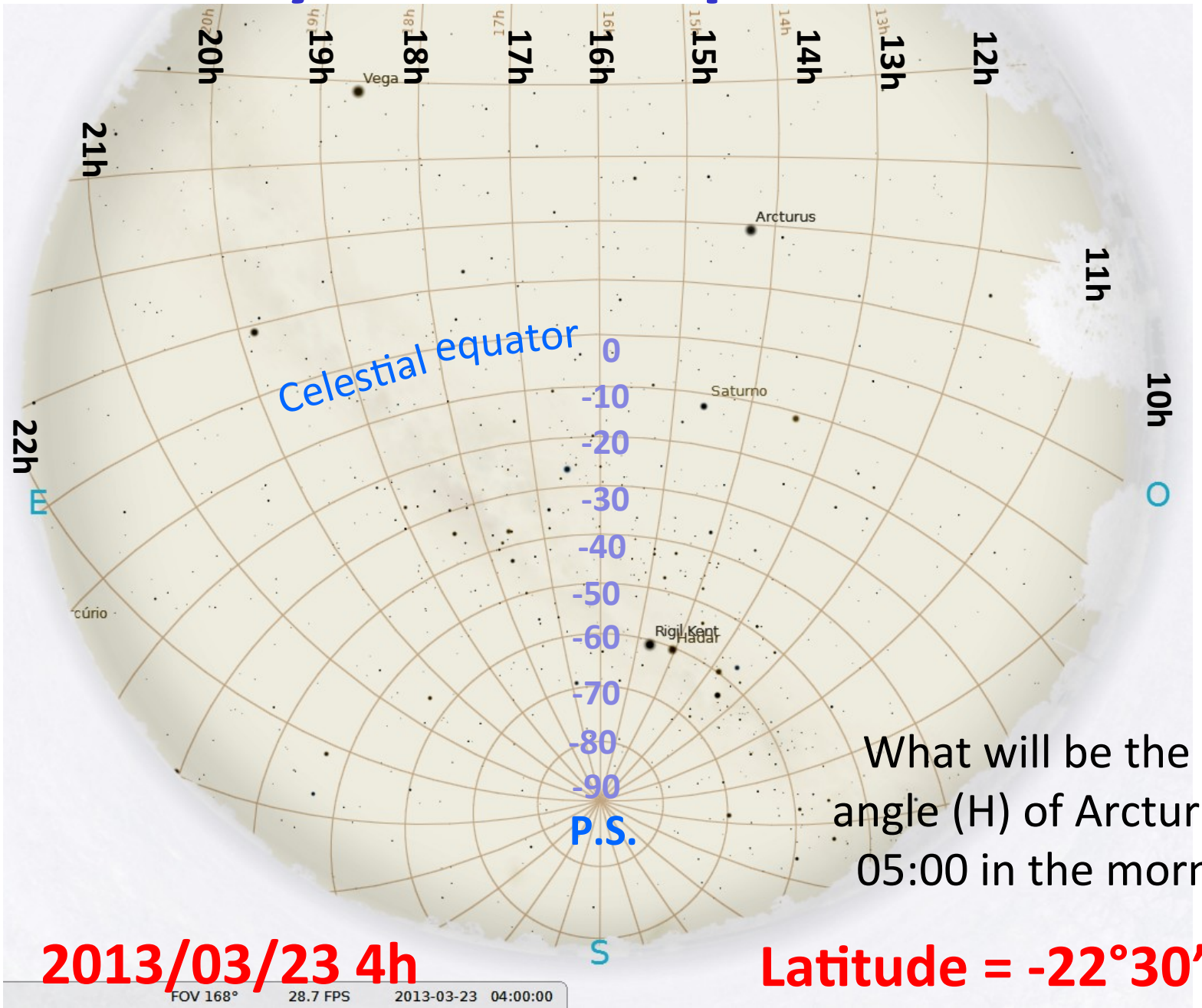


What is the R.A. of Scorpius' tail?

2013/03/23 2h

Latitude = -22°30'

Sky at OPD: equatorial

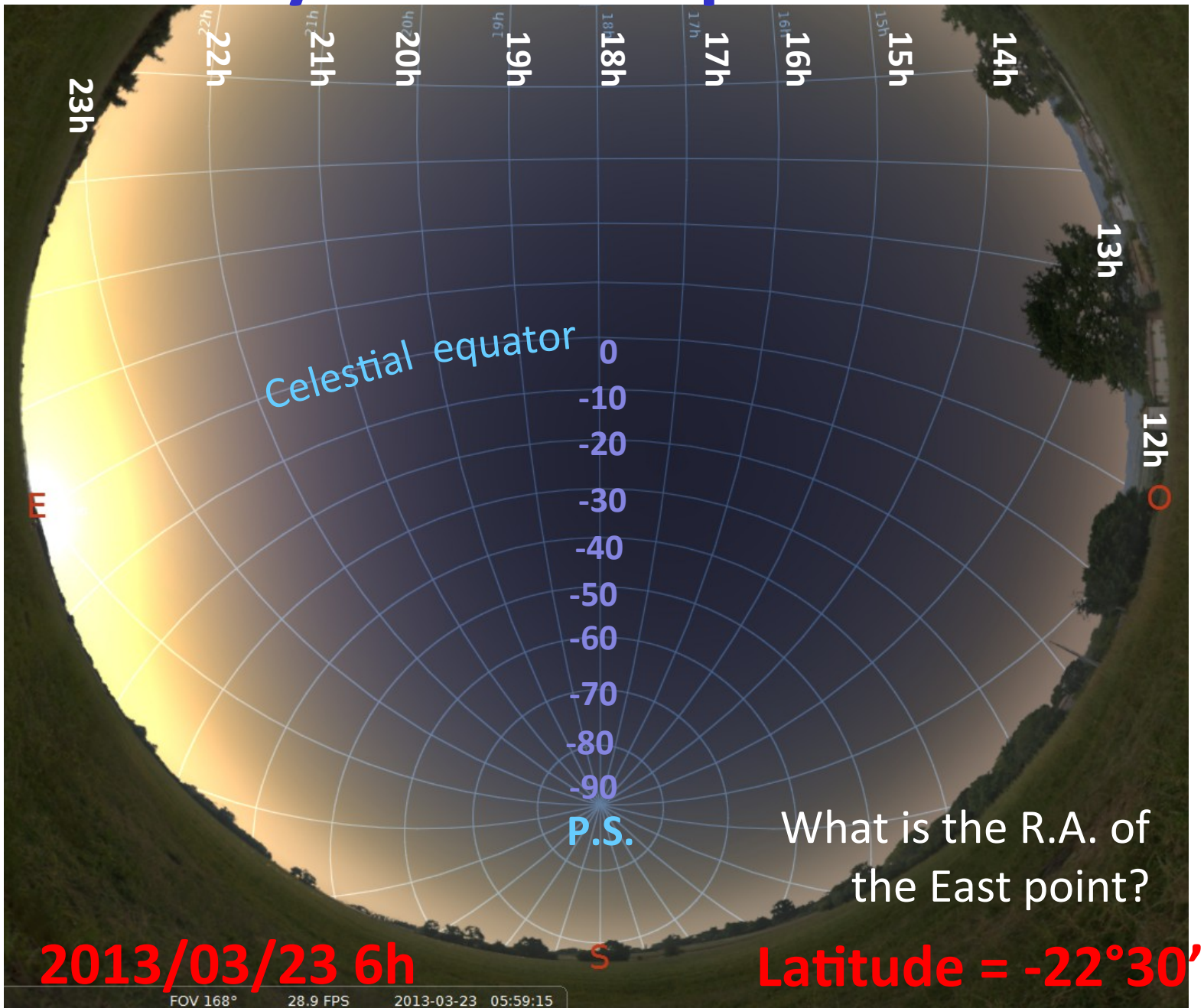


What will be the hour angle (H) of Arcturus at 05:00 in the morning?

2013/03/23 4h

Latitude = -22°30'

Sky at OPD: equatorial



Campos dos Goytacazes, RJ

http://www.twanight.org

http://apod.nasa.gov/apod/ap090509.html

Imagine the equatorial system on the sky!

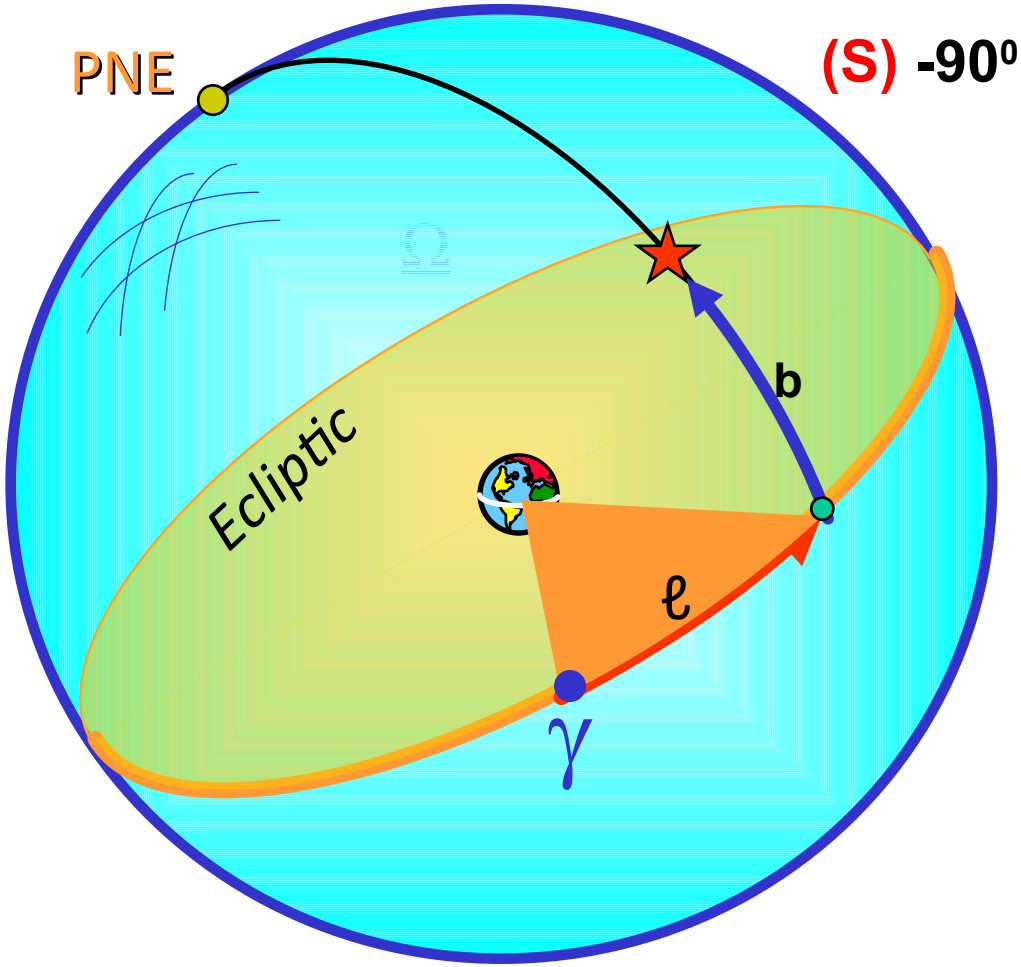
Ecliptic system

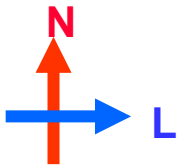
ℓ : ecliptic longitude
b : ecliptic latitude

★ **(ℓ , b)**

$0^0 \leq \ell < 360^0$

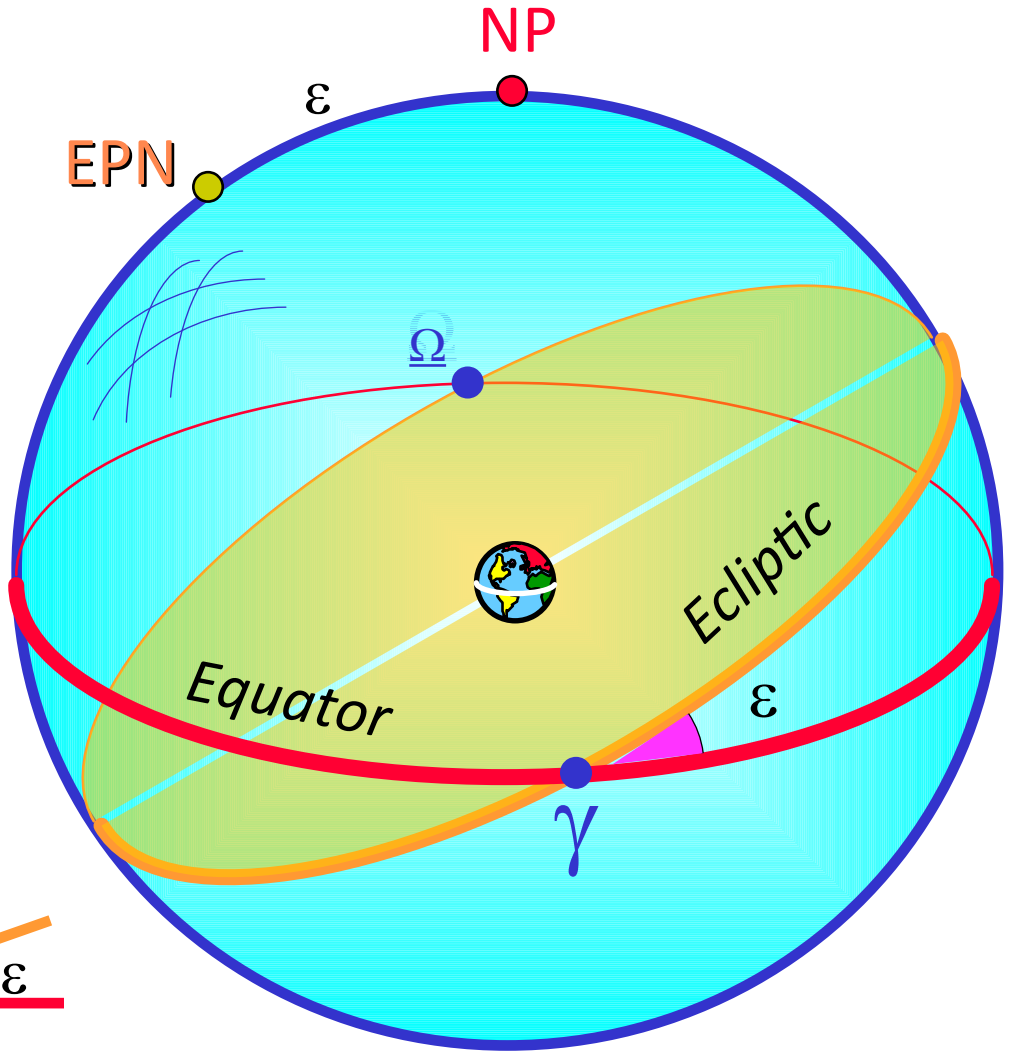
(S) $-90^0 \leq b \leq +90^0$ **(N)**

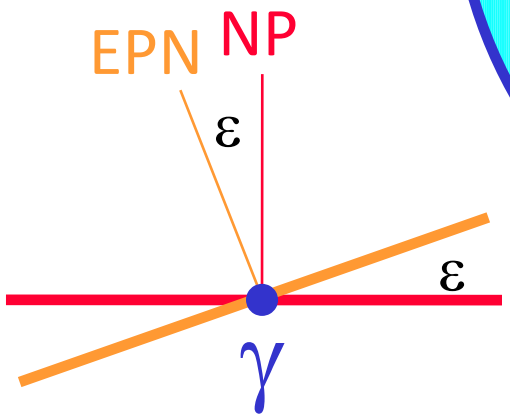


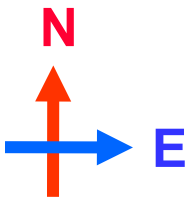


Slide adapted from Prof. Boczko

Equatorial & Ecliptic System







Slide adapted from Prof. Boczko

Galactic system (ℓ , b)

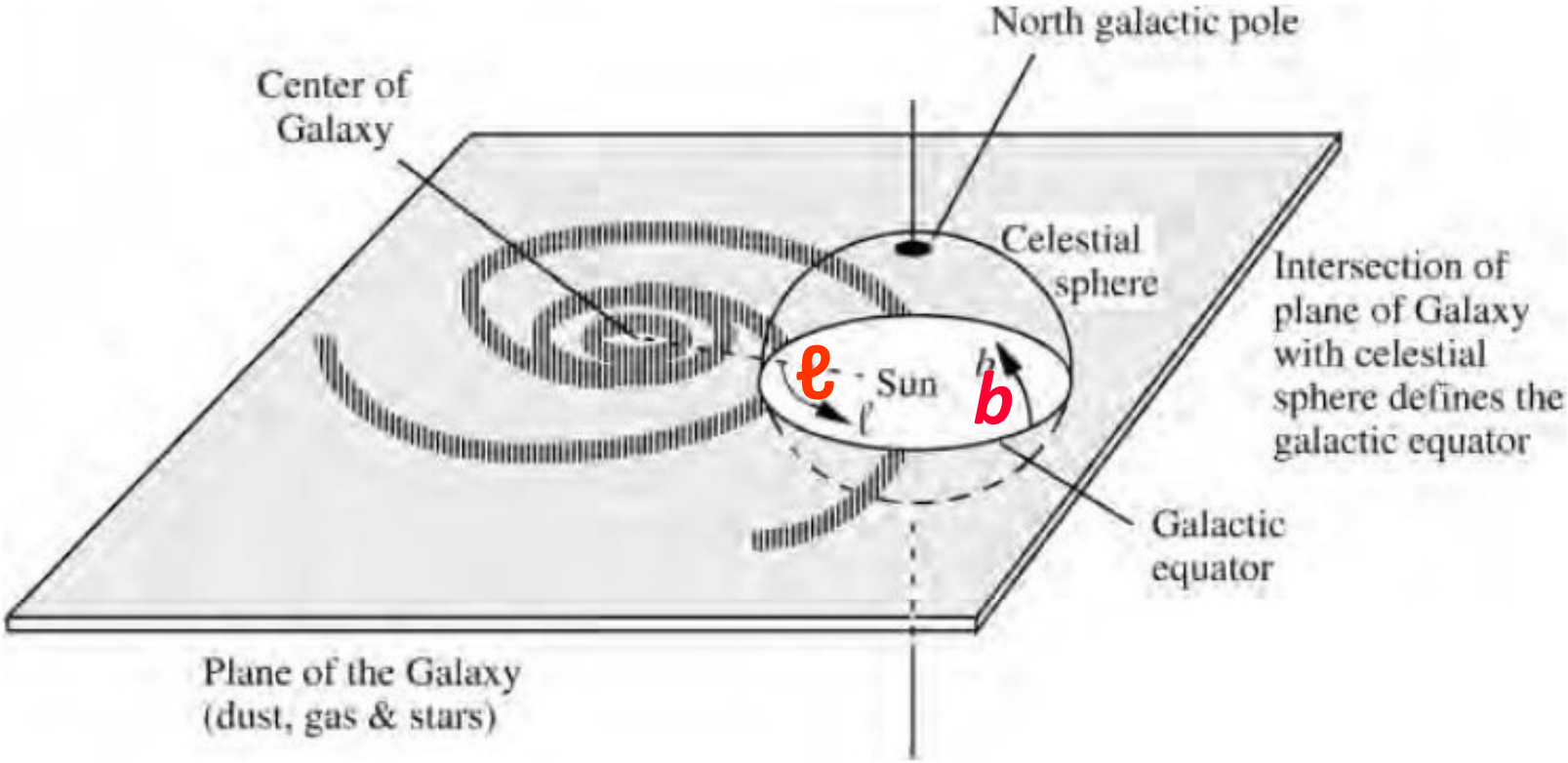
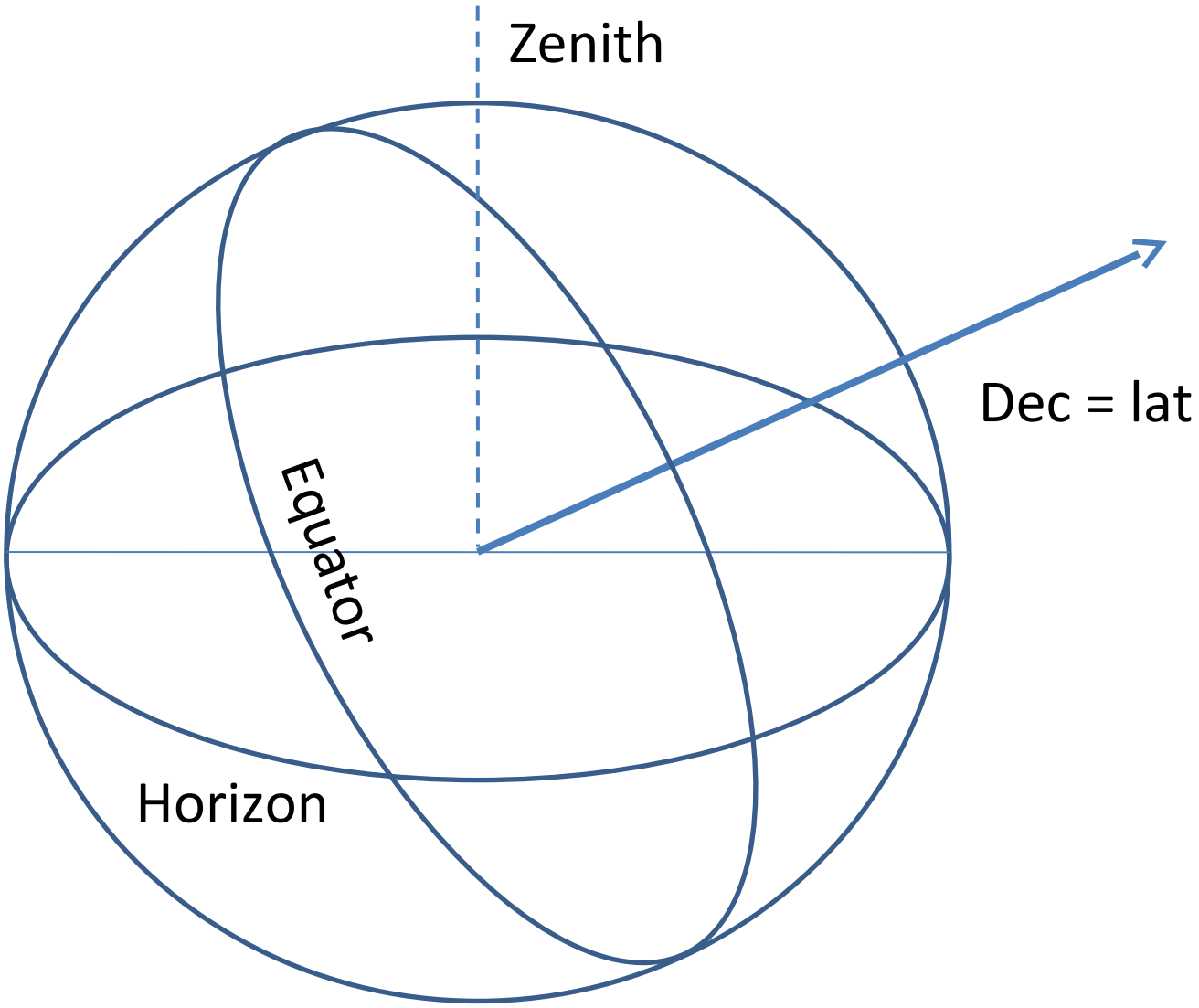


Figure 3.4. Galactic coordinates. The plane of the Galaxy defines the galactic equator on the celestial sphere. The angles that specify the location of a celestial body are measured from the sun. Galactic longitude, ℓ, is measured approximately eastward from the direction of the galactic center in units of degrees (0° to 359.9°) as shown. Galactic latitude, b, is measured in degrees (0° to ±90°) from the galactic equator, similar to latitude on the earth's surface. The north galactic pole (dark circle) is shown. The celestial sphere is quite small in this figure; in fact, its radius is infinite. The earth observer is located close to the sun.

Example drawing



The Complete Galactic Plane

Lebanon 6/2017
Chile 12/2017

(c) Moophz Himself (Maroun Habib)

https://apod.nasa.gov/apod/ap180313.html