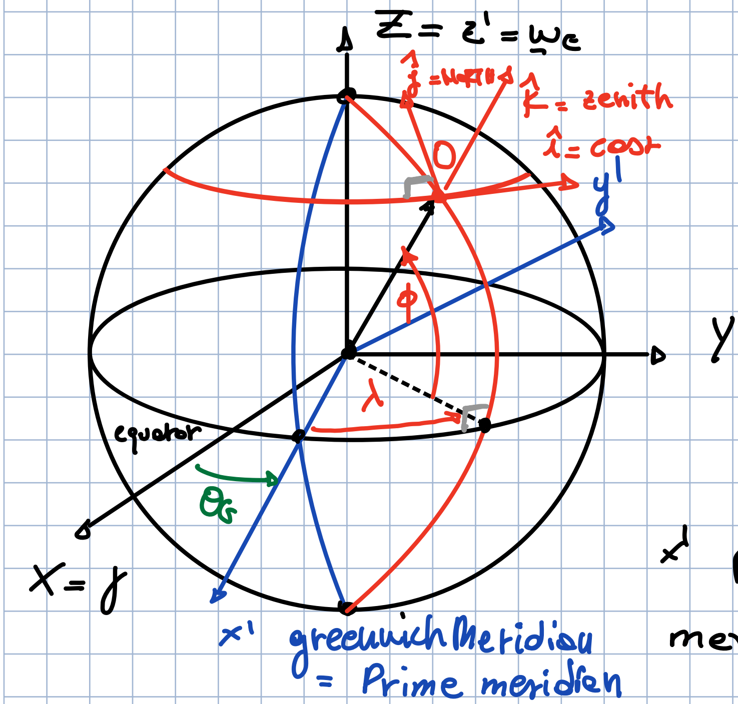
ORBITAL MECHANICS

TOPOCENTRIC HORIZON COORDINATE SYSTEM



XYZ = non-rotating, inertial Earth centred, equatorial frame

x'y'z' = RF embedded with the Earth, rotating with it.

$z = z' = \underline{\omega_e}$ axis of rotation of the Earth

x' passes trought greenwich meridian

meridian = part of a great circle

θ_G = angle between x' and X = GREENWICH SIDERAL TIME $\theta_G(t)$
↓
define wrt a fixed direction (X)

λ = LONGITUDE (EAST positive)
ϕ = LATITUDE (NORTH positive)
} → Identify the observer

O = TOPOCENTRIC HORIZON COORDINATE SYSTEM

ZENITH = same direction of the radial component points outward

$\hat{z} = \hat{k}$ = ZENITH $\quad \hat{i}, \hat{j}, \hat{k}$ spherical coordinate system $\quad$ xy plane = LOCAL HORIZON

NADIR = point at the center of the Earth opposite direction of the zenith.

PARALLEL = is not on arc of a great circle ⇒ It is only on arc of a circle.

xy ∈ PLANE ⊥ to $\hat{k} = \hat{z}$ passing through O and tangent to Earth surface at O.

OBSERVER POINT OF VIEW

An observer O see all the s/c and satellite projected on a celestial sphere centred in O with an infinite radius.

- CELESTIAL SPHERE = centred at the observer

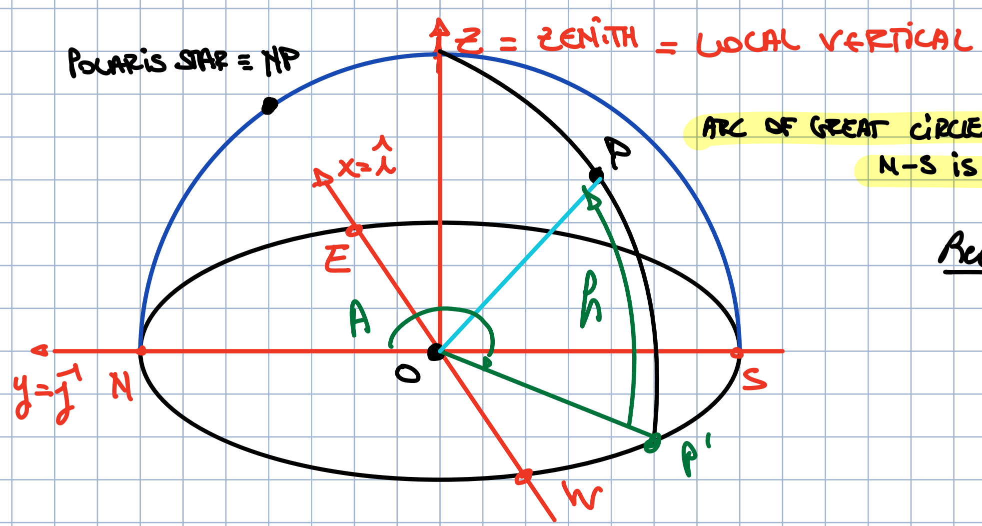
  ZENITH LINE

  NADIR POINT = opposit direction wrt zenith line

  HORIZON = plane $\perp$ to zenith-nadir line (Z) at observer position

  ↳ plane intersect the celestial sphere in the horizon

  The horizon is a GREAT CIRCLE OF SPHERE at 90° wrt zenith.



ARC OF GREAT CIRCLE OF THE OBSERVER
N-S IS THE MERIDIAN OF THE OBSERVER

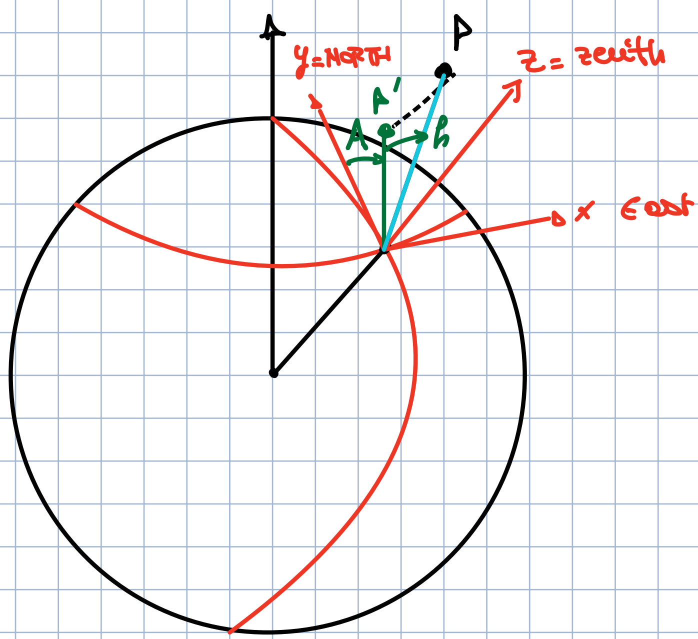
Recall = meridian is arc of a great circle

NP = position on the celestial sphere of the polaris star

$\overset{\frown}{\text{N NP Z}}$ S great circle trough zenith and NP

⟹ it will intersect the horizon at the N and S point.

*



the star is at an infinite distance so it does not matter where is P along the line of its projection.

A = AZIMUTH $\quad 0 \leq A < 360°$ $\quad 0 \leq A < 2\pi$ $\quad$ Angle clockwise from north to P'

h = ALTITUDE $\quad$ Angle from P' to line OP $\quad -\frac{\pi}{2} \leq h \leq \frac{\pi}{2}$

↳ Two angular spherical coordinate associated with $\hat{i}, \hat{j}, \hat{k}$

$\frac{\pi}{2} - h$ = ZENITH DISTANCE

A, h $\quad$ LOCAL VARIABLES (ANGLES)

- as observer moves on Earth surface ⟹ z changes
  - ↳ They are associated to the observer
- two observer in different location see different angles
- Earth's rotating around its axis ⟹ stars appears rotating

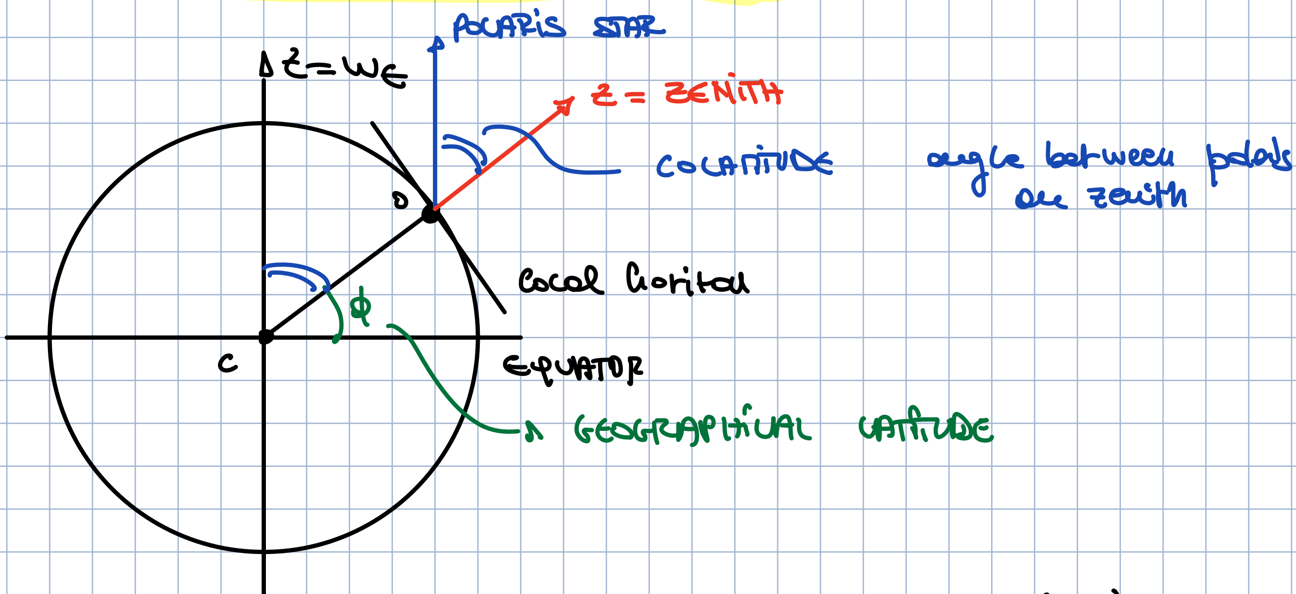
AZIMUTH, h change with time (Earth's rotating)

NOTE The only star that it appears to be fix is the Polaris stars ⟹ cause it is alligned with the axis of rotation of the Earth.

NOTE

A, λ are the same kind of angle as a spherical one but they are defined wrt two different reference frame

GEOGRAPHIC AND GEOCENTRIC COORDINATES

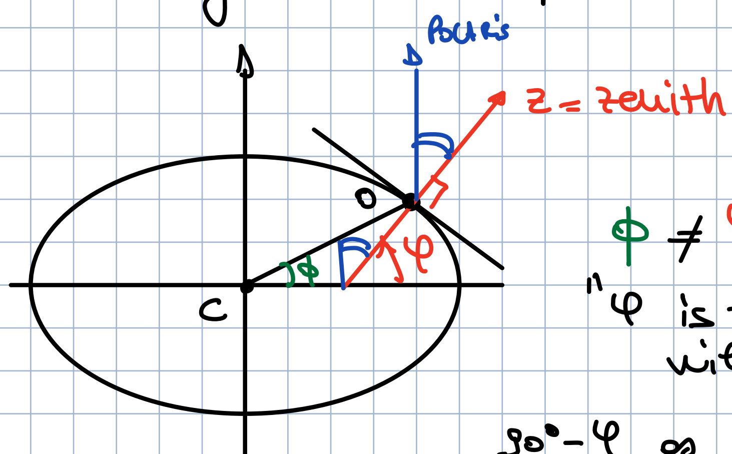


The Earth is not a perfect sphere (J_2 effect)

GEOGRAPHICAL LATITUDE — astronomical latitude corrected for station error (due to different distribution of mass).

φ = GEODETIC LATITUDE (ASTRONOMICAL LATITUDE)

angle between plumb line and Earth's equator



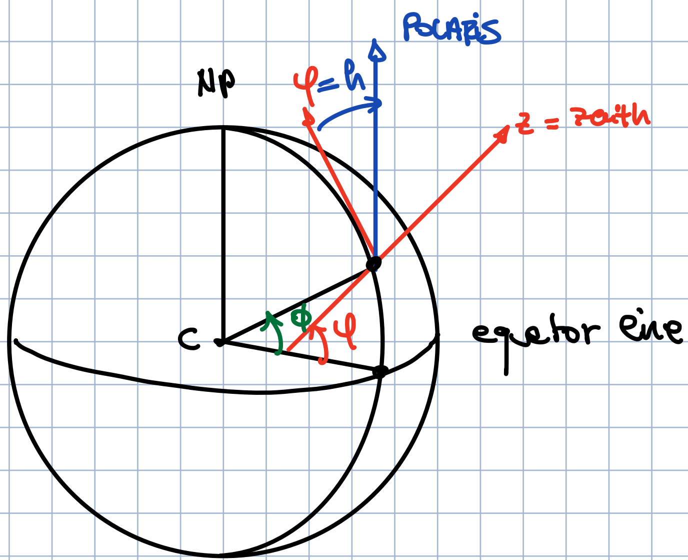
local horizon $\not\perp$ $\overline{OC}$

$\Phi \neq \varphi$

"φ is the actual angle that a station will measure" → not sure.

$90° - \varphi$ as angle between Polaris and local zenith

φ = ALTITUDE POLE OF THE CELESTIAL SPHERE



$\varphi = h$

other measurments errors due to ≠ mass distribution to be considered for precise calculus determination.

GEOGRAPHICAL LONGITUDE = angle along terrestrial equator from intersection of a fixed meridion and the one passing by observer

>0 eastward from Greenwich

<0 westward from greenwich

radius at the equator

radius of the poles

$$f = \frac{R_E - R_P}{R_E}$$

the same value we use to describe the precession motion.