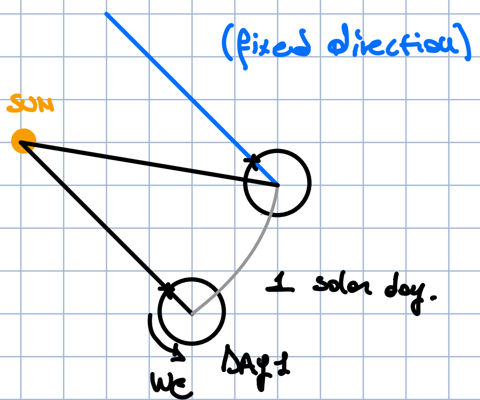
ORBITAL MECHANICS

To know the position of the local mean time wrt the local apparent time the quantity ε is tabulated in the American Ephemerides for each day of the observer

$$\varepsilon = LAT - LMT \qquad (2.64)$$

SIDEREAL DAY measured wrt a fixed star (fixed direction)

SOLAR DAY measured wrt the sun.



The Sun is very far away from Earth 1 AU but it is not at an infinite distance.

Solar day 24 h > Sidereal day 23 h 56 min

Earth rotates 360.986° in a solar day

Earth rotates 360° wrt fixed direction in a sidereal day.

The meridian is going to be back at the same position before wrt the fixed position and after that the meridian will align wrt to the sun.

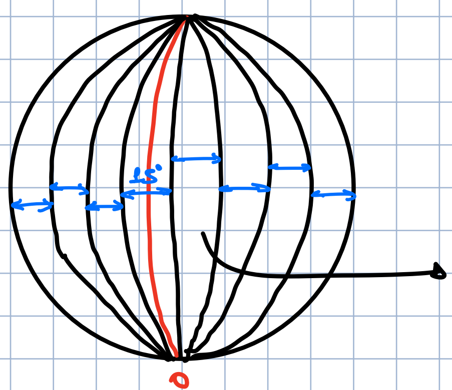
1 years = 365.25 solar days = 366.24 sidereal days

UNIVERSAL TIME

determined by Sun passage across the Greenwich meridian

Every other time discussed before were defined by the point of view of an observer.

LOCAL STANDARD TIME



UT + 1h (time zone)

ITALY $LST_{IT} = UT + 1h$

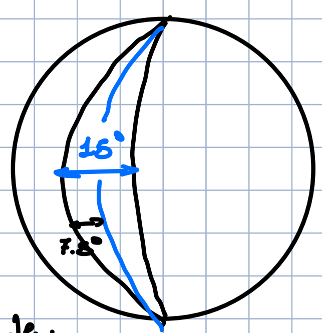
$$\frac{360°}{24h} = 15°$$

note it is different than the WE because WG is referred to a fixed point.

example

$\lambda = 32.5°$ → refer to $\lambda_{ref} = 30°$ (LMT)

LST = LOCAL STANDARD TIME = LMT of the reference longitude



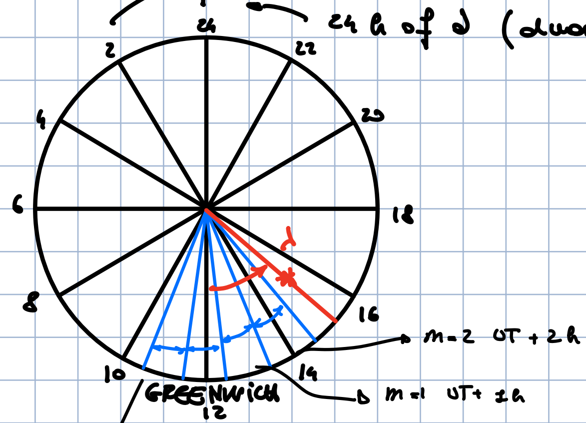
$LMT = GMT + \lambda$

$\lambda = GAT - LAT = GMT - LMT$ (2.65)

day 1

↳ Meridian that slices in two parts the slice of 15°

24 h of d (almost d+1)



m-1 UT-1h m=0

GMT
LMT

$\lambda = LMT_* - GMT$

we must be consistent to the longitude that may be positive or negative. it depends if we go to the east or to the west.

λ^* → refer to the reference time zone longitude → count m (time zone slice positive or negative

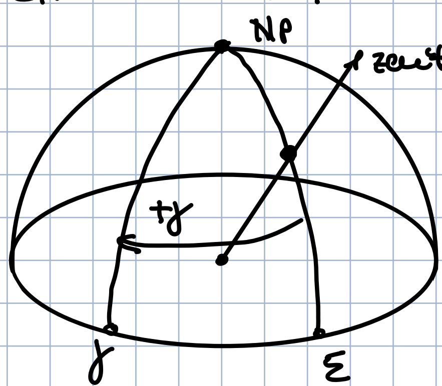
UT ± m h

LOCAL SIDEREAL TIME

Time elapsed since the passage of the local meridian through the vernal equinox.

$$\theta_{LOCAL\ SIDEREAL\ TIME} = \theta_G + \lambda \qquad (2.66)$$

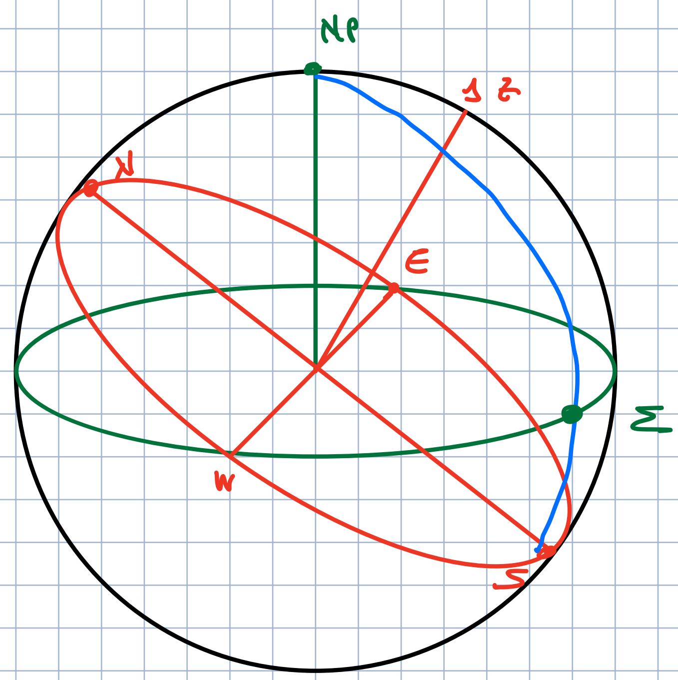
LOCAL SIDEREAL TIME : hour angle of the vernal equinox.



t_γ = LOCAL SIDEREAL TIME = θ_L = T

example

On 21 st of march the sun is at the vernal equinox when the sun is setting what are the CAT and the LOCAL SIDEREAL TIME.



$t_\gamma = \Theta_L = 6\,h$

$t_A = 6\,h$

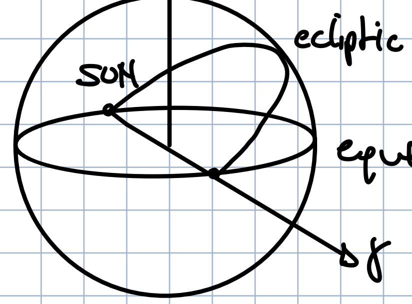
$CAT = t_A + 12\,h = 18\,h$

example

What is the sidereal time at midnight LMT on september 21st (autumn equinox)

At this time the sun is at the autumn equinox. Sun ∈ lower meridian (opposite to Σ)

⇒ the vernal equinox is at the upper meridian and the sidereal time reads 0 h



$LMT = t_m + 12\,h = 24\,h$

with $t_m = 12\,h$

$t_\gamma = \Theta_L = 0$

TROPICAL YEAR

A year is defined as passage of the Earth by the same position on its orbit around the sun.

1 year = 365.2417 days (solar days)

every year should start 6h later

every four years we add one day but it is not precise enough so every 100 years we remove 1 leap year and then when it is a multiple of 400 we add back 1 year.

leap year

$$\left(\left(\underbrace{365 \times 4 + 1}_{365.25 \text{ days}}\right) \times 25 - 1\right) \times 4 + 1 = 146096.88 \text{ days}$$

leap year added back at multiples of 400

remove 1 leap year every 100 years

example 2000 multiple of 100 so should have not been a leap year since it was multiple of 400 it had a leap years

1 year = 365.25 days for exercises

SIDEREAL YEAR

measured wrt a fixed star (we define a full revolution of Earth about the sun).

DATES CONVENTIONS

JULIAN DATE (JD) number of days since noon UT on

1-1-4713 BC

MJD 2000 (modified Julian date since 2000)

number of days since noon UTC on 1-1-2000

(at noon) MJD 2000 o J2000