

Ag 20 #1 - Coordinates, celestial motion, and Time.

* The dynamic Universe:

* rotation of Earth @ equator : 0.5 km s^{-1}

* orbit of Earth : 30 km s^{-1}

* orbit of Sun in Milky Way : 220 km s^{-1}

* Milky Way \rightarrow Andromeda : 110 km s^{-1}

These are all due to gravity; orbital velocity is given by $v_{\text{orb}} = \sqrt{\frac{GM}{R}}$.

How do we approximate absolute reference frames?

┌ Interlude : Mach's Principle, from a

GR standpoint, suggests that inertia originates from an interaction between objects. Do you agree?

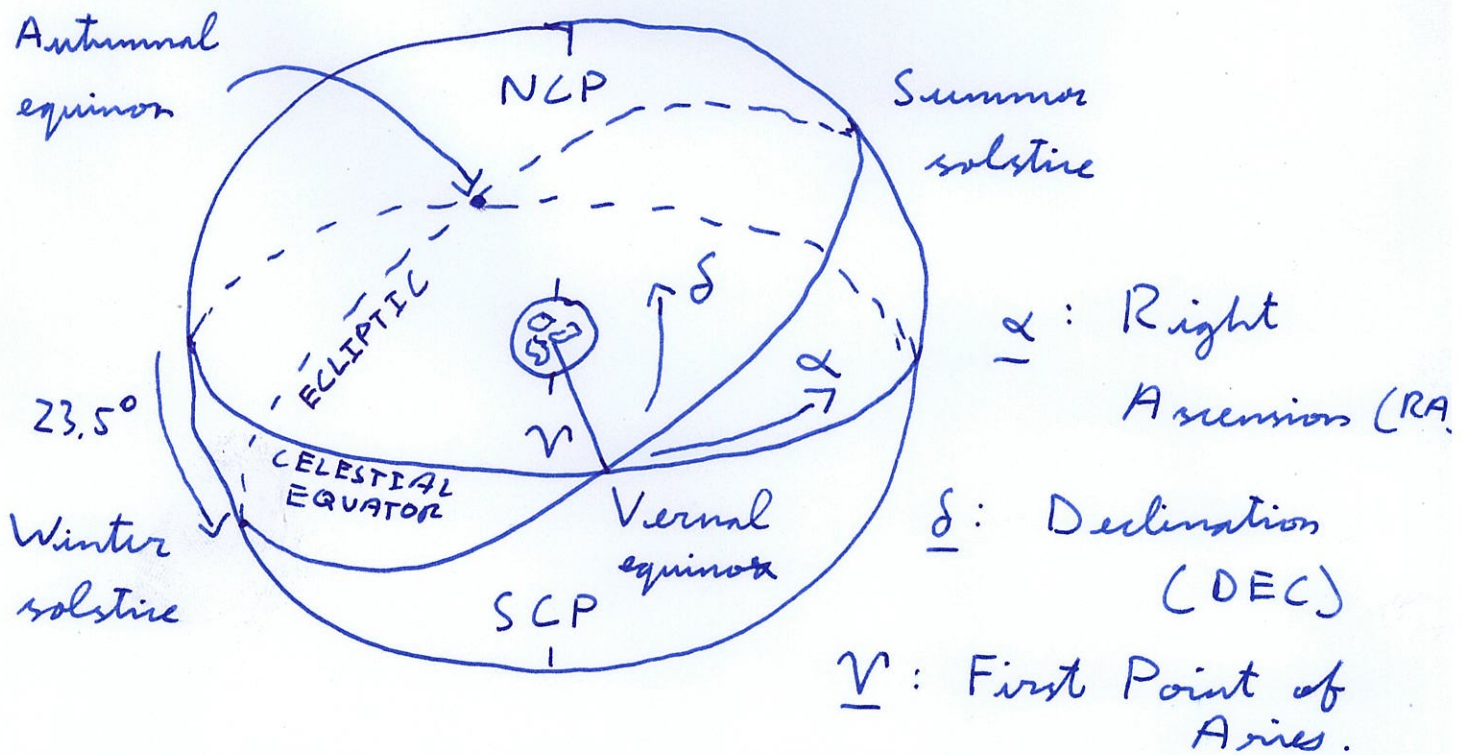
Why is the Milky Way a disk?

* International Celestial Reference System (ICRS)

- IAU standard, fixed coordinates wrt. SSB. Realized as ICRF (1-3).
- Defined using 303 radio quasars, with contributions from 4536 radio quasars in total. (ICRF3, 2018)
- 0.03 mas accuracy, accounting for 5.8 mas/yr Galactocentric acceleration.

Previously (< 1998), we used "Fundamental - katalog" (FK) 1-5 coordinates, based on optical astrometry of stars. FK5 (Hipparcos) had 3272 stars.

* Geocentric Celestial Sphere



Precession : 26,000 yr rotation of Earth

Ω -axis about ecliptic pole.

Nutation : 18.6 yr wobble of Earth Ω -axis
by $\pm 9.2''$.

* For any useful observation, need to relate
local coordinates (in, e.g., International
(ITRS) Terrestrial Reference System, or World Geodetic
(WGS) System) to celestial coordinates.

The ITRS / WGS \rightarrow ICRS transform
at any time is done using Earth
Orientation Parameters (EOP).

However, Traditionally ...

B1900, B1950, J2000 define reference
epochs for the position of the vernal
equinox.

RA: e.g., hours: min: sec. sec (J2000)

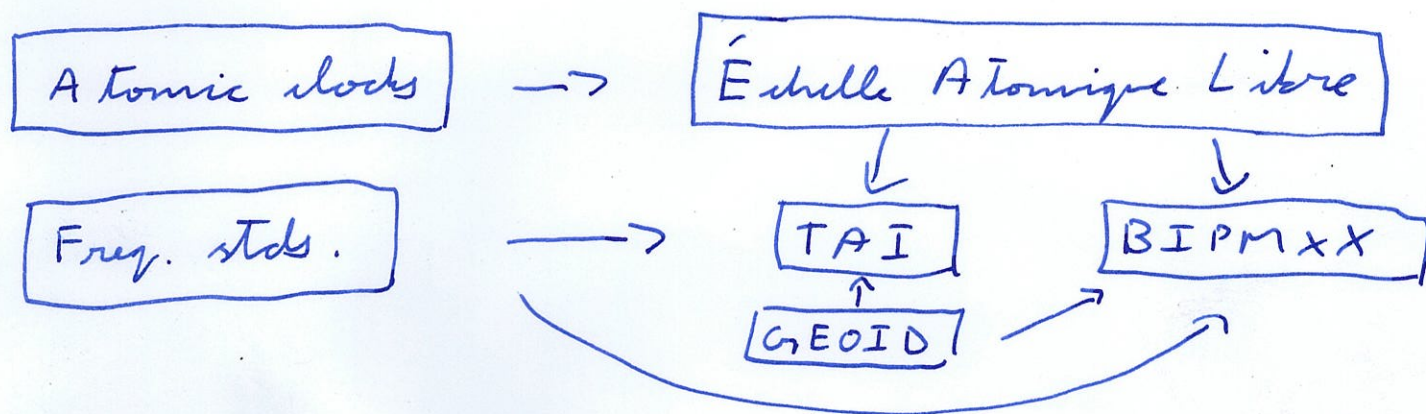
DEC: e.g., deg: arcmin: arcsec. arcsec (J2000)

* Definitions of Time.

The Bureau International des Poids et Mesures (BIPM) realizes Terrestrial Time (TT) using

* Temps Atomique International (TAI)

* BIPM XX (XX = year) corrections.



Universal Time relies on the Earth's rotation.

(postdates GMT). UT1 most accurately tracks the Earth's Rotation Angle wrt. ICRF.
(ERA)

UTC is constrained to have an integer

of sec. per day (usually 86,400), and is always < 0.9 s from UT1.

Both are close to Solar Time (synodic time)

Sidereal Time is effectively the ERA. But
geocentric version persist:

Local Apparent ST : + nutation .

Local Mean ST : - nutation .

Calculated using sidereal time on Greenwich
(prime) meridian .

"The Sun is at RA 0, DEC 0 (apparent)
at noon (UT 1) on the vernal equinox, at
which time the local (apparent) sidereal time
is 0."