Some common problems in geodesy and astrometry after establishing ICRF

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Distribution of duties between astrometry and geodesy

- Connection between the 2 sciences was established by the **plumb-line** near Earth surface.
- Astrometry: Earth’s axis in space (known, need only more precise determination).
- IERS (formerly International Latitude Service): determination of polar motion \((\Delta \phi, \Delta \lambda) \leftarrow (\alpha, \delta)\)
  - Pole was common for terrestrial and celestial frames → difficulties in division of Earth’s axis motion about CF and TS.
Distribution of duties between astrometry and geodesy

• Geodesy
  – The main directions:
    • Normals to ellipsoid (don’t cross in his centre)
    • Plumb-lines (don’t cross in centre of masses)
  – The main tasks:
    • Establishing of terrestrial system connected with geocentre (geometrical method)
    • Earth gravitational field (physycal method)
Former astrogeodetic connection

Astrogeodetic and gravimetric measurements allowed to establish ellipsoid for \((\varphi, \lambda) \rightarrow (B, L)\) (semimajor axe \(a_e\) and flatness \(1/\alpha\) of ellipsoid need for precise satellites orbit modeling)

- “normal field” in geodesy – ellipsoidal, but in celestial mechanics – spherical

– Astrogravimetric leveling allowed to transfer \(\zeta\) (for reduction to ellipsoid)
Reference ellipsoid → mean/main Earth ellipsoid
Revolution in astrometry

• “Nothing will remain the same as it was before” [Walter and Sovers, Astrometry of fundamental catalogues. The evolution from optical to radio reference frames]
Revolution in astronomy

The arguments

– Increased of accuracy of radioastrometrical measurements
– Declared absence of proper motions
– The low value of atmospheric refraction, especially with VLBI

Problems

– New system is not connected with ecliptic and equator (vernal point)
– Unsolved question with radioobservations of Soon and Solar system bodies

Paradox

– more easily to connect between (quasi)inertial reference system with TRF, that with one celestial [Robertson 1981]
Problem of origin

- Transitions from barycentre ICRS to the Earth center is difficult because nobody can observe from the centers of Earth and Sun.
- For this transition we need 4 models (E-M orb. motion, M. rot., E. rot., pole motion). Transition from triad connected with barycenter to other triad performs with relativistic effects.
- This corrections follow from impossibility of making measurements from origins:
  - For rotating motion studies is required a triad X,Y,Z and point, center of masses (unobservable, but computed by relativistic hypothesis, periodically updated and complicated).
  - Problem: quantity of parameters to determine grow up, but quantity of independent equations is too small.
  - Position of centre of CF is indeterminate, accuracy of arc measurements will 0,000 001” (!)
    - star observations: place origin in any point of Earth
    - quasars observations: place origin in any point of terrestrial orbit
Establishing of radiosystem

• Question of coincidence of optical- and radiosources
  – $\Delta RA = 01^{m} 32^{s}$
  – $\Delta DEC = -15'{32}''$

• Question on the radiorefraction

See Lipovka A., Lipovka N. On the transition to the radio system coordinates ICRF
Geodesy problems

• Old problems (astronomy is no more needed):
  – Determination of LAT and LONG (time) 
    (but **is desirable** periodically control) 
  – Projection of geod. measures on ref.-ellipsoid for further adjustment

• Rests 2+1 problem:
  – Astroorientation systems for photosurvey 
  – Astronomical azimuth (for ballistics) 
  – Rotations of **plumb-line** $(\Delta \xi, \Delta \eta)$ - can be solved by only geod. and grav. meas., but more complicated…

  *Radiosources are unobservable from points of geodetic net.*
New reality

1. Astroorientators
2. Astrogeodetic azimuth

HUBBLE
HIPPARCOS

ICRS
$\sigma \approx 0.001''$

On the astrometric satellite height $\{\xi, \eta\} = 0$
and no refraction
Conclusion

• In postrevolutionary situation the original empirical relation between the three branches of the same science is disturbed
  – Astronomy
  – Geodesy
  – Gravimetry

• Pulkovo!

• It is necessary to save the any empirical connection between them