RELATIVISTIC INTERPRETATION OF ASTROMETRIC DATA

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ABSTRACT. In papers (Pavlov, 1984 a,b and 1985), a complete and self consistent procedure of relativistic reduction for fundamental and radio-interferometric observations of distant sources has been developed. Relativistic formulae of apparent star positions, time delay and fringe frequency were derived. These formulae include all relativistic corrections due to the gravitational field of the Sun and the observer's motion. In the case of ground observations relativistic corrections are calculated to a relative accuracy of 5.10^{-9} or 0.001 arcsec.

The difference between the proposed methods and the existing ones (Brumberg, 1981, Murray, 1981 and Finkelstein et al., 1983) consists in the correct determination of the observer's frame of reference and in the interpretation of radio-interferometric data according to the VLBI basic equation. Quantitatively, it means a correct inclusion into the reduction scheme of the relativistic geodetic precession and relativistic corrections due to the rigidity of the celestial body, from which the observations are being carried out. The latter corrections are of second order in v/c (v = observer's orbital velocity, c = light velocity) and for this reason the existing reduction schemes do not take into account the relativistic corrections of the same order of magnitude and of the same period as the $1/c^2$ aberration corrections.

All calculations are performed in the post-Newtonian approximation of general relativity. The relativistic corrections due to inhomogeneity of the Sun's gravitational field within the body of reference (BR), as well as the spin-orbital and spin-spin corrections are being neglected. This determines the relative accuracy of relativistic corrections in the reduction formulae.

As global coordinates of fundamental inertial frame of reference (f. r.) we take the harmonic coordinates (ephemeris time and the rectangular heliocentric ecliptic coordinates). Alongside with global, we introduce local coordinates, describing a spatial region containing masses of BR. For this purpose we determine two frames of reference connected with the BR centre-translatory moving f.r. and rotating f.r. comoving the masses of BR (observer's f.r.), and the corresponding rectangular coordinates (for the Earth, rectangular equatorial and rectangular geographic coordinates).

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For a comparison between data obtained in different observing sites, particularly during interferometric observations, it is necessary to synchronize clocks of all observers. Synchronization in terms of dynamic time is inconvenient because an element of proper time of comoving f.r. contains the terms depending on dynamic time. This is why in Pavlov,1985, we chose the Lorentzian time of the translatory f.r. In terms of the Lorentzian time the clocks are synchronized as in special relativity.

The observational relations are derived by an uniform procedure : the radiation is described in global coordinates, then the four-dimensional characteristics of radiation (wave vector, Maxwell tensor) are transformed into comoving coordinates and from comoving chronometrically invariant components, measured values are being constructed. It is the transformation formulae, connecting inertial and comoving (measured) characteristics of radiation, that are the unknown observational relationships necessary for reduction of astrometric observations to relativistic accuracy. To simplify the interpretation, all the formulae are divided into two groups corresponding to transitions from inertial f.r. into translatory f.r. and from the latter into the comoving one.

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