HIPPARCOS AND CELESTIAL REFERENCE FRAME

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ABSTRACT. A discussion of four methods that can be used to link HIPPARCOS to an absolute reference system shows that the best method is to refer it to extragalactic objects. This would free the resulting frame from any parameter describing Earth's motion.

It is now well publicized, that HIPPARCOS will determine positions and parallaxes to a precision of 0".002 and proper motion to 0".002 per year. The great advantage of this mission is that every star is linked to many other stars largely separated and disposed on a wide variety of great circles. This implies a very great rigidity of the solution and chances that some regional errors of the order of a few 10^{-4} second of arc remain in the solution seem to be very low. However, during the reduction process, the stellar positions are globally determined to an arbitrary rotation R and the system of proper motions, to an arbitrary linearly time dependent rotation $R'(t-t_0)$ that cannot be determined from the HIPPARCOS data alone (see, for instance, Kovalevsky, 1984). Four different methods can be used to determine these two rotation matrices so as to refer the results to an absolute or quasi-inertial reference system (for more details, see Kovalevsky, 1981 or 1984).

1. Reduction to FK5 system : All FK5 stars will be observed by HIPPARCOS. By minimizing the differences in position and proper motion in both catalogues, one may determine R and R'. The drawback is that it will introduce in the HIPPARCOS system the precession parameters and a degradation due to the mismatch of precisions. This technique should rather be used to determine regional errors of the FK5.

2. Use of minor planets : Minor planets observation can be used to link the HIPPARCOS catalogue to a dynamical heliocentric reference frame. About 40 minor planets will be observed by the satellite. However, the time span of observations is unsufficient to determine accurately their periods and the motions of perihelia and nodes. One should add other observations with respect to HIPPARCOS stars as proposed for instance by Hemenway (1980). It is long term project and it cannot be realized in time for use in the HIPPARCOS catalogue itself.

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3. Link to VLBI system : It has been recently shown by Lestrade et al. (1984) that RS CVn binaries have optical and radio sizes of the order of a couple of milliseconds of arc and that radio sources seem to be located within the binary system. Several stars have been observed by JPL with precision better that 0".01. If, as it is expected proper motions of 15 to 20 such objects also observed by HIPPARCOS can be determined by VLBI to an accuracy of about one millisecond of arc per year, simulations have shown (Froeschlé and Kovalevsky, 1982) that one can determine R' to 0".0015 per year accuracy improvable with time.

4. Optical links to quasars : Relative observations by small field astrometry such as will be available on Space Telescope, give the variation of the distance of stars to quasars. The same simulations have shown that the VLBI information provided by one radio star is equivalent to the information given by 5 such links to quasars. Only R' can be determined and the same accuracy may be obtained as in the case of the VLBI link if one uses about 80 stars.

It results from this discussion, that the optimum method to connect HIPPARCOS stars to an quasi-inertial reference frame will be to connect HIPPARCOS stars to quasars. The catalogue will then be a realization of a celestial system based upon the hypothesis that a system of extragalactic objects does not have a systematic rotation. This is different from the FK4/FK5 concept which uses dynamical information. In the case presented here, the actual coordinate system is totally arbitrary and does not depend on any quantity related to the Earth such as equator, ecliptic, equinox, etc.. It is the intermediate system which will define the mean or the true equatorial system of a given day. Such a situation is quite analogous to what exists in connection with terrestrial systems where an intermediary system is used in order to define polar motion and irregularities of the Earth rotation. With such a concept, the actual reference frame does not have to coincide with the intermediate frame at any time (including J D 2000). Any improvement of the precession of the nutation, etc.. will modify the intermediate system, but never the fundamental celestial system.

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