CONNECTING THE DYNAMICAL FRAME TO THE ICRF BY USE OF NEAs OBSERVATIONS

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ICRF (practical realization of ICRS) is now adopted as the fundamental celestial frame in astronomy. The Hipparcos catalogue is a primary realization of the ICRF at optical wavelengths. In spite of the fact that the ICRF is a quasi-inertial system there are a great number of problems associated with the use of the ICRF, the main of them being the connection of ICRF to dynamical systems. The parameters of this connection are known with insufficient accuracy and further work is necessary on the problem of mutual orientation of this systems at new level of accuracy using different new observations of different solar system objects.

In classical paper (Folkner et al.,1994) for relating DE200/LE200 to ICRF the combined array of VLBI measurements and LLR ones have been used. In the paper (Standish et al.,1995) the connection of dynamical system DE403/LE403 to ICRF was determined at level of mas accuracy by use VlBI observations relative to the sources from radio catalogue with spacecraft observations around the planets. The VLBI observations of spacecrafts relative to the planets at the distant star background are very precise but very rare and can be obtained for short time intervals. In the papers (Batrakov et al.,1999), (Batrakov and Chernetenko, 2001), (Chernetenko, 2007) these parameters relative to dynamical systems DE200/LE200, DE403/LE403 and DE405/LE405 were obtained on the basis of ground minor planet observations and observations of 48 minor planets by Hipparcos. In the present paper we suggest to use optical and radar NEAs observations for the purpose. We consider our results as preliminary ones and are going in nearest future to use the above objects for receiving the orientation parameters dynamical systems relative ICRF. For obtaining connection between FK5 catalogue and Hipparcos Mignard and Froschle (Mignard and Froschle, 1997) gave orientation angles between FK5 and Hipparcos at J2000.0. At present modern optical observations of planets and their satellites are transformed into ICRF by observers using transformation between the systems of their catalogues and ICRF (Hipparcos) system. The same approach was taken for NEAs observations in the present paper. In paper mentioned above (Batrakov and Chernetenko, 2001) the algorithms for determining orientation parameters are shown and angles of orientation connected with the old parameters, zero-points of star catalogues, are given. Using all the designations and formulae which are given in the papers of these authors, the connection between the angles of rotation and corrections to zero-points star catalogue can be written:

$$\epsilon_x = -\Delta\epsilon, \epsilon_y = \Delta L sin\epsilon, \epsilon_z = \Delta A - \Delta L cos\epsilon, \quad (1)$$

where ΔD is a characteristic of the declination star system permanent error, is not connected with the angles of turning. For velocities of changing these angles

$$\omega_x = -\Delta\dot{\epsilon}, \omega_x = \Delta\dot{L} sin\epsilon, \omega_z = \Delta\dot{A} - \Delta\dot{L} cos\epsilon. \quad (2)$$

Optical and radar observations of NEAs from the paper (Yagudina, 2002) were transformed to Hipparcos, that is, into ICRF. The interval of optical observations was about 90 years, the radar observations started in 1968. All the optical observations were taken from MPC catalogue (FK5 system), radar (doppler and delay)–from database "Small astrometric radar observations", JPL. The precision of optical observations is varied within the range from 1" to 0.5" and even smaller for observations after 1965, as for doppler–from 30.0 Hz to 0.1 Hz, delay– from 140 to 0.1μs. The number of optical observations is 16600, radar–345. The result (together with the results of other authors)are given in Table 1. It is in good agreement with the result of (Batrakov et all.,1999) but as compared with results from (Batrakov and Chenetenko, 2001) our values of the parameters and their errors are too big. In 2001 paper authors jointed to minor planets ground observations very precise observations of 48 minor planets observed by Hipparcos. As for NEAs observations in our paper the optical observations till 1950 year have very big error (from 1" to 0.5"). It

is possible to use this kind observations but it is necessary to eliminate the optical observations till 1950 year from our solution .

Orientation parameters mas,mas/y epoch	Folkner et al., 1994 VLBI, LLR J2000.0	Batrakov et al.,1999 12 minor planets 1991 07 02.0	Yagudina, 2002 30 NEA's 2001.8	Batrakov and Chernetenko,2001 12 m.pl.+Hip. 1991.25
ϵ_x	-2.0 ± 2.0	19.3 ± 17.3	19.1 ± 12.2	2.5 ± 1.3
ϵ_y	-12.0 ± 3.0	-18.8 ± 17.9	-23.0 ± 15.8	-12.7 ± 2.2
ϵ_z	-2.0 ± 3.0	41.8 ± 26.0	36.9 ± 10.9	1.4 ± 3.3
ω_x	–	1.3 ± 0.5	0.2 ± 0.1	0.4 ± 0.3
ω_y	–	-0.4 ± 0.6	0.4 ± 0.3	-0.7 ± 0.3
ω_z	–	1.6 ± 1.0	-0.2 ± 0.2	-0.9 ± 0.6

Table 1: Orientation parameters dynamical system DE200/LE200 with respect to ICRF

Orientation param. mas, mas/y	Chernetenko, 2007 15 minor pl.+48 m. pl. Hip.	This paper, 2007 30 NEA's+4 m.pl.
ϵ_x	-0.1 ± 0.9	-0.3 ± 2.1
ϵ_y	3.0 ± 1.1	4.8 ± 2.5
ϵ_z	-5.2 ± 1.6	-8.2 ± 2.9
ω_x	0.15 ± 0.08	0.2 ± 0.5
ω_y	0.66 ± 0.10	0.9 ± 0.6
ω_z	-0.40 ± 0.17	-0.5 ± 0.4

Table 2: Orientation parameters dynamical system DE403/LE403 with respect to ICRF

After excluding NEAs observations from 1900 to 1950 year the orientation parameters of DE403/LE403 with respect to ICRF were calculated and the result is represented by table 2. One can see that our results are worse than the results from the paper (Chernetenko, 2007). The reason is the high precision of Hipparcos observations of minor planets as compare with the ground optical observations of asteroids. Nevertheless, ground observations have an advantage of obtaining velocities of angles changes, that can not be obtained by Hipparcos observations.

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