TRANSFORMATION BETWEEN ICRS AND ITRS UNDER IAU (2000) RESOLUTIONS

I.I. KUMKOVA
Institute of Applied Astronomy of RAS
10 Kutuzov quay, 191187 St.Petersburg, Russia
e-mail: kumkova@quasar.ipa.nw.ru

M.V. STEPASHKIN
Saint-Petersburg Institute for Informatics and Automatics of RAS
39, the 14th Line, 199178 St.Petersburg, Russia

ABSTRACT. Algorithms of direct and reverse relativistic four dimension transformation of barycentric and geocentric celestial reference coordinate systems (BCRS and GCRS) according to IAU Resolution B1(2000) are developed. It is shown that application of four dimension coordinate systems does not involve any complications for the reduction of observations. Transformation between BCRS and GCRS is considered as a part of the general procedure of linking International Celestial Reference System to International Terrestrial Reference System, provided by the International Earth Rotation Service.

1. INTRODUCTION

The sub-milliarcsecond-level and the microarcsecond-level of precision anticipated for future observational systems demands improved models at all levels of analysis. These improved models require to take into account corrections of General Relativity Theory in data processing. That is why in 1990 at IAU Colloquium N127 (IAU, 1991), IAU recommendations for reference frames and time scales have been formulated in the framework of General Relativity for the first time. In 1991 affirmation of IAU recommendations as Resolution A4 (1991) at the 21th GA IAU and later as Resolution 2 of IUGG (1991) gave the floor for the qualitative change of General Relativity role for ephemeris.

At present according to IAU Resolutions two main practically used coordinate systems are existing. There are ICRS, International Celestial Reference System and ITRS, International Terrestrial Reference System. The time scales of ICRS and ITRS should be respectively TCB (Barycentric Coordinate Time) and TCG (Geocentric Coordinate Time). These scales should be considered as four-dimention relativistic coordinate system, connected by four-dimention relativistic transformation with additional three-dimention rotation of space axes of coordinates. To solve the majority of astronomical tasks it is sufficient to have the only ICRS, ITRS and its practical realization as ICRF and ITRF. However to connect ICRF and ITRF it is necessary to introduce one more local geocentric system with the same time scale TCG, as well as ITRS has, and with the same direction of space axes, as well as ICRS has. Such a system is intro-

duced by IAU Resolution 1.3 (2000) and it is intermediate system between BCRS, Barycentric Celestial Reference System, identified with ICRS, and ITRS and has a title of GCRS, Geocentric Celestial Reference System. The present work is aimed to develop technique for practical use of BCRS→GCRS and GCRS→BCRS transformations in astrometry taking into account IAU Resolutions (IAU, 2001), specified realization of BCRS and GCRS with TCB and TCG, correspondingly.

2. CALCULATIONS AND RESULTS

To perform transformation from BCRS to GCRS and reverse is necessary to calculate in advance several values, such as vector of Earth's velocity, Solar System bodies potential, function of time and function called relativistic time equation, what has been calculated by integration in numerical as well as analytical form. The algorithm includes determination of a time moment and source coordinates in GCRS, correspondent to the time moment and barycentric source coordinates in BCRS, following to formula of transformation (Brumberg and Groten, 2001)

The reverse transformation is constructed by means of similar tabled values of functions mentioned above but in dependence on argument TCG (in limits of Post-Newtonian accuracy it does not requires any additional calculations). Additional calculations (comparatively to direct transformation) will be needed only in the case of determination of value, defined Earth motion as function of TCG. After the tabled values have been calculated, then source coordinates at the time moment in BCRS are determined by reverse transformation (Brumberg and Groten, 2001)

We carried out calculation following suggested scheme of direct and reverse transformations in two ways (analytical and numerical) for an object, located in point of orbit of geostationary satellite and conditional object, located at the distance of 1 a.u. from barycenter of Solar System. To control of accuracy of transformations, four-dimension object coordinates have been used as initial data for reverse transformation. The reverse transformation resulted again to four-dimension coordinates of the source in BCRS. The comparison of the obtained values and initial numbers, used in direct transformation serves as characteristic of accuracy of calculations. The analysis of performed calculations has shown that accuracy level, what has been initially fixed has been obtained. In the both considered sources (at geostationary orbit and conditional source) in time transformation an error is not manifested up to 10-9, for the coordinate transformation, relative error is less then.

3. CONCLUSIONS

Study of results obtained shows that calculated coordinates by use of suggested technique do not differ from set values at the level of required precision (Post-Newtonian approach taken into account terms of order). Thus, the precision level of the task is reached. Consequently proposed numerical realization for transformation BCRS→GCRS and GCRS→BCRS can be used in data processing.

4. REFERENCES

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