The Celestial Reference System I.C.R.S. Principles & Present Realization

Jean Souchay

(ICRS-PC, Paris Observatory)

1 INTRODUCTION

From 1998 January 1st, and according to the decision taken during the 23rd IAU General Assembly (Kyoto, August 1997), the International Celestial Reference System of the IERS (Arias *et al*., 1995) has been recommended for adoption as the International Celestial Reference System (ICRS), thus replacing the FK5. Moreover the IAU has officially stated that the IERS should accomplish the task of insuring the maintenance of the ICRS. In the following, we present the specificities of the ICRS with related basic definitions, its materialization through the **International Celestial Reference Frame** (**ICRF)**, and the astrometric studies which are undertaken to establish the link between the various galactic or extragalactic objects, and the **ICRS**.

- **ICRS definition**

  A reference system can be defined as a « set of prescriptions and conventions together with the modelling required to define, at any time, a triad of axes ». To complete this definition, we should not forget also the fundamental choice of the origin.

  The **ICRS** is defined in the following way : its origin is located at the barycentre of the solar system, and the directions of its three axes are fixed relative to the distant extragalactic sources (Arias *et al.,*1995).

- **ICRF definition**

  A reference frame can be defined as a « *practical realization with given fiducial directions agreeing with the concepts introduced in the corresponding Reference System* » (Feissel and Mignard, 1998) :

The first realisation of the **ICRF** (Ma *et al*., 1997, 1998) consists of a catalogue of equatorial coordinates of 608 extragalactic radio-sources. Therefore these radio-sources define implicitly and at the fundamental date J2000.0, the reference equatorial plane and the origin on the equator, from which the coordinates in right ascension and declination of any celestial object must be measured. Consequently the triad related to the definition of the ICRS is implicitly defined by the set of coordinates of the radio-sources above. The underlying characteristic for the adoption of these sources is that they do not present significant time variations of their relative positions one to each other. This must be interpreted as a condition of non-rotation of the frame related to the selected radio-sources. More precisely, the sources belonging to the ICRF can be separated into three groups, according to their astrometric stability and the number of observations to which they were subject: The ***defining*** sources (212) The ***candidate*** sources (294) The ***other*** sources (102).

2 MAINTENANCE AND EXTENSION OF THE ICRF

The IAU charged the IERS with the responsibility of monitoring the ICRS and maintaining its realization, i.e. the ICRF. Starting in 2001, these activities are run jointly by the ICRS Product Center (Paris Observatory and US Naval Observatory), and the International VLBI Service for Geodesy and Astrometry (IVS).

As a part of the maintenance process, an extension of the initial ICRF was elaborated (IERS, 1998), which is named ICRF-Ext.1, and which consisted in adding 59 new sources to the 608 initial ones, whereas the 212 defining sources of the initial ICRF and their respective coordinates remained unchanged with respect to the first realization of the frame.

Recent investigations conducted by the ICRS Product Centre (2001 IERS Annual Report) concern various topics with respect to the ICRF : these are stability analyses based on time series of source coordinates, additional sources since the construction of the ICRF-Ext.1, and comparisons of the ICRF with newly computed radio catalogues (IERS, 2001).

3 THE ICRS-PC (Product Centre)

Since 2001 January 1st, the Paris Observatory and the U.S. Naval Observatory have been charged by the IERS Central Bureau to act jointly as the International Celestial Reference System Product Centre (ICRS-PC) of the IERS. Each of the parts is presently responsible of tasks as summarized below :

- Maintenance and extension of the ICRF
- Investigation of future realizations of the ICRS
- Monitoring of structure to assess astrometric quality
- Maintenance of the time stability of the ICRF
- Maintenance of the link to the Hipparcos catalogue
- Linking the ICRF to frames at various wavelengths
- Maintenance of the link to the dynamical reference frame
- Maintenance of the link to the ITRF

Among these tasks, some of them are fulfilled on a regularly basis (cf. IERS Annual Report, 2001), whereas other ones aim at developing new specific researches with respect to the tasks above: preparation of future space astrometric missions (ex. DIVA, FAME) comparisons inter-catalogues (Hipparcos vs. 2MASS etc…), or optimization of proper motions and positions measurements on specific fields (Pleiades cluster etc…). The maintenance of the link between the Hipparcos Catalogue and the ICRF remains one of the principal tasks of the ICRS-PC.

References

Arias E.F., Feissel M., Charlot P., Lestrade J.-F., 1995: *"The celestial system of the International Earth Rotation Service- ICRS"*, A&A **303**, 604

Feissel M., Mignard F., 1998,*Astron. Astrophys*. 331, L33.

IERS Annual Report for 1998, 1999, ICRF Maintenance, 87- 114, Observatoire de Paris.

IERS Annual Report for 2000, 2001, 26-52, BKG.

Ma C., Arias E.F., Eubanks T.M., Fey A.L., Gontier A.-M., Jacobs C.S., Sovers O.J., Archinal B.A., Charlot P., 1997: *IERS Technical Note No 23*, C.Ma and M.Feissel (eds.), Observatoire de Paris.

Ma C., Arias E.F., Eubanks T.M., Fey A.L., Gontier A.-M., Jacobs C.S., Sovers O.J., Archinal, B.A., Charlot P., 1998, *AJ*, **116**, 516.

McCarthy D.D. (ed.), 1996: IERS Conventions, *IERS Technical Note 22*, Observatoire de Paris.