IAU Division I Working Group
"Nomenclature for Fundamental Astronomy" (NFA)

Newsletter 1

Nicole Capitaine, 20 October 2003

1 Introduction

The present Newsletter of the Working Group "Nomenclature for Fundamental Astronomy" (NFA) provides its task and composition and a preliminary discussion on the current situation and questions relevant to the WG. A method for organizing the work within the WG is proposed.

2 Task of the Working Group

The general task of this Working group is to provide proposals for new nomenclature associated with the implementation of the IAU 2000 Resolutions and to make related educational efforts for addressing the issue to a large community of scientists.

3 Composition of the Working Group

The members of this WG include, as recommended by the Division I Board, (i) promoters of IAU Resolutions 2000, (ii) experts in the different fields of importance for the task of the WG (*i.e.* Standards and Conventions, Relativity, star catalogues, etc.) and (iii) Commission 5 "Documentation and Astronomical Data" representative.

The membership is:

Nicole CAPITAINE (Paris Observatory, France): *Chair*
Toshio FUKUSHIMA (NAO, Japan, Division I President): *ex officio*
Bernard GUINOT (Paris Observatory, France): *IAU 2000 Resolutions*
Catherine HOHENKERK (HMNAO, UK): *Almanac*
George KAPLAN (USNO, USA): *Implementation and educational efforts*
Sergei KLIONER (Lohrmann Observatory, Germany): *Relativity*
Jean KOVALEVSKY (OCA, France): *IAU 2000 Resolutions*
Irina KUMKOVA (IAA, Russia): *Star Catalogues*
Dennis D. MCCARTHY (USNO, USA): *IERS Conventions*
Ray NORRIS (CSIRO, Australia): *Commission 5 representative* (to be confirmed)
Ken SEIDELMANN (Virginia University, USA): *IAU 2000 Resolutions*
Patrick WALLACE (HMNAO, UK): *Standards Of Fundamental Astronomy*

4 The IAU 2000 Resolutions

At its 23rd General Assembly in 1997, the IAU adopted an International Celestial Reference Frame (ICRF) (Ma et al. 1998) that realizes the International Celestial Reference System (ICRS), as specified by IAU Resolution A4, 1991. Several resolutions were adopted by the 24th IAU General Assembly (Manchester, August 2000) that concern the definition of the astronomical reference systems and transformations between them, which are required when dealing with Earth's rotation or when computing directions of celestial objects in various systems.

Resolution B1.3 specifies that the systems of space-time coordinates as defined by IAU Resolution A4 (1991) for the solar system and the Earth within the framework of General Relativity are now named the Barycentric Celestial Reference System (BCRS) and the Geocentric Celestial Reference System (GCRS) respectively. It also provides a general framework for expressing the metric tensor and defining coordinate transformations at the first post-Newtonian level (see Soffel et al. 2003). Resolution B1.6 recommends the adoption of the new precession-nutation model that came into force on 1 January 2003 and is designated IAU 2000 (version A corresponding to the complete model of Mathews *et al.*, (2002), of 0.2 mas accuracy and version B corresponding to its shorter version (McCarthy and Luzum 2002) with an accuracy at 1 mas level). Resolution B1.8 recommends the use of the "non-rotating origin" (Guinot, 1979), designated CEO (Celestial Ephemeris Origin) and TEO (Terrestrial Ephemeris Origin), as origins on the moving equator in the celestial and terrestrial reference systems respectively, and defines UT1 as linearly proportional to the Earth Rotation Angle (ERA) between the CEO and the TEO on the moving equator. This resolution recommends that the transformation between the International Terrestrial Reference System (ITRS) and the GCRS be specified by the position of the Celestial Intermediate Pole, CIP, (defined by Resolution B1.7) in the GCRS, the position of the CIP in the ITRS and the ERA, and that the IERS continue to provide users with data and algorithms for the conventional transformations.

5 Terminology for Implementing the IAU Resolutions

The implementation of these Resolutions (especially B1.3, B1.7 and B1.8) for various astronomical applications require that a terminology is adopted by the astronomical community for all the quantities based on the new concepts. The terminology issue has begun to be discussed in recent papers (Seidelmann and Kovalevsky 2002, Capitaine et al. 2003 a, b, c) and within the Working Group ICRS before the latest IAU General Assembly resulting in the following documents that were circulated and discussed within the WG ICRS on the first term of 2003:

(i) a summary (Annex 1) untitled "The new reference Systems: some answers" prepared by K. Seidelmann on March 2003, with input from N. Capitaine, B. Guinot, J. Kovalevsky and D.D. McCarthy,

(ii) a document (Annex 2) with suggestions for improving document (i) (M. Soffel and S. Klioner, April 2003),

(iii) a summary (Annex 3) untitled "Implementation of the IAU 2000 precession-nutation and Universal Time using the new paradigm. Summary for the Division 1 ICRS Working Group and Commission 19 Precession-Nutation Working Group" (N. Capitaine, P. Wallace, D.D. McCarthy, J. Chapront, February 2003),

(iv) the project of an IAU resolution (Annex 4) that, after discussion within the ICRS WG, was eventually not submitted as an IAU resolution at the latest GA.

Then, at the XXV IAU General Assembly in Sydney, there has been a discussion on the "Implementation of the IAU Resolutions for the Almanacs" during the Division I meetings on which a report (Annex 5) will be published in IAU Transactions XXV B. The conclusion of this discussion has been that:

(i) procedures, models and software are available to users for the implementation of the IAU 2000 resolutions based on both classical and new paradigms,

(ii) the implementation has already been done in IERS products and will be done in almanacs in a near future,

(iii) official recommendations are required in order that the almanacs implement the new IAU resolutions based on a common and approved terminology,

(iv) an important educational effort is needed to inform a wider astronomical community about the new system recommended in IAU 2000 Resolutions,

The discussion made it clear that the educational effort would be easier if "intermediate" was used for both the "Celestial Intermediate Pole" (CIP) and the "Celestial Intermediate Origin", instead of "Celestial Ephemeris Origin", thus providing the "Celestial Intermediate Frame", as it was in the recent project of IAU Resolution. Note that the reason for not having adopted the expression "Intermediate Origin" in the IAU 2000 Resolution was for avoiding a possible confusion with the acronym CIO, used in the past for the "Conventional International Origin" for polar motion. To overcome this difficulty, a different font could be proposed, as $\mathcal{CIO}$ for the previously used acronym, the normal one being kept for the Celestial intermediate origin.

6 Terminology for the Almanacs

The implementation of the IAU Resolutions has to be finalized within one year to be effective in the 2006 Almanacs. A preliminary document has been prepared by C. Hohenkerk with a list of terms that have to be chosen for the implementation in the Almanacs (Annex 6) together with relevant questions.

7 Educational effort

An educational effort is needed for addressing the issue of the new system to a large community of scientists who want basic concepts, background, justification, and some assessment of the effect the changes will have on their work. This requires to provide practical information and background material and provide basic explanations of the ICRS, BCRS, GCRS, transformation between space-time coordinates, non-rotating origin concept, and other aspects of the IAU 2000 resolutions. The preliminary IERS educational effort in making available to users an initial set of frequently asked questions on the recent IAU resolutions, has to be extended and addressed to a wider community.

8 Preliminary list of questions about terminology

Given the astronomical quantities that have to be defined based on the new concepts (see for ex Annex 6), a preliminary terminology list can be provided including, for each definition, the involved concept and several choices for the corresponding quantity.

The WG should have to agree on the final terminology to adopt.

The terminology has to be selected in the two official languages of the IAU (English and French), with possible compatibility with other languages.

The use of capitals has to be questioned (see Annex 6) for the new terms such as "Earth Rotation Angle", whereas lower case is used (except for the first letter of the first word) for classical terms such as "Greenwich sidereal time".

One choice (Choice A) can be to use a terminology based on an approach similar to the classical one. Example "the equation of the equinoxes" $\Rightarrow$ "the equation of the origins" (See Annex 6).

An other choice (Choice B) can be not to rely on an approach similar to the classical one, but rather to try to be as close as possible to the concept.

The following list, that should have to be extended to all the relevant quantities, provides several choices for each quantity corresponding to one concept[1].

PRELIMINARY LIST OF TERMINOLOGY CHOICES (as an example)

1. *Origin on the equator of the CIP with respect to the GCRS* (cf Annex 4)
(1) Celestial ephemeris origin (CEO), (2) Celestial intermediate origin (CIO), (3) other
(1) Origine céleste des éphémérides (CEO), (2) Origine céleste intermédiaire (CIO), (3) autre

2. *Origin on the equator of the CIP with respect to the ITRS* (cf Annex 4)
(1) Terrestrial ephemeris origin (CEO), (2) Terrestrial intermediate origin (TIO), (3) other
(1) Origine terrestre des éphémérides, (2) Origine terrestre intermédiaire (TIO), (3) autre

3. *Equatorial longitude*
(1) CEO right ascension, (2) intermediate right ascension, (3) other
(1) Ascension droite CEO, (2) Ascension droite intermédiaire, (3) autre

4. *Angular distance between the equinox and the CEO*
(1) instantaneous origin distance, (2) equation of origins, (3) other
(1) distance des origines instantanées, (2) équation des origines, (3) autre

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9 Organization of the Work of the Working Group

The proposed work of the Working Group NFA is:

(i) to prepare, in coordination with the IERS, with the Almanac offices and with the Division I Working Group on "Precession and Ecliptic" (and possibly other kinds of users), the finished and approved implementation of the models for all astronomical purposes,

(ii) to select the appropriate terminology for the implementation,

(iii) to do educational efforts for offering the new system to a larger community,

(iv) to provide a report with recommendations to the 2006 IAU General Assembly leading to a proposal of new IAU Resolution(s).

The proposed organization of the work is the following:

(i) to provide regular WG Newsletters to report on the progress of the work, including questions to the WG and discussion,

(ii) A webpage (http://syrte.obspm.fr/iauWGnfa) with the purpose of allowing users to follow the progress in the work, ask questions to the WG and give opinion, incuding:

- WG Newsletters
- related information and discussions within the WG
- possibility of asking questions or giving comments to the WG (not yet available)

(iii) A specific role will be attributed to (or chosen by) each member who will have to report to the WG on this specific issue.

[1] The capitals being used only for the first word of the expression

10 References

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Capitaine, N., Wallace, P.T, McCarthy, D.D., 2003b, "Expressions to implement the IAU 2000 definition of UT1", *Astron. Astrophys.* 406, 1135-1149.

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Guinot, B., 1979, in *Time and the Earth's Rotation*, D.D. Mc Carthy, J.D. Pilkington (eds), D. Reidel Publishing Company, pp. 7–18.

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Ma, C.,Arias, E.F., Eubaks, M. Fey, A.L., Gontier, A.-M., Jacobs, C.S., Archninal, B.A., Charlot, P., 1998, "The International Celestial Reference Frame as realized By Very Long Baseline Interferometry," *Astron. J.* 116, 516–546.

Mathews, P. M., Herring, T. A., and Buffett B. A., 2002, "Modeling of nutation-precession: New nutation series for nonrigid Earth, and insights into the Earth's Interior," *J. Geophys. Res.*, 107, B4, 10.1029/2001JB000390.

McCarthy, D. D. and Luzum, B. J., 2002, "An Abridged Model of the Precession-Nutation of the Celestial Pole," *Celest. Mech.* 85, 35-49.

Seidelmann, P. K., Kovalevksy, J., 2002, "Application of the new concepts and definitions (ICRS, CIP and CEO) in fundamental astronomy," *Astron. Astrophys.* 392, 341–351.

Soffel, M., Klioner, S.A., Petit, G. et al. 2003, "The new IAU Resolutions for astrometry, celestial mechanics and metrology in the relativistic framework: explanatory supplement", *Astron. J.* in press.

11 List of Annexes

All the Annexes are available on the Working Group webpage (at: http://syrte.obspm.fr/iauWGnfa): Annexes 1, 2 and 4 as Word files, Annexes 3 and 5 as PS files and Annex 6 as PDF file.

Annex 1:"The new reference Systems: some answers" (K. Seidelmann), March 2003.

Annex 2: Suggestions for improving the previous document (M. Soffel and S. Klioner), April 2003

Annex 3: "Implementation of the IAU 2000 precession-nutation and Universal Time using the new paradigm. Summary for the Division 1 ICRS Working Group and Commission 19 Precession-Nutation Working Group" (N. Capitaine, P. Wallace, D.D. McCarthy, J. Chapront), February 2003

Annex 4: Project of an IAU resolution, WG ICRS, April 2003

Annex 5: Report of Division I meetings at the XXV IAU GA (N. Capitaine), October 2003

Annex 6: Draft of Nomenclature and Terminology for the IAU WG (C. Hohenkerk), October 2003