

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

Newsletter 3

Nicole Capitaine, 13 January 2004

1 Introduction

The present Newsletter of the Working Group “Nomenclature for Fundamental Astronomy” (NFA) reports on the recent discussion within the WG about the preparation of a questionnaire regarding the implementation of the IAU 2000 Resolutions and related terminology choices. A contribution from George Kaplan on “Some different ideas for Nomenclature” that is especially relevant to the topic of the questionnaire is included as an Annex.

The two parts of the final NFA questionnaire with a general presentation and an Annex are provided with this Newsletter.

All this material will be put on the NFA WG webpage.

2 The NFA Questionnaire

The general task of the NFA Working group being 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, it has been decided to prepare a questionnaire. The purpose of this questionnaire is to provide information to the WG so that it can determine the opinions of the astronomical community regarding the terminology needed to implement and promulgate the IAU 2000 resolutions, including those on nutation and the new origin. A complementary questionnaire NFA/B is intended to the Almanac Offices.

The draft version of the NFA questionnaire that was submitted to the WG with the previous Newsletter has been revised by Catherine Hohenkerk and myself. In doing this revision, we have tried to take into account all comments, suggestions and contributions from the WG members that we received by e-mails (i.e. from Ken Seidelmann (11 Nov), Bernard Guinot (22 Nov), Dennis McCarthy (24 Nov), George Kaplan (26 Nov, 4 Dec, 10 Dec), Chopo Ma (27 Nov), Patrick Wallace (30 Nov)) and suggestions that were mentioned during discussions with WG members and other colleagues. The final version is thus expected to largely reflect the views of the Working Group regarding the approach to be followed.

Additionally to Part A on ‘Terminology choices’ and Part B ‘for Almanac offices regarding the implementation of IAU Resolutions’, the final version of the questionnaire is supported by a general presentation and an Annex providing a Table of terms (names, symbols, abbreviations, definitions and alternatives) that can help people to answer to the questions.

In a first step, Part A of the questionnaire is intended both to the WG members and the almanac offices (together with Part B that is especially intended to them).

In the same time, the WG is asked to provide suggestions to identify the future addressees for Part A and B of the questionnaire.

Deadline for receiving answers from the WG members is 25 January 2004

In a second step, Part A will be sent to the addressees that will have been identified, the list of which could be extended progressively.

The provisional list of addressees for Part B of the questionnaire is:

1) Almanac offices

US Naval Observatory, US (J. Bangert)

HM Nautical almanac office, UK (S. Bell)

Astronomisches Rechen Institut, Germany (R. Wielen)

Institute of applied Astronomy, Russia (M.S. Sveshnikov)

National Astronomical Observatory of Japan, Japan (T. Fukushima)

Institut de Mécanique Céleste et de Calcul des Ephémérides, France (W. Thuillot)

2) Providers of ephemerides:

Jet Propulsion Laboratory, US (M. Standish)

Paris Observatory Lunar laser ranging Center, France (J. Chapront)

IAA (G. Kransinsky, E. Pitjeva)

3) Organizations providing national almanacs (incomplete list)

The Astronomical Institute of the Czech Republic, Czech Republic (J. Vondrák)

Observatoire Royal de Belgique (R. Verbeiren),

Observatorio Astronomico de Madrid (J.G. Gonzalez)

Annex 1

Some Different Ideas for Nomenclature

10 December 2003

George Kaplan, USNO

I was planning on waiting to submit this until after the beginning of the year, but with the possibility of a questionnaire going out soon, I realized that waiting was not a good idea. That is because the answers we receive back will, for the most part, be circumscribed by the choices presented on the questionnaire. So I am hereby submitting a few more terminology choices for consideration. I would like others to do the same; I am concerned that not enough ideas have been forthcoming.

As a start, it's probably good to remind ourselves of the terms actually used in the IAU 2000 resolutions. While not "cast in stone", these terms probably should not be changed without due consideration to the confusion such a change would likely cause. That is, the benefits of any change made now should clearly outweigh the disadvantages. Here are the terms introduced by the 2000 IAU resolutions relating specifically to Earth rotation/orientation:

IAU 2000 precession-nutation model: Combination of MHB (2003) nutation series with secular changes in the longitude and obliquity of the pole; it has been agreed that the latter will be incorporated into a new, dynamically consistent precession theory to be chosen by the Working Group on Precession and the Ecliptic.

Celestial Intermediate Pole (CIP): Pole of the IAU 2000 precession-nutation model plus time-dependent observationally determined corrections. The pole represents the motion of the Tisserand mean axis but is limited to those forced periodic components with periods greater than 2 days when viewed from a space-fixed (kinematically non-rotating) coordinate system.

Celestial Ephemeris Origin (CEO): The non-rotating origin on the equator of the CIP in the celestial reference system.

Terrestrial Ephemeris Origin (TEO): The non-rotating origin on the equator of the CIP in the terrestrial reference system.

Earth rotation angle (θ): The angle between the CEO and TEO (in the instantaneous equator), which increases linearly with UT1.

There is some sentiment in favor of changing the names of the Celestial Ephemeris Origin (CEO) and Terrestrial Ephemeris Origin (TEO) to Celestial Intermediate Origin (CIO) and Terrestrial Intermediate Origin (TIO), respectively, and for calling the coordinate system defined by the CIP and the CIO (i.e., CEO) the "intermediate frame" or "intermediate system". This system of terminology has already found its way into some papers and documentation. It has some obvious appeal from the point of view of consistency, but below I suggest an alternative.

The term “intermediate” has come into use (apparently recently) to refer to the celestial pole that by convention effectively divides the instantaneous orientation of the Earth into components we label polar motion (in the terrestrial system) and precession-nutation (in the celestial system). That is, by the use of this pole (axis) we need five parameters to completely specify Earth orientation, when three Euler angles, or the equivalent, would suffice. As described by Mathews and Herring in their paper in the proceedings of IAU Colloquium 180 (2000), the “intermediate pole” is arbitrary and unnecessary; the same components of Earth rotation can be obtained from a harmonic decomposition of a time series of the instantaneous orientation measurements. Eubanks and others have pointed out that the choice of such a pole is similar to the choice of gauge in electromagnetism (I am not qualified to comment on this). The 2000 IAU resolutions define an intermediate pole (the CIP) and specify the IAU 2000 precession-nutation model that predicts its coordinates in the celestial frame. Although I think that “reference pole” or “conventional pole” is a better term to use than “intermediate pole” for what these resolutions describe, I don’t believe it would serve a useful purpose now to revisit the logic or terminology used in the resolutions. So I accept all of the above terms.

However, I believe that we can do better than to propagate the term “intermediate” further.

My main objection to the use of the term “intermediate” is simply that it is not very descriptive. It’s a very weak word, in either English or French, and doesn’t convey much meaning. In particular, with respect to the proposed term, “intermediate frame”, people have asked me, “intermediate between what and what”? Well, of course, the answer is that it is an intermediate step in the transformation between the terrestrial and the celestial systems (or vice versa). But if this coordinate system represents only a transitional step — that it has no use of its own — we could legitimately ask why it needs a label at all. That is, the very act of naming it “intermediate” indicates that the name is superfluous! Furthermore, there are *two* intermediate frames, since there are three matrices in the new-paradigm transformation between the ITRF and the ICRF: both have the same reference plane, the equator of the CIP, but one uses the TEO as the x-axis and the other uses the CEO as the x-axis. The angle between the two x-axes is θ , the Earth rotation angle, a linear function of UT1.

The fact that there are two intermediate coordinate systems (the one involving the TEO has been largely neglected so far in the discussion of terminology) that share a common reference plane suggests a logical and pedagogically helpful pair of labels: both of these coordinate systems are based on the instantaneous equator, so they are both *equatorial* systems. One of the systems rotates with respect to the other around the CIP. So I suggest that we call the one based on the CEO the “Non-rotating Equatorial System” (NES) and the one based on the TEO the “Rotating Equatorial System” (RES). These names suggest, correctly, that the only difference between them is a rotation around the common pole (z-axis), which is represented in the ITRS-to-ICRS transformation by the $R_3(-\theta)$ rotation matrix that separates them. (Alternative names might be the “Celestial Equatorial System” (CES) and “Terrestrial Equatorial System” (TES).)

It is interesting to note that the classical equatorial system, with the instantaneous equinox as the x-axis, has only ever been referred to as “the true equator and equinox of date”. Perhaps that could be considered a name, but it is not a very convenient one, and there is no corresponding abbreviation or acronym. If we decided the classical coordinate system needed a new name, possibly the name “Equinoctial Equatorial System” (EES) wouldn’t be too inappropriate. (Note, however, that the term equinoctial line (ligne équinoxiale) is in the dictionary as referring to the equator, so that anyone who wanted to be pedantic could claim that the term “Equinoctial Equatorial System” is redundant.)

I do not have a strong opinion about what to call the angle in the NES (the intermediate frame) that corresponds to right ascension. I do think that the name right ascension, unmodified, should continue to refer to conventional right ascension, that is, measured with respect to the equinox. There is just too much history with this term (in ordinary dictionaries, in fact) to

attempt to completely redefine it. There are people who are quite adamant on this point. For the angle in the equatorial system measured from the CEO, I would accept some modified form of the term right ascension, e.g., right ascension with respect to the CEO, or CEO right ascension. But it might be preferable to propose a different term entirely; for lack of anything better, consider “equatorial azimuth” or “celestial equatorial longitude”. “Celestial longitude” would be even better, but that term is sometimes used to mean “ecliptic longitude” and unfortunately the glossaries in the *Astronomical Almanac* and the *Explanatory Supplement* use it in that sense.

If we adopt these names, a remaining issue — for some people — is the non-parallelism between the names Celestial Intermediate Pole and Celestial (or Terrestrial) Ephemeris Origin. I suggest re-establishing the term “Celestial Ephemeris Pole” (CEP) to mean simply “the pole defined by the precession-nutation theory”, which currently is the IAU 2000A precession-nutation model. Note that this is *not* synonymous with “Celestial Intermediate Pole” because the latter includes time-dependent observational corrections. This new CEP definition also encompasses the term’s previous use as the name of the pole of the 1980 IAU Nutation Theory and could be applied to future theoretical developments (we should not have to name a new pole every time the theory changes). The new definition is a very “nuts and bolts” concept that is independent of the particular theoretical basis of the precession and nutation developments. It is useful to have a name for what comes directly out of the precession and nutation computations, because the CEP (in the sense suggested here) is predictable but the CIP is not. Because of this, the expressions for (or ephemeris of) the position of CEO that have been provided are really derived from the CEP, not the CIP. So the parallelism in terminology would then involve the CEP and CEO, correctly reflecting the practical computational link between the two points. Since an expression has also been adopted for the (tiny) drift of the TEO in longitude, based on an assumed ephemeris of the pole in the ITRS over the next few decades, similar considerations apply to the TEO as practically realized. Re-adopting the term Celestial Ephemeris Pole as suggested here also has the benefit that the published (observed) celestial pole offsets can then be simply described as the difference between the CIP and CEP, thus helping to clarify all three concepts.

This nomenclature scheme also avoids the problem, previously noted, that if we change the CEO to CIO, we end up re-using the abbreviation for Conventional International Origin. That reference point is no longer used, but was common in the Earth rotation literature over many decades, and confusion is certainly possible.

In summary, my suggestions are:

1. Retain the terms Celestial Intermediate Pole (CIP), Celestial Ephemeris Origin (CEO), and Terrestrial Ephemeris Origin (TEO) as per their definitions in the 2000 IAU resolutions.
2. Re-establish the term Celestial Ephemeris Pole (CEP) to mean the computational pole defined by the adopted precession-nutation theory.
3. Introduce the term Non-rotating Equatorial System (NES) (alt: Celestial Equatorial System (CES)) to mean the coordinate system defined by the CEP and the CEO.
4. Introduce the term Rotating Equatorial System (RES) (alt: Terrestrial Equatorial System (TES)) to mean the coordinate system defined by the CEP and the TEO.
5. Consider an alternative to right ascension for the azimuthal angle in the NES. Attaching some modifier to right ascension would be acceptable, but it would be better to use an entirely different term, such as equatorial azimuth or celestial equatorial longitude.

It’s my view that the WG should try to find nomenclature that is descriptive and helps illuminate the concepts involved, a responsibility that flows from our other task of helping to

educate the astronomical community about this topic. We should seek the clearest and most transparent terminology that is consistent with technical accuracy. Other members of the WG will probably be able to suggest better terms than I have outlined above, and in fact my real purpose is to encourage those suggestions. The terminology should be open to real discussion and new ideas, and I'd like there to be a choice.

By the way, I generally think we should avoid capitalizing words as much as possible (i.e., celestial intermediate pole is my preference instead of Celestial Intermediate Pole), but I have adopted the capitalization practice above simply because that is the way it is done in the 2000 IAU resolutions. We should also be careful about too much use of abbreviations in documents that are intended for a wide audience. We can talk in “code” amongst ourselves, but we should recognize that in doing so it is very easy to write material that is incomprehensible to everyone except a dozen or so people in the world.

Comments, criticisms, and better ideas are most welcome!