HIGHLIGHTS OF THE SCIENTIFIC MEETINGS OF DIVISION I "FUNDAMENTAL ASTRONOMY"

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ABSTRACT. This paper summarizes the Division I meetings that have been held during the XXVth General Assembly of the Astronomical Union in Sydney (16-24 July 2003).

1. INTRODUCTION

Division meetings have been organized for the first time during the XXVth General Assembly, according to the recent evolution in the scientific organisation of the IAU. The SOC of the Division I meetings was composed of the Division Board, enlarged with Vice-Presidents of Division Commissions, Presidents of the current Division Working Groups and with the upcoming Division I President, T. Fukushima, who was elected in March 2003. The first meeting (on 17 July) included three sessions devoted to scientific discussions and one session devoted to reports of the Division Working Groups. The second meeting (on 21 July) included one session devoted to the future organization of the Division. At the opening of the first meeting, the memory of P. Bretagnon and Ch. de Veght, who had outstanding contributions to the topics to be discussed and passed away last year, was recalled.

The report of Division I meetings at the General Assembly is being published in IAU Transactions Vol XXVB (2003, O. Engvold ed.) and that of Division I activity during the past triennium including the Working Groups have been published in the Reports in Astronomy (IAU Transactions Vol XXVA, 2003, H. Rickmann ed.). The main points of the presentations and discussion during the Division I meeting are summarized in the following sections.

2. SUMMARY OF THE SCIENTIFIC SESSIONS

Besides organisation issues regarding the Division 1 Working Groups, the two major points that have been discussed in the scientific sessions were the "Implementation of the IAU Resolutions" and the "Precession and Astronomical Standards".

2.1. Implementation of the IAU Resolutions

The session on the implementation of the IAU Resolutions has included a) two presentations on the present status of this implementation, b) a specific consideration of the implementation of the resolutions for the Almanacs (chaired by J. Vondrák) with five presentations and one large discussion, and c) a special discussion on experiences and problems (chaired by P. Wallace) introduced by two presentations.

a) N. Capitaine recalled that the implementation of the IAU 2000 resolutions required the adoption of (i) the IAU 2000 model (Resolution B1.6) to replace the IAU 1976/1980 precession-nutation for the motion of the Celestial Intermediate Pole (CIP) in the Geocentric Celestial Reference System (GCRS), (ii) a conventional model (Resolution B1.7) for high frequency motions of the CIP in the International Terrestrial Reference System (ITRS) and (iii) the conventional relationship for defining UT1 (Resolution B1.8) as proportional to the Earth Rotation Angle (ERA) between the Celestial and Terrestrial Ephemeris Origins (CEO and TEO). Expressions with an accuracy of a few microarcseconds have been provided in a number of scientific papers published in 2002 and 2003 for all the models necessary to implement the IAU 2000 system, using equivalently either the CEO-based or the equinox-based transformations.

D.D McCarthy presented the International Earth rotation and Reference system Service (IERS) implementation of the IAU resolutions in its products. The IERS Conventions now provides an outline of the procedures to be used along with software consistent with those procedures. IERS Bulletins A and B have made the data required to implement the resolutions available since January, 2003. To assist users in the transition period between the previous system and that recommended by the 24th General Assembly, the IERS also continues to provide data consistent with the previous system. It also plans to make available a file of frequently asked questions to assist users in the transition between systems.

b) J. Bangert introduced the special issue of implementing the new resolutions in the almanacs. These publications provide practical astronomical data in an accessible form to satisfy the needs of a wide variety of user applications such as navigation, pointing a telescope, planning an observing session, or scientific research. Implementing the IAU 2000 resolutions in the almanacs must be considered in the context of specific criteria (i.e. a proposed change is implemented only when it (1) will result in more accurate information in the almanac, (2) is based on sound scientific underpinnings, and (3) will result in data or information relevant to the users of the almanac). Moreover, a considerable lag has to be expected between the time a resolution is adopted and the time that it is implemented in the almanacs due to the time needed to develop, implement, and test new production software, and to the normal publication schedule.

Special presentations from various Almanac offices specified how they would implement the IAU resolutions on reference systems and Earth rotation adopted in 1997 and 2000.

G. Kaplan presented the changes in the Astronomical Almanac, prepared jointly by the US and UK nautical almanac offices and based to the greatest extent possible on IAU-endorsed and other internationally recognized standards. Both the reference data and algorithms used must be changed, and some new tabulations added. Some of the required modifications have already been made and others will be introduced into the editions now in preparation.

W. Thuillot reported on this implementation in the French ephemerides, which are prepared by the Intitut de Mécanique Céleste et de calcul des Ephémérides (IMCCE), at Paris Observatory, under the auspices of Bureau des longitudes. The use of new models for precession and nutation will be done at first and the changes in the systems of coordinates will only be introduced in parallel with the usual systems.

T. Fukushima reported on the two kinds of national almanacs in Japan; the more precise and comprehensive one for the nautical use, the Japanese Ephemeris (JE) by the Maritime Safety Agency (MSA), and the more compact for the civil use, the Ephemeris Year Book (EYB) by the National Astronomical Observatory of Japan (NAOJ). The MSA will make no revision of the JE until all the required procedures for the changes are clear. As for EYB, a major revision from the edition of Year 2003 was already made including (1) the change of base planetary/lunar ephemeris from DE200 to DE405, (2) the change of nutation theory from IAU 1980 to Shirai and Fukushima (2001), and (3) the change of geodetic datum from Tokyo datum to the new Tokyo datum, being almost the same as the latest ITRF.

I. Kumkova gave the report prepared by M.L. Sveshnikov, N.I. Glebova, M.V. Lukashova, A.A. Malkov on the Russian astronomical yearbooks (RAS) prepared at the Institute of Applied astronomy in St.-Petersburg. The report recalled that the structure and contents of the IAA RAS are changed regularity to satisfy IAU resolutions and requirements of users. The current plan of implementing the IAU 2000 resolutions includes the replacement of planetary ephemerides, precession-nutation model, stellar catalogue and transfer to the new CEO concept. It will be carried out during 2003-2006.

The presentations and discussion in this session showed that procedures, models and software are available to users for the implementation of the IAU 2000 resolutions and that the implementation has already been done in IERS products and will be done in almanacs in a near future. They have also made it clear that (1) official recommendations are required in order that the almanacs implement the new IAU resolutions based on a common an approved terminology, (2) an important educational effort is needed to inform a wider astronomical community about the new system recommended in IAU 2000 Resolutions.

c) In this context, G. Kaplan presented an alternative to the usual quantities used for positioning the CEO. This scheme may have pedagogical and pratical advantages for the vast majority of astronomers who are unfamiliar with the history of this topic as it consists in a simple vector differential equation for the position of a non-rotating origin on its reference sphere. This directly yields the ICRS right ascension and declination of the CEO, or the ITRF longitude and latitude of the TEO, as a function of time and also yields a simple vector expression for apparent sidereal time.

C. Ma recalled that initial set of FAQs on the recent IAU resolutions has been prepared for linking from relevant web sites and discussed the content, future refinement and expansion, and distribution.

2.2 Precession and Astronomical Standards

The session on Precession and Astronomical Standards has included a) four presentations on improved precession models followed by a discussion (chaired by G. Kaplan) and b) one presentation on astronomical standards followed by a discussion (chaired by V. Dehant).

a) T. Fukushima presented his recent precession solution which uses modified Williams' formulation (1994) for precession and nutation and is based on (i) the planetary precession of Harada and Fukushima (2003) derived from DE405 JPL ephemerides, (ii) the nutation theory of Shirai and Fukushima (2001) and (iii) a fit of the luni-solar precession to VLBI observation of celestial pole offsets (1979-2000). As by-products, he obtained the new determinations of (1) the mean pole offset at J2000.0, (2) the speed of general precession in longitude at J2000.0, (3) the mean obliquity of ecliptic at J2000.0, and (4) the dynamical flattening of the Earth.

N. Capitaine presented the expressions for precession quantities compliant with IAU 2000 that have been obtained by N. Capitaine, P. Wallace and J. Chapront (2003). This includes (1) the currently used precession quantities, in agreement with the MHB corrections to the precession rates, that appear in the IERS Conventions 2000 and (2) the new P03 precession expressions that are dynamically consistent. The P03 precession of the ecliptic is based on most recent theories for the Earth and the Moon and the most precise numerical ephemerides. The P03 solution for the precession of the equator is dynamically consistent and compliant with IAU 2000. This also reported on the most suitable precession quantities to be considered in order to be based on the minimum number of variables and to be the best adapted to the most recent models and observations.

W. Thuillot presented a recent work on precession expressions and consideration about the EOP and a conventional ecliptic that was done by P. Bretagnon, A. Fienga and J.L. Simon

(2003). The new precession quantities consistent with the IAU 2000A model have been derived from the analytical solution of the rotation of the rigid Earth SMART97 which provided together precession and nutation and was based on the new value of the precession rate of the equator in longitude. This work includes the derivatives of the expressions with respect to the precession constant and the obliquity. It also reports on the possible use of Euler angles in IERS publications for a global modelling of the Earth rotation and proposes the definition of a conventional ecliptic plane close to the mean ecliptic J2000 and with a non-rotating origin.

J. Hilton discussed the future directions in precession and nutation. One concern is that the IAU 2000A precession-nutation theory is computationally expensive, requiring over one thousand evaluations of sine and cosine functions to evaluate IAU 2000A just once and IAU 2000B has a reduced precision that was designed to cover only a limited time span around the epoch J2000.0, whereas applications such as the Multiyear Interactive Computer Almanac (MICA), are being developed that require long coverage periods and the ability to reach the accuracy of modern day observations. He concluded that to address this deficiency future precession and nutation theories will need to do one or more of the following: (a) make a serious effort to optimize the code; (b) reduce its precision to match the accuracy with which the Earth orientation can accurately be determined; (c) no longer separate terms that are so close together in frequency space that their individual contributions cannot be determined at the level of accuracy of the observations; (d) move from representation as an analytic theory to a numerically integrated representation.

Presentations and discussion in this session showed that a physically consistent precession should have to be considered in the near future based on an improved precession of the ecliptic and that an IAU Working Group is needed to recommend a new precession model resulting from comparisons of the recent available models.

b) M. Standish discussed the sources and uses of astronomical constants and especially the use of ephemerides based upon the independent variable, "Teph" (which has been used over the past three decades for the ephemerides created at JPL, CfA, and IPA) and compared it with the use of ephemerides based upon the recent IAU-defined "TCB". He showed that Teph and TCB are are both relativistic coordinate times that are mathematically equivalent. Proper use of a Teph-based ephemeris should give results identical to those obtained using a TCB-based ephemeris. He discussed special situations such as navigating a spacecraft in orbit around a remote planet while timing the dynamics on an earth-based clock.

The discussion about astronomical standards has made it clear that a strong coordination is required between the various sources of standards (IAU, IERS or IAG values) in order to improve consistency between the standards for astronomical or geophysical uses. An effort should be done in that sense by the representatives of these bodies in various Committees.

3. SUMMARY OF THE SESSION ON DIVISION I ORGANISATION

The last session of Division I meetings has been devoted to a large discussion on the future of Division I commissions and working groups within the future revised by-laws of the IAU. According to the discussions that have been held during the scientific sessions and during the session devoted to the reports of the Division I Working Groups, Division I Board proposed to continue the Working Groups that have very specific tasks and to establish two new Working Groups: one on "Precession and ecliptic" (Chair: J. Hilton, USA) and the other on "Nomenclature for Fundamental Atronomy" (Chair: N. Capitaine, France). This proposal was presented by the upcoming President, Toshio Fukushima, at the end of the Joint Discussion 16 "The International Celestial Reference System: Maintenance and future realizations" (on 22 July) during which the future of the Working Group ICRS, considering a possible distribution of its tasks to some Division I Commissions, has been discussed.