

THE IAU WORKING GROUP ON REFERENCE SYSTEMS

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ABSTRACT: The IAU Working Group on Reference Systems (WG) was founded by a Commission Resolution passed at the XXth General Assembly in Baltimore in 1988. Since most, if not all, participants in this meeting are familiar with that resolution, it will not be discussed here. Background material may be found, for example, in *Highlights of Astronomy*, XX General Assembly (1988, Ed. D. McNally). Particular attention is called to the reports by B. Morando, R. Duncombe and J.A. Hughes (pp. 482-500) which were given as part of the Joint Commission Meeting, *Towards Milliarcsecond Accuracy*, chaired by P.K. Seidelmann. This short presentation will provide a description of the current state of affairs of the WG, which is chaired by the speaker.

Introduction

The WG is charged with the consideration of four essential matters: Nutation of the Earth, Astronomical Constants, Time and Reference Frames/Origins. In order to address these diverse topics, several distinct areas of expertise are needed. Thus a single group would necessarily be quite large and would no doubt soon become unmanageable. For this reason, the Chairman opted to set up four subgroups, each with its own leader, to separately address the four matters listed above. After consultations with many colleagues, including Commission presidents, the Chairman drew up the membership lists which follow. The selection criteria are easy to describe. However, a perfect implementation based upon these criteria is impossible. The members of the subgroups were chosen primarily for demonstrated knowledge and interest regarding a specific area of concern to the WG. Next, consideration was given to achieving the greatest possible representation of all the Commissions involved, i.e., Commissions, 4,7,8,19,20,24,31,33 and 40; nine Commissions in all. Finally, in a completely similar way, every effort was made to achieve the best geographical distribution of the membership possible. The results of these efforts will now be presented. The membership of each subgroup will be displayed, each followed by brief remarks about the work of that particular subgroup.

Subgroup on Nutation

Leader: D. McCarthy; Members: V. Dehant, E. Groten, T. Herring, G. Kaplan, H. Kinoshita, M.G. Rochester, R. Vicente, J. Vondrak, J.M. Wahr, Ya.S. Yatskiv.

The work of this group is proceeding well. There appears to be a general consensus that for the immediate future the current IAU nutation be used. Those few users requiring the very highest accuracy should apply the IERS corrections to the IAU values. It is unlikely that any *ad hoc* adjustments to present coefficients will be recommended.

Souchay with Kinoshita as well as Groten have developed new theories for the celestial part of the nutation problem. I believe we will hear more on this topic later in this meeting. As far as a new Earth theory is concerned, we will assuredly hear more on this topic when Dr. Wahr speaks later this week. It may be remarked here that at present it appears that observation is driving geophysical theory in this area rather than the other way round.

Subgroup on Constants

Leader: T. Fukushima; Members: M. Bursa, J. Campbell, J. Chapront, W. Jin, G.A. Krasinsky, R. Reasenberg, P.K. Seidelmann, A.T. Sinclair, E.M. Standish, C. Veillet.

Although the work of all the subgroups is inter-related to some degree, there is an almost symbiotic relationship between Constants and Time which ought to be kept in mind. The current IAU time units are, in the end, proper units based upon International Standard (SI) values. The use of such "localized" units has led to inconsistencies in the definitions and usage of various constants. This has been clearly demonstrated by Fukushima *et al.* (1986). In addition, as has been pointed out by Murray (1983) and Fukushima *et al.* (*op. cit.*), the IAU has no clearly defined unit of length comparable to any time unit. These are the kinds of difficulties which must be addressed by the group. In short, some constants are inappropriately or inconsistently defined and a critical examination of the IAU76 System *vis a vis* General Relativity (GR) is necessary.

These brief comments cannot address all the issues. Examples of other questions are: What items should be included as constants? Which are the defining constants? How are values to be updated? How are the accuracies to be characterized?

Subgroup on Time

Leader: B. Guinot; Members: V.A. Brumberg, H. Deboer, M. Fujimoto, J. Lieske, P. Paquet, I. Shapiro, J. Taylor, G. Winkler, B. Xu, B. Yallop.

As already mentioned, the time scales currently in use are all ultimately based upon proper SI units. Since any realization of an observable time scale must be based upon some kind of a proper unit (event), the task is to define the interrelationships (transformations) between such scales and any functional arguments one might use in GR theory. Once any scale is adopted, provision must be made for the projection of that scale into the past. In addition, the complex process of the transfer of time must be addressed while considering the protocols which have already been established. Of course the "symbiotic" relationship with the Subgroup on Constants is a two-way street and this must be taken into account.

Subgroup on Frames/Origins

Leader: J. Kovalevsky; Members: V.K. Abalakin, S. Aoki, F. Arias, C. Boucher, N. Capitaine, Ch. de Vejt, K. Johnston, C. Ma, I. Mueller, C.A. Murray, H. Schwan, C.A. Smith, R. Wielen.

In my opinion the tasks of this group are perhaps the most difficult of all those facing the WG. Ironically, the idea of assigning positions and motions to celestial objects appears almost conceptually trivial and therefore many of our astronomical colleagues do not appreciate the intricacies involved, especially those difficulties encountered at the milli-arcsecond level of concern. For example, the very motions which are being characterized complicate matters tremendously.

The reconciliation of a milli-arcsecond radio coordinate frame with an optical frame known to be more than one order-of-magnitude less accurate is a central concern of this subgroup. Such a reconciliation may not be a simple matter since the needs of diverse groups must be satisfied. These groups may have completely different views. Indeed, within our own astrometric community, there is not even universal agreement on what constitutes a "reference frame", a "reference system", a "coordinate frame" and a "coordinate system"! Nevertheless, the essential issues are appreciated and the significance of various courses of action are becoming more widely known. The word "Origins" appears explicitly in the title of this subgroup since the choice of an origin, or origins, for the various possible coordinates is a distinct and to a great degree, a separable problem which can be addressed somewhat independently. For example, the origins of the coordinate frames used for celestial coordinates and the metering of the Earth's rotation need not, in principle, be identical, although there are clear advantages to such an identity. In this connection I call attention to the presentation to follow by Andrew Murray. He will undoubtedly illustrate the kinds of issues involved with his talk on the *Non-rotating Origin* (NRO), an origin originally proposed by Guinot (1979). (The concept of the NRO undertakes to remove the partial dependence of the origin of coordinates on the orbital motion of the Earth.)

Summary

I believe that the WG is off to a good start and that the people involved are capable of effectively crafting sensible proposals for the IAU based upon a thoughtful consensus. This is not to say that there are not many other individuals who could also make a good contribution. However, in order to have a WG of reasonable size, it was impossible to include all those who I would have otherwise chosen to participate. In any event, I do solicit the viewpoints of all those concerned with the work and its outcome. These may be addressed to me or to the leaders of the subgroups.

Finally, let me once again remind you of IAU Colloquium No. 127, *Reference Systems*, to be held at Virginia Beach, Va., 14-20 October 1990. The WG will formally meet at this Colloquium and those interested should plan on attending.

REFERENCES

Fukushima, T., Fujimoto, M., Kinoshita H., Aoki, S. (1986), *Celestial Mechanics* 36, pp. 215-30.

Murray, C.A. (1979), *Vectorial Astrometry*, Adam Hilger Ltd., Bristol.

Guinot, B. (1979), "Basic problems in the kinematics of the rotation of the Earth," in *Time and the Earth's Rotation*, IAU Symp. #82, D.D. McCarthy and J.D. Pilkington eds., D. Reidel Pub. Co., Dordrecht, pp. 7-18.