POSSIBLE FEATURES OF IAU STANDARDS

P. K. Seidelmann
U S Naval Observatory

INTRODUCTION

In the past, the IAU has adopted standard values for some constants, primarily for use with solar system ephemerides. The constants adopted in 1976 were specifically adjusted to provide internal consistency. In each case, when constants have been adopted, the changes have reflected accuracy improvements, and the purpose has been to encourage the accomplishment of better science.

Over the past 12 years, the Working Group on Cartographic Coordinates has issued triennial reports giving the best values for the sizes and rotations for the planets and satellites. This working group now is an IAU/IAG/COSPAR working group reflecting the different organizations that have recognized the benefits of this group. This is an example of a properly functioning working group, which provides the best values on a regular basis. The IUGG also provides best estimates triennially for values of interest in geodesy and geodynamics.

Clearly, there are interrelationships among geodesy, space sciences, physics, astronomy, and other fields. It would be very unfortunate if the IAU adopted standards that are in conflict with the values recommended by another group. Considering the current ability to compute ephemerides very easily by means of modern computers, and the advances of communications, (such that information can be provided instantaneously by E-mail, FAX, or telephone), perhaps we need to be ready to change more rapidly. Constants were adopted or recognized in 1950, 1964, 1976, and possibly in 1994, which does not indicate acceleration of changes. However, methodologies have changed. Where before we talked about constant values, now, for example, the constant of nutation is regarded as insufficient. We need a theory of nutation. The constant of precession by itself is inadequate; an expression is needed. So now, we're not talking about just constants, we're talking about methods, formulae, and subroutines as well.

SCOPE OF THE IAU STANDARDS

What should be included in the IAU standards? In the past, it has been solar-system related. Should it be all astronomy? What about the related sciences? I would suggest that the scope be all that is necessary for

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astronomers to pursue their activities. The purpose of IAU standards should be to provide the means for comparison of results, so that different people doing the same thing would use the IAU standards and compare their evaluations. Likewise, the standards should provide the means of communicating values. Scientists publishing their work should be able to say that the IAU standards were used in their work. Thus, the existence of the standards should provide a means of communicating which methods were used throughout astronomy, and ensure resulting accurate levels. The standards should also provide efficiency, e.g. a means of one person writing a computer subroutine that other people can use, thus avoiding duplication of effort. They should provide a set of values that can be used without requiring additional investigation by the researcher. Finally, the standards should be a means of keeping people up-to-date. The availability of these standards in a publication would enable someone to use the best or most accurate value, rather than one they find in an older text or reference.

What are the characteristics of these IAU standards? I think they should take the form of a set of numerical values for certain constants. They should also include standard mathematical formulations for such things as nutation, precession, and time transformations. The standards should include the methodologies, for example, to be used to calculate the apparent places of stars and solar system bodies, and for converting between different coordinate systems, (such as the FK4 on B1950 to the FK5 on J2000, or from the radio reference system to the optical reference system). The standards also should include subroutines, such as for computing nutation, which everyone can use.

In relationships as those indicated above, I think it would be unfortunate if there were a conflict between the standard values of one international organization and those of another. Generally, I think the constants provided by CODATA should be adopted and accepted. Either the IAU committee on Standards should be consolidated into a joint committee, sponsored by a number of organizations, as is the case for the Cartographic Coordinates Working Group, or there should be some common membership and communication between the groups to ensure that there are no inconsistencies. These groups include the IAG, IUGG, IERS, COSPAR, and other organizations concerned with constants in some aspect of astronomy.

SUBDIVISIONS

I would divide the astronomical standards into three basic groups: numerical values, mathematical formulations or methodologies, and software. Concerning numerical values, there are certain primary standards that should never change. These include the speed of light and the Gaussian Gravitational Constant. There are other astronomical constants that should change only when necessary. These include the precession constant, the obliquity of the ecliptic, and other constants that are used throughout astronomy. There are subordinate quantities for which best estimates could be given on a triennial basis. These include

items such as the masses of the minor planets. There are peculiar quantities that are of interest only to people in specialized areas, such as the Earth Rotation Service or the IUGG. Those groups should provide the appropriate values, and maybe these should be placed in specialized tables. In some cases, we can standardize to a given accuracy level that is adequate for most applications. Then, to higher accuracy, where the values are not well determined, there would not be standardization.

As we talk about establishing a working group to recommend changes, it is natural to ask how often changes should be made. In some cases this depends on the quantity; in other cases it depends on the method of distribution. If we are publishing data, then changes need to be limited. On the other hand, if the standards were being provided electronically, the values could change daily, hourly, or even more frequently. I don't think this is desirable, but it is certainly possible. The researcher, pushing at the very limits of the accuracies available from the observational data, needs to use the best and latest values. For the observer who's undertaking an extended observing program, changes in constants are undesirable and can be disastrous. In general, changes should not be more frequent than annually or triennially. When constants are being changed, it is imperative that the researcher document what set of standards has been used in the published work.

Generally, the same comments apply to mathematical formulations or methodologies as to numerical values. Consistency and standardization may be more difficult to specify in this case unless it is achieved by computer software that provides the standardization.

SOFTWARE

IAU standardization of software is a new field, which presents challenges and opportunities. Nevertheless, I think it represents what most people want to have in the future. It's my opinion that standardized software should be written under a set of rules concerning documentation. The interfaces to be used between subroutines, the structure of the program, and the maximum size of the subroutines should be specified. The software should be written in conservative versions of standard languages, so that there is a high probability of compilation on different types of computers. There should be critical case examples accompanying the software, with the resulting values specified, so that the first thing a person can do after compiling such standardized software is test it and ensure that the subroutine produces the correct result.

There is a need for verification of such software. Test groups or referees have to exist to check each routine to make sure that it functions properly. There is a problem in controlling standardized software. If it were provided as object code, one would be inhibited from tinkering with the code. On the other hand, object code is more difficult to transport from one computer to the other. Source code is desirable from that point of view, but how does one control it? Possibilities include line numbers and check sums across the rows. There are other

questions. Should it be copyrighted? How can the necessary security precautions be taken to insure that viruses and bugs are not included in the software?

The software also presents a problem for distribution. There is no center for software distribution. It could be put on a bulletin board where people can help themselves to the software. Alternatively, it could be distributed on floppy or optical disks where it can be copied and handed from person to person.

A major difficulty with software is that one needs a point of contact. Inevitably, when software is distributed, someone has a question about what this means, or how this works. The handling of inquiries or, even worse, telephone calls can be the biggest problem of all with standardized software.

ORGANIZATION

There are organizational considerations for the IAU standards. Should this be a standing working group, or an IAU commission? The recommendation adopted indicates it should be a permanent working group from a number of commissions. It's clear that it must report back by 1994. That report should be printed somewhere, probably in a separate publication rather than the IAU Transactions. Alternatively that report can be put on an electronic bulletin board or distributed on floppy or optical disk. With the modern means of communication today, it certainly would be desirable and possible for this report to be available by computer. This means it could be available on a message board, which would provide a rapid means of communication.

SUMMARY

We have reached a time when the IAU Standards need to include a larger scope of values that require coordination with other international organizations. For some quantities it is desirable to provide best estimates of the values on a regular basis. The IAU Standards also need to be expanded to include not only values for certain quantities, but also formulae, methodologies, and computer software. These IAU Standards should not only be published, but they should be made available by electronic means also.

DISCUSSION

Vincente:
I should like to mention the frequency of change. Of course you hadn't time to go into details, but the frequency of change depends on the techniques we have. In the last twenty years we have been fortunate to have new techniques: lunar laser ranging, satellite laser ranging, very long baseline interferometry, and now the global position system. So therefore we have increased our precisions very dramatically lately. So I think it is very difficult to give a sort of time scale for the frequency of change, and you did not mention it, and I think you are quite wise about that. But we have to keep in mind also, that it is not so easy to decide which of the observation techniques are going to be improved again in the near future. So we have to keep that question open depending on the precision and the observation techniques we are going to have at the present time and in the near future.

Seidelmann:
I would agree. I think the frequency of change may well be driven by the advantages of change. If there is no advantage to change, the change should not be made, when it's necessary it should be.

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