

## Comments on Recommendation III of the IAU Working Group on Reference Systems

E.M. Standish  
JPL/Caltech, Pasadena, CA.

IAU Recommendations should 1) help to avoid confusion and 2) help to enhance scientific capability. Recommendation III does neither. It would create confusion while doing nothing to improve scientific results.

If Recommendation III is ever implemented, the result will be sheer chaos. This recommendation proposes that the rate of the basic ephemeris time scale be changed - by an amount of nearly one-half second per year. This implies that all existing planetary, lunar, satellite, spacecraft, asteroid and comet ephemerides would be referenced to an obsolete time scale; all existing sets of orbital elements would need a modification; that epoch J2000 (JED 2451545.0) would differ from the presently defined one by nearly 15 seconds.

What are the benefits? What are the costs? What are the risks?

What are the benefits of Recommendation III? There is not one single scientific application which can be done more accurately with the proposed new time scale. The only benefits are very minor in nature: 1) The proposal would formally acknowledge the use of relativity in the coordination of atomic time throughout the world, and 2) The proposal would provide a more convenient definition of a time scale for the purposes of analytical work in relativity.

What are the costs of Recommendation III? There are now over 500 institutions throughout the world where machine-readable astronomical ephemerides are used on a continual basis in association with countless man-years' worth of computer software. It is impossible to even estimate what it would require to convert and validate all of these resources. The costs alone would be prohibitive.

What are the risks? Enormous. This would be the most insidious of changes - perhaps unnoticeable for a while, but eventually crucial. True, to many users the difference would be insignificant, to others however, it would be monumental.

Scientific knowledge cannot be enhanced by a mere change of units. In a practical sense, the present time scale (TDB) is now too entrenched. For those actually using the ephemeris time scale i.e., people involved in data reductions, spacecraft tracking, time coordination, etc., there is nothing to be gained from the new proposal. Only potential disaster.

## DISCUSSION

Vincente:

I should like to congratulate you for the excellent explanation you gave and I haven't talked with you about this service nor with the previous speaker Dr. Winkler. Yesterday I presented a paper at commission 31, where I asked two questions. First, why make the change at the present time? And then another question; Have our observations attained such a degree of precision, that we really require these new time scales? Then I gave an example of two groups of users which was as follows. First, the main users of time services employing their results for the determination of time in their laboratories for every day applications. Second, the outstanding program of space probes, the Voyager mission, which was extremely successful, involving the computation of very accurate orbits. These two important groups of scientist employed, in their computer programs, the present-day time scales, and they did not need or require any other concepts of time scales. I did not know anything about this paper, I did not know anything about Dr. Winkler As you see, it is extremely important that we do not change just for theoretically nice ideas or for a few cosmologists. There are hundreds of people, and I mentioned in the paper yesterday that which Dr. Standish just mentioned: the great danger and complications of changing your software. So I congratulate for your excellent exposition.

Fliegel:

I fully agree with every point that Myles Standish has made, and I only want to add this: we agreed at Virginia Beach that we would accept the new nomenclature if others wanted to use the new kinds of time, TCG, TCB and so forth. We, on our part (MGPS), will add comments to our code to the effect that TAI is also known as TT and so on. That is the only change we will make. We will not introduce any changes in frequency or time offset.

Standish:

I probably should reply to that to. I know for a fact that JPL will have the same reaction. It may interest you to know; somebody mentioned our success in navigating Voyager. We have never navigated a mission yet on the J2000 system, they are still on the 1950 system in navigation. They asked, "what benefit?" "What risk?" And that's your answer. Now, how can I ever get JPL to adopt a new time system? So at JPL we will have the same reactions as Henry outlined.

Seidelmann:

I don't know if Henry (Fliegel) intentionally wanted to illustrate a point or whether he made a mistake, but TT is not equal to TAI, it differs by 32.184 seconds, and that's the kind of confusion I guess that is of concern.

Fukushima:

I'd like to make two comments. One comment is: if you do not adopt this multiple-rate timelike argument system, we should prepare different sets of units systems and constant systems, as I described it. That is one point. The other point is that I'm rather optimistic about the confusing matter of the interaction of the several time scales, because as my subgroup proposes, we need just a few small subroutines or functions which can transform say TCB to

TDB or TCG to TDT, if you want. True, preparing the actual subroutines requires some effort, because there are still some controversial matters, such as mentioned by Myles, about our Japanese results and the French results. But I feel that preparing the kind of standard transformation routines needed, will be a good answer to the question of confusion about the introduction of multiple time scales.

Kaplan:

I think the introduction of the new time scales can be beneficial in certain theoretical developments. There's a recent paper in AJ by Soffel et al. in which they develop some very precise VLBI delay algorithms, and they use the new time scales. I think that paper is conceptually simplified by the use of these time scales. However, I have done some rethinking on this since the Virginia Beach meeting, because I'm responsible for the algorithms which are used in the Astronomical Almanac. I have come to share a lot of Dr. Standish's and Dr. Winkler's concerns about the introduction of new time scales for very practical applications, and in particular the fact that the older time scales are propagated throughout software. All of our precession/nutation formulas are really based on the old time scale, all of the arguments for our theories of the motion of the planets are based on all of the old time scales. I'm afraid that the solution to this is going to be as both Henry and Myles have said, to simply put comments in the code, that we are not using IAU standard time scales. So in conclusion, I support the establishment of these time scales for certain types of theoretical development. I think they in fact simplify certain types of theoretical developments, but I'm very concerned about the practical applications of these as we actually develop algorithms and subroutines that people are actually going to have to use on a day-to-day basis.

Standish:

Whether we adopted this or not, it did not prevent Soffel from doing his analysis.