FUNDAMENTAL ARGUMENTS OF THE CURRENT NUTATION THEORY

DYNAMICAL REFERENCE FRAME

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1. The Ephemerides

The latest JPL planetary and lunar ephemerides, DE405, are now referenced to the ICRF with an accuracy of about 1 *mas.* This has been accomplished mainly by fitting the ephemerides to 18 VLBI observations of the Magellan Spacecraft in orbit around Venus, 1990–1994, and to 2 VLBI observations of the Phobos Spacecraft in its approach to Mars, 1989. The orientation of DE405 is discussed in more detail elsewhere in this volume (Standish, 1997). Since all of the parameters of the inner solar system are now determined to 1 *mas* or better, one should be able to extract numerically the fundamental arguments of the nutation theories to the level of 1 *mas.*

There are two ways of extracting the ecliptic, for example, from a numerical ephemeris: 1) one computes the node and obliquity of the instantaneous ecliptic at multiple points in time and then fits these with analytic functions, or 2) one fits an analytical planetary theory to the ephemerides and then computes the node and obliquity from the theory's parameters. This paper relates a short example using method #1 and concludes that method #2 is probably more preferable.

2. Numerical determination of $\overline{\Omega}$ and $\overline{\epsilon}$

Using the "inertial" definition (Standish, 1981) of the instantaneous ecliptic, $\Omega_I \equiv \tan^{-1}(\hat{h}_x/-\hat{h}_y)$ and $\epsilon_I \equiv \sin^{-1}(\hat{h}_z)$, different fits were made to values of the node and obliquity, computed over various time intervals. One can judge the validity of the resultant values by the appearance of the post-fit residuals and by how much the resultant values themselves vary from one to the other. As in Standish (1982), there were 56-58 periodic terms, 7 mixed-secular terms, and 3-8 time-polynomial terms; the time intervals used were 1500 AD – 2500 AD, 1000 AD – 3000 AD, and 3000 BC – 3000 AD. The best results seem to be $\overline{\Omega} = 0''.052 \pm 0''.010 + 10''.556(\pm 0''.001)T + \ldots$ and $\overline{\epsilon} = 23^\circ\ 26'\ 21''.409(\pm 0''.010) - 46''.811(\pm 0''.001)T + \ldots$

3. Discussion

Relatively large uncertainties were assigned to the mean values because it seems that a long interval (5000 years or more), centered at J2000, would be necessary to produce trustworthy results at the 0''.001 level. However, it is possible that the analytical theories, containing thousands of terms, developed at the Bureau des Longitudes, could be fit to the present existing intervals to give milliarcsecond results. Otherwise, it will be necessary to extend DE405 another 4000-5000 years into the future.

References

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