EXPECTED USE OF LUNAR RANGE DATA TO DETERMINE MODIFIED NUTATION TERMS

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The lunar laser range data from the McDonald Observatory in Texas have been used so far to determine major improvements in the lunar ephemeris and librations, to provide a new test of gravitational theory, and to determine single-day UT0 values on about 200 days during the period 1970-1974. The mean uncertainty in the UT0 values is 0.5 msec, and the smallest uncertainty is 0.2 msec (Stolz et al. 1976). The changes in the angular position of the moon with time are believed to be well enough known so that their uncertainty does not substantially degrade the accuracy of the UT0 values.

Unlike the situation for determining UT0, the accuracy of the results for polar motion and nutations using data from a single ground station will be quite sensitive to errors in the range ephemerides for the lunar retroreflections. This is because the spread in hour angle H of the measurements rarely is sufficient to determine the distance from the rotation axis accurately from the cos H part of the diurnal time signature. Thus, information on polar motion and nutations in effect has to be obtained mainly from the variation in the meridian passage residuals with time. Since the BIH smoothed Circular D values of polar motion and Molodensky's values for the nutations have been used in fitting the lunar ephemeris to the data, there is a real possibility that the ephemeris may have absorbed errors in the polar motion or nutations at some frequencies.

Fortunately, there are no parameters in the lunar theory which can be altered in fitting the data in order to produce the expected time signature for the 460 day free nutation. Thus, it should be possible to set reliable limits on the amplitude of this nutation from the lunar

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ranging results from even a single station. In addition, it appears that the signature for the semi-annual forced nutations is considerably less likely to be present erroneously in the lunar range ephemeris than are the signatures for the fortnightly and annual nutations. Thus, there is a good chance of obtaining a useful determination of the semi-annual nutations also.

The main limitation on the accuracy of the nutation results is expected to come from errors in the polar motion data which are not absorbed in the lunar ephemeris but have the same time signature as the nutations of interest. Since such polar motion errors probably are substantially correlated over periods of a month or longer, their effects will not be reduced anywhere near as fast as the square root of the number of days of useful lunar range observations. To overcome this limitation partially, Doppler polar motion data can be used in the analysis, as well as conventional astronomical results. However, full advantage cannot be taken of single-station lunar range data for determining nutations until more accurate polar motion measurements are available.

References

Stolz, A. et al.: 1976, Earth rotation measured by lunar laser ranging, Science 193, 997-999.

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