Improvement of Non-rigid Earth Nutation Theory by Adding a Free Core Nutaion Term

Toshimichi Shirai[1], Toshio Fukushima[2]

[1] Astronomy, Tokyo Univ., [2] Nat'l Astr. Obs. Japan, PR Center

We improved nutation theory by adding a Free Core Nutation(FCN) term. We adopted RDAN98 (Roosbeek 1998) as the rigid Earth nutation theory. We adopted FCN as a single damping oscillation. The form of the transfer function was the same as that of Herring(1995), however,its free parameters such as the complex amplitude and frequency of FCN were adjusted by fitting to the above VLBI data. The RMS of the residuals for the new nutaion theory is 8 percent smaller than that of the IERS96 nutation theory. As for the FCN term, we estimated its oscillatory period as -431+/-4 days,its half-life period as 9+/-7 years,its amplitude as 0.60+/-0.15 mas in longitude. Also we estimated the correction of the precession constants as -2.99+/-0.03 mas/jy in longitude and -0.246+/-0.0015 mas/jy in obliquity.

From the analysis of VLBI observation of the Earth orientation for 1984-1999 (IERS Bulletin A), we showed that a strong peak around 400 days in the spectrum of its differences from the IERS96 nutation theory (McCarthy 1996) could be explained by adding a model Free Core Nutation (FCN) term. We considered three models on the treatment of the FCN;

(1) no FCN contribution,

(2) the FCN with no excitation during the observation, and

(3) the FCN excited frequently during the observation.

The functional form of the FCN is a single damping oscillation in the second case and a simple harmonic oscillation in the last case.

From the root mean square (RMS) and spectra of the residuals obtainedfor these models, we adopted the second as the best model.

Then we developed a new analytical theory of the non-rigid Earth nutation including thus adopted FCN model. We adopted RDAN98 (Roosbeek and Dehant 1998) as the rigid Earth nutation theory.Then it was convoluted with a transfer function by the numerical covolution in time domain (Shirai and Fukushima 2000).The form of the transfer function was the same as that of Herring (1995),however, its free parameters such as the complex amplitude and frequency of FCN were adjusted by fitting to the above VLBI data.

The RMS of the residuals forthe new nutaion theory is about 8(null)maller than that of the IERS96 nutation theory. As for the FCN term, we estimated its oscillatory period as -431+/-4 sidereal days, its half-life period as 9+/-7 years, its amplitudes as 0.60+/-0.15 mas in longitude and 0.24+/-0.06 mas in obliquity atJ1984.0,respectively. Also we estimated the correction of the precession constants as -2.99+/-0.03 mas/jy in longitude and -0.246+/-0.0015 mas/jy in obliquity, respectively.