# ANALYSIS OF DISCREPANCIES OF THE NUTATION THEORIES MHB2000 AND ZP2003 FROM VLBI OBSERVATIONS

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ABSTRACT. Spectral and structural analysis of discrepancies of the nutation theories for the nonrigid Earth ZP2003 and IAU2000 from VLBI observations was performed.

As a result of structural analysis it was shown that the linear parts of the equations of momentum in these theories are modeled well enough and the improvement in the future is possible only by the perfection of the models of the nonlinear parts.

As a result of spectral analysis it was derived that the main differences between ZP2003 and IAU2000 are at semiannual and main nutation 18.6-year periods. The causes of these discrepancies are under discussion. The major part of deviations of the theories from observations is determined by the free core nutation (FCN). Spectral investigation proved the existence of an unknown process, which compensates the influence of atmosphere at the semiannual frequency.

With use of SVD least squares method the empirical corrections to the main harmonic oscillations for ZP2003 were estimated.

## 1. INTRODUCTION, INITIAL DATA

The theory MHB2000 [Mathews et al., 2002] was adopted at the XXIV assembly of the International Astronomical Union (IAU) as the new nutation theory IAU2000. The theory ZP2003 [Pasynok, 2003] developed in Russia differs from IAU2000 by the method of calculation of the atmosphere and liquid core effects. In ZP2003 the laws of conservation of energy and momentum are taken into account during the determination of the parameters of the Earth internal structure, which are not known precisely from observations.

The series of discrepancies between the theories and observations were derived by processing of VLBI observations since 1984 till 2003 year with use of OCCAM 5.0 package. The series of discrepancies of $d\varepsilon$ and $d\psi$ in more then 2000 points were used in analysis. Weighted mean squares deviations made up 235 ($d\varepsilon$) and 829 ($d\psi$) $\mu$as for ZP2003, 199 and 480 $\mu$as for IAU2000 accordingly.

## 2. STRUCTURAL AND SPECTRAL INVESTIGATIONS, DISCUSSION

At the first stage the corrections to the amplitudes of the main 300 nutation harmonic oscillations were estimated by the least squares method (LSM) with use of algorithm SVD [Forsite et al., 1980].

At the second stage the corrections to the transfer function's parameters were estimated with use of SVD LSM. Attempts to approximate the amplitudes corrections by varying of the transfer function parameters do not lead to a success. This testifies that the linear parts of the equations of momentum in both theories are modeled well enough and the improvement in the future is possible only by the perfection of the models of the nonlinear effects.

Than the periodograms of the smoothed and equal-spaced series of discrepancies were calculated, wavelet-analysis was performed. Scalograms illustrate the temporal evolution of the periodical components of d$\varepsilon$ at Fig. 1. The major part of the discrepancies is determined by the

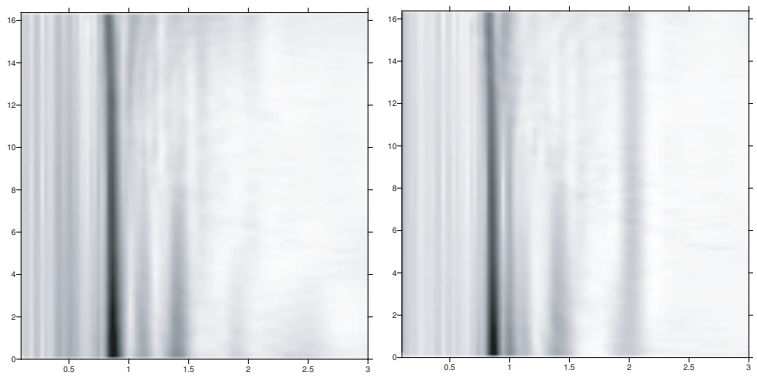

Figure 1: Scalograms of discrepancies of d$\varepsilon$ for IAU2000 (left) and ZP2003 (right) theories. The frequency in years$^{-1}$ across, years since 1984 in vertical direction.

free core nutation FCN. The discrepancies of the theory ZP2003 from VLBI observations contain more energy at 18.6-year period, then the discrepancies of IAU2000. It can be connected with the problem of separation of harmonic oscillations with close frequencies.

The components at semiannual frequencies are present in the discrepancies of ZP2003, but are absent in those ones of IAU2000. The IAU2000 theory doesn't include the atmosphere correction at this frequency. It was suggested, that an unknown process compensates the influence of atmosphere [Mathews et al., 2002]. In ZP2003 the atmosphere was taken in account in the equations of momentum, but no other unknown processes was. So the spectral investigation proves the existence of an unknown process, which compensates the atmosphere influence at the semiannual frequency in IAU2000.

Corrections at the semiannual and 18.6-year periods for ZP2003 were estimated with use of SVD LSM. The agreement of ZP2003 became better and weighted mean squares deviations of discrepancies reached the level of 207 (d$\varepsilon$) and 808 (d$\psi$) $\mu$as. After estimation of corrections to 300 first harmonics weighted mean square deviations became 146 (d$\varepsilon$) and 345 (d$\psi$) $\mu$as.

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