ZERO DRIFT IN MEAN ANOMALY OF THE SATELLITE OF 1996 FG3 AND ITS IMPLICATION FOR THE BYORP THEORY.

Introduction: We present an analysis of photometric observations of binary Near-Earth asteroid (175706) 1996 FG₃₃, taken from 1996 to 2012. The analysis gave a single solution for a quadratic drift of the mean anomaly of the satellite, \((0.00_{-0.01}^{+0.18})\) deg/yr².

A quadratic drift of mean anomaly of satellites of binary asteroids was predicted by [1],[2] as a result of the binary YORP (BYORP) effect of asymmetric emission of thermal radiation. The mean anomaly of changing orbit expanded to the 2nd degree in time is expressed as

\[ M = n(t-tₜ₀) + ΔM_d(t-tₜ₀)^2, \]

\[ ΔM_d = \frac{1}{2} \hat{n}, \]

where \( n \) is the mean motion, \( tₜ₀ \) is the time when \( M₀ = 0 \) and \( t \) is the current time. Pravec and Scheirich [3] adapted results of [1] and predicted the quadratic drift \( ΔM_d \) for several binary Near-Earth asteroids with values ranging from \(-0.24\) to \(-3.27\) deg/yr². A value predicted for 1996 FG₃₃ was \(-0.89\) deg/yr².

Recently, Jacobson and Scheeres in [4] presented a theory of BYORP where mutual tides between the two components are included for the first time. A counterbalance of the two effects results in a long-term stable solution for synchronous binary asteroids with zero drift in mean anomaly.

Observed Data: The data used in our analysis were obtained during five apparitions: from 1996-04-09 to 1996-04-21, from 1998-12-03 to 1999-01-09, from 2009-04-12 to 2009-04-17, from 2010-12-14 to 2011-02-09, and from 2011-11-23 to 2012-01-24.

The data were reduced using the standard technique described in [5]: a rotational lightcurve produced by the primary was removed in the reduction.

Numerical Model: A numerical model for deriving basic parameters of sizes and shapes of the two components, as well as of their mutual orbit, was described in [6]. The shapes of the components are represented as ellipsoids, orbiting each other on a Keplerian orbit, except for that we included a quadratic drift in mean anomaly \( ΔM_d \), which is fitted as an independent parameter. The key to the \( ΔM_d \) determination are times of mutual events (i.e., occultations and eclipses) in the lightcurve.

Results: We found a unique solution with the quadratic drift in mean anomaly \( ΔM_d \) of \((0.00_{-0.10}^{+0.18})\) deg/yr² (3-σ error bar). A solution for the pole of the mutual orbit in ecliptic coordinates is shown in Fig. 1.

![Fig. 1: Admissible (3-σ) area of pole of the mutual orbit of 1996 FG₁ in ecliptic coordinates.](6123.pdf)