**ZERO DRIFT IN MEAN ANOMALY OF THE SATELLITE OF 1996 FG3 AND ITS IMPLICATION FOR THE BYORP THEORY.** P. Scheirich[1], P. Pravec[1], S. Mottola[2], M. Mommert[2], K. Hornoch[1], P. Kušnirák[1], J. Pittichová[3], S.A. Jacobson[4], D. Pray[5], D. Polishook[6], Yu.N. Krugly[7], I. Slyusarev[7], J. Pollock[8], E. Jehin[9], J. Manfroid[9], M. Gillon[9], A. Galád[1,10], J. Licandro[11], V. Alí-Lagoa[11], J. Brinsfield[12], R.Ya. Inasaridze[13], I.E. Molotov[14], [1]Astronomical Institute AS CR, Ondřejov, Czech Republic, petr.scheirich@centrum.cz, [2]DLR Institute of Planetary Research, Berlin, Germany, [3]Institute for Astronomy, University of Hawaii, Honolulu, USA, [4]Department of Astrophysical and Planetary Sciences, University of Colorado, Boulder, USA, [5]Sugarloaf Mountain Observatory, Massachusetts, USA, [6]Wise Observatory, Israel and Massachusetts Institute of Technology, Cambridge USA, [7]Institute of Astronomy of Kharkiv National University, Sumska Str. 35, Kharkiv 61022, Ukraine, [8]Physics and Astronomy Department, Appalachian State University, Boone, NC 28608, U.S.A., [9]Institut d'Astrophysique et de Géophysique, Sart-Tilman, B-4000 Liège, Belgium, [10]Modra Observatory, Department of Astronomy, Physics of the Earth, and Meteorology, FMFI UK, Bratislava SK-84248, Slovakia, [11]Instituto de Astrofísica de Canarias, c/vía Láctea s/n, 38200 La Laguna, Tenerife, Spain, [12]Via Capote Observatory, Thousand Oaks, CA, U.S.A., [13]Kharadze Abastumani Astrophysical Observatory, Ilia State University, K.Cholokoshvili Av. 3/5, Tbilisi 0162, Georgia, [14]Keldysh Institute of Applied Mathematics, RAS, Miusskaya sq. 4, Moscow 125047, Russia.

**Introduction:** We present an analysis of photometric observations of binary Near-Earth asteroid (175706) 1996 $FG_3$, taken from 1996 to 2012. The analysis gave a single solution for a quadratic drift of the mean anomaly of the satellite, ( $0.00^{+0.18}_{-0.10}$ ) deg/yr$^2$.

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

$$M = n(t - t_0) + \Delta M_d (t - t_0)^2,$$

$$\Delta M_d = \frac{1}{2}\dot{n},$$

where $n$ is the mean motion, $t_0$ is the time when $M_0 = 0$ and $t$ is the current time. Pravec and Scheirich [3] adapted results of [1] and predicted the quadratic drift $\Delta M_d$ for several binary Near-Earth asteroids with values ranging from –0.24 to –3.27 deg/yr$^2$. A value predicted for 1996 $FG_3$ was –0.89 deg/yr$^2$.

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 used 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 $\Delta M_d$, which is fitted as independent parameter. The key to the $\Delta M_d$ 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 $\Delta M_d$ of ( $0.00^{+0.18}_{-0.10}$) deg/yr$^2$ (3-σ error bar). A solution for the pole of the mutual orbit in ecliptic coordinates is shown in Fig. 1.

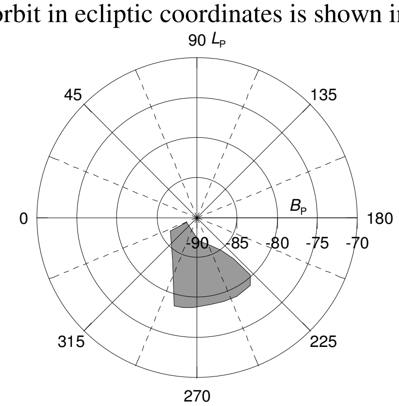


Fig. 1: Admissible (3-σ) area of pole of the mutual orbit of 1996 $FG_3$ in ecliptic coordinates.

**References:** [1] McMahon J. and Scheeres D. (2010) *Celestial Mechanics and Dynamical Astronomy, 106,* 261–300. [2] McMahon J. and Scheeres D. (2010) *Icarus, 209,* 494–509. [3] Pravec P. and Scheirich P. (2010) 42nd DPS, Oct. 2010, Pasadena, CA. [4] Jacobson S.A. and Scheeres D. (2011) *ApJ Letters, 736*, L19. [5] Pravec P. et al (2006) *Icarus, 181*, 63–93. [6] Scheirich P. and Pravec P. (2009) *Icarus, 200*, 531–547.