

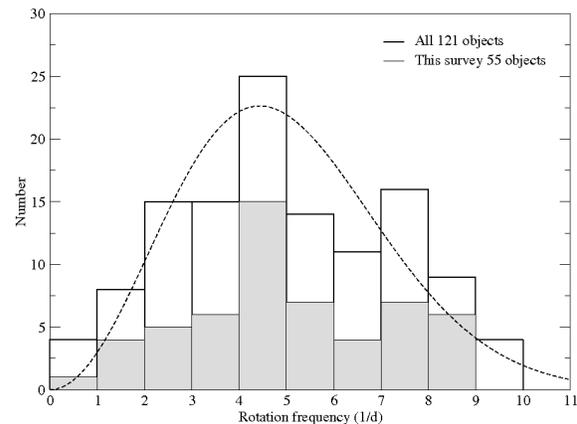
FINGERPRINTS OF THE YARKOVSKY AND YORP EFFECTS IN THE FLORA FAMILY. A. Kryszczyńska¹, F. Colas², M. Polinska¹, R. Hirsh¹, V. Ivanova³, G. Apostolovska⁴, F.P. Velichko⁵, B. Bilkina,³ T. Kwiatkowski¹, P. Kankiewicz⁴, F. Vachier², V. Umlenski³, T. Michałowski¹, A. Marciniak¹, A. Maury⁷, K. Kaminski¹, M. Fagas¹, W. Dimitrov¹, W. Borczyk¹, K. Sobkowiak¹, J. Lecacheux⁸, R. Behrend⁹, A. Klotz^{10,11}, L. Bernasconi¹², R. Crippa¹³, F. Manzini¹³, R. Poncy¹⁴, P. Antonini¹⁵, D. Oszkiewicz^{16,17}, T. Santana¹, ¹Astronomical Observatory, A. Mickiewicz University, Poland, agn@amu.edu.pl, ²IMCCE, Paris, France, ³Inst. of Astronomy, Bulgarian Academy of Sciences, Sofia, Bulgaria, ⁴Faculty of Natural Sciences, Cyril and Methodius University, Skopje, Macedonia, ⁵Inst. of Astronomy, Karazin National University, Kharkov, Ukraine, ⁶Institute of Physics, J. Kochanowski University, Kielce, Poland, ⁷San Pedro de Atacama Observatory, Chile, ⁸Observatoire de Paris, Meudon, France, ⁹Geneva Observatory, Switzerland, ¹⁰Centre d'Etude Spatial des Rayonnements, Toulouse, France, ¹¹Observatoire de Haute-Provence, France, ¹²Observatoire des Engarouines, France, ¹³Stazione Astronomica di Sossano, Italy, ¹⁴Le Cres Observatory, France, ¹⁵Bedoin Observatory, Avignon, France, ¹⁶Department of Physics, University of Helsinki, Finland, ¹⁷Nordic Optical Telescope, Santa Cruz de Tenerife, Spain.

Introduction: Recent studies have shown evidence that statistical properties of asteroids' physical parameters are the fundamental source of information on the physics of their collisions and evolution. The analysis of the spin vector distribution helps to understand the role of various known and new effects. Studies of NEA spin vectors of $D < 10$ km showed strong and statistically significant excess of retrograde rotators [1]. This result is consistent with theoretical expectations of the Yarkovsky effect as responsible for injecting MBAs into resonant regions. The alignments of asteroid spin vectors and correlations of spin rates were observed in the Koronis family [2] and explained with a play of the YORP effect and spin-orbit resonances [3]. Vokrouhlicky et al. [3] investigated whether small asteroids in other MB regions may also be trapped in Slivan states. They concluded that such states may be found for low inclination asteroids in the outer MB. More complex spin vector evolutionary path was obtained for inner MBAs. They also suggested making careful comparison between numerical results and observations.

Observations: Observing campaign of small bodies in the outer MB would require continuous access to the 1-m class or larger telescopes. Because of lack of such dedicated instruments we decided to concentrate our observing campaign on small bodies in the inner MB, namely the Flora region. Thus we were able to reach small objects of diameters less than 30 km which are sensitive to the influence of Yarkovsky and YORP effects. The Flora dynamical family is one of the the biggest and presents several denser groupings [4,5] which is consistent with commonly suggested multi-collisional event origin of this family.

Results: During almost 10 years long observing campaign we obtained 540 individual lightcurves for 55 objects using telescopes located in 15 observatories. To improve statistics we add to our dataset all objects up to number 4150 having published secure nonambiguous solution for period. This process yield a total sample of 124 Flora asteroids with known synodic rotation periods. The observed rotation rate distribution for 121 asteroids smaller than 30 km is

presented in figure below. The dashed curve shows the Maxwellian distribution. The presented distribution of spin rates in the Flora family is significantly different than the distribution reported for the Koronis [6] and Hungaria [7] families.



Dynamical simulations showed that the age of the Flora family is significantly less than 1 Gy [8]. Cratering on 951 Gaspra suggests even younger age of 200 My of this family. These values are significantly smaller in comparison with the age of the Koronis $\sim 2-3$ Gy or Hungaria ~ 4 Gy families. If we assume that the spin rates are modified by nongravitational effects like YORP in the case of Flora clan it had much less time to leave its fingerprint. Spin rates distribution confirms that Flora is much younger than Koronis and Hungaria families. We will also present the possible influence of YORP on the spin axes of Flora family asteroids and Yarkovsky effect on their current orbital location.

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