Rotational properties of the Maria asteroid family

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Introduction: The Maria family is regarded as an old-type ($\sim$3 $\pm$ 1 Gyr) [1] asteroid family which has experienced substantial collisional and dynamical evolution in the main belt. It is located near the 3:1 Jupiter mean-motion resonance area that supplies near-Earth asteroids (NEAs) to the inner Solar System.

Observations: We carried out observations of Maria family asteroids in 134 nights from July 2008 to May 2013 using 0.5-m to 2-m class telescopes at seven observatories in the northern hemisphere, and derived synodic rotational periods for 51 objects, including new periods for 34 asteroids [2].

Results: We found that there is a significant excess of fast and slow rotators in the observed rotation-rate distribution. From the correlations among rotational periods, the amplitudes of lightcurves, and the sizes, we conclude that the rotational properties of the Maria family asteroids have been changed considerably by non-gravitational forces such as the YORP effect. Using the lightcurve inversion method [3,4], we successfully determined pole orientations for 13 Maria members, and found an excess of prograde spins over retrograde spins with a ratio (N_p/N_r) of 3. This implies that the retrograde rotators could have been ejected by the 3:1 resonance into the inner Solar System since the formation of the Maria family. We estimate that approximately 37 to 75 Maria family asteroids larger than 1 km have entered the near-Earth space as per 100 Myr [2].

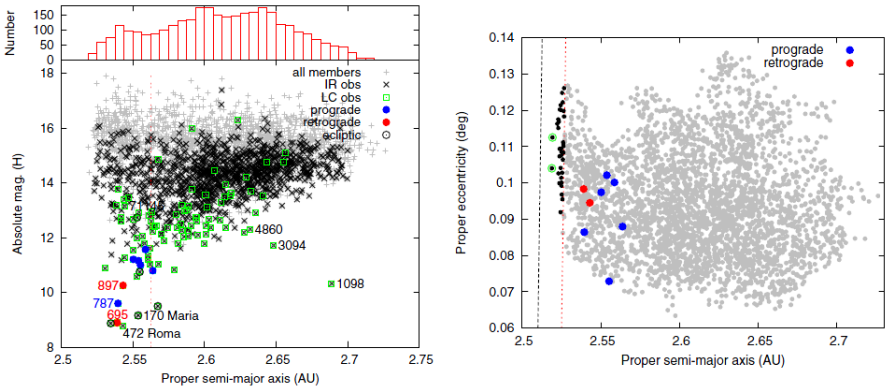

Figure: (Left) A total of 3,230 known members of the Maria asteroid family (grey crosses) projected onto the proper semimajor axis (au) versus absolute magnitude (H) plane. 1,152 members matched with the WISE IR observation are marked with the black '$\times$ symbols and the empty green square represents all 92 objects we used in this study from the lightcurve observations. The filled blue and red circles stand for prograde and retrograde rotators, respectively, while the five rotators with the pole along the ecliptic are marked with open circles. The upper part of this figure is the density histogram with respect to the semimajor axis. (Right) The Maria asteroid family (grey) projected onto the proper semimajor axis versus proper eccentricity plane. The dashed black and red lines denote the 3:1 resonance boundary and chaotic diffusion region, respectively. The 37 asteroids placed within 0.015 au from the resonance border are marked with the filled black circles. Two objects marked with green open circles, (114123) 2002 VX_{49} (lower one) and (137063) 1998 WK_1 (upper one), are the most promising candidates for becoming new NEAs.

References: [1] Nesvorny D., et al. (2005), Icarus, 173, 132. [2] Kim, M.-J., et al. (2014), AJ, 147, 56. [3] Kaasalainen, M. & Torppa, J. (2001), Icarus, 153, 24. [4] Kaasalainen, M., et al. (2001), Icarus, 153, 37.