Subaru Lightcurve Observations of Sub-km-sized Main-belt Asteroids

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Investigations of the spin period and shape distributions for a certain asteroid group using their lightcurve observations are essential to understand collisional evolution of that group. We therefore conducted lightcurve observations of such asteroids with the Subaru telescope + Suprime-Cam, which can detect many asteroids in a single field of view at the same time. And from them we selected main belt asteroid (MBAs) and determined their spin periods and shapes. Although about 4000 asteroids are currently listed in the spin period catalogue, it includes a very small number of sub-km-sized MBAs which are considered to be outcomes from the collisional evolution in the main asteroid belt. Meanwhile, most asteroids detected by our Subaru observation are in the size range between 0.1–1 km in diameter. Hence we would say that our observation is the first dedicated lightcurve observation of sub-km-sized asteroids.

The observation was done in October 2001. We surveyed a sky field of 34′ × 27′ near opposition and the ecliptic, covering a time-span of 8.3 hours for a single night. As a result we detected 127 asteroids down to a limiting magnitude of $R \approx 24.6$ mag. Among them, we picked up 68 asteroids showing reliable spin periods. Out of 68 asteroids, it turned out that the spin periods of 33 asteroids are faster than 2.2 h, which are often called fast-rotator MBAs (FRAs). The fraction of fast-rotating asteroids is found to be about 48%. This is the first observational confirmation on the existence of FRAs among sub-km MBAs; those detected small MBAs fill up the region that used to be almost void of asteroids in the spin period vs size distribution (see Fig. 1)[1].

We calculated the shapes of 68 asteroids based on their lightcurve amplitudes and then found a tendency that FRAs are more spherical than non FRAs. This tendency was confirmed by rigorous statistical tests[2]. Our conclusion is that most of the fast-rotators show a strong trend that they are more spherical in shape than any other groups. Considering several timescales of the orbital and rotational evolution for small asteroids in the main asteroid belt, we showed that the above mentioned trend is not due to coincidence but primordial. Therefore, referring to shape distributions of impact fragments produced in laboratory experiments, our discovered sphericity preference of small fast-rotating asteroids probably requires some spin deceleration mechanisms, which selectively worked on all elongated objects during their impact formation and/or subsequent evolution.

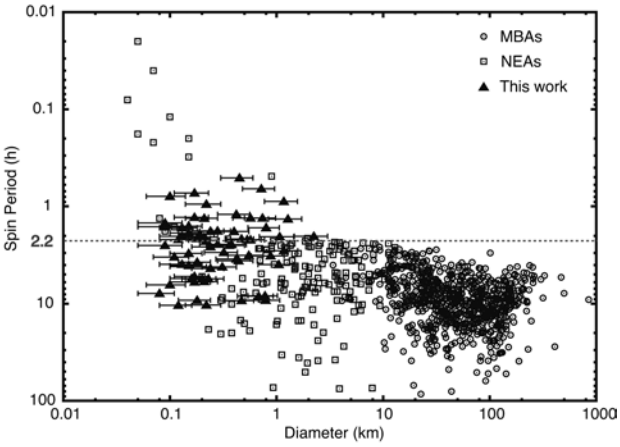

Figure 1: Distribution of size vs. spin period for know asteroids (open circles and open squares) and very small asteroids discovered (filled triangles) in this survey observation. Asteroids being above the horizontal line of 2.2 h are FRAs.

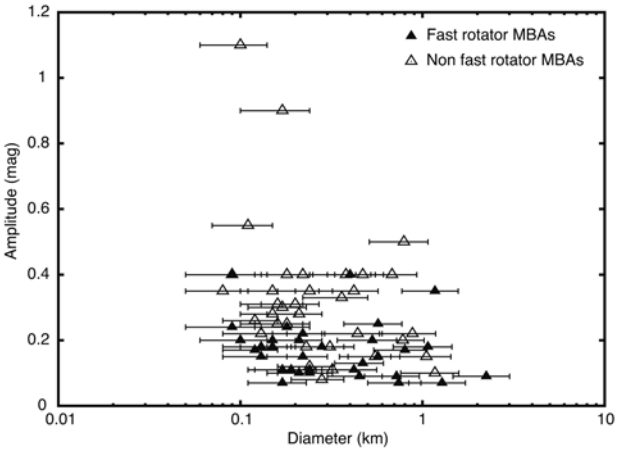

Figure 2: Diameter vs. lightcurve amplitude for 68 sub-kmsized MBAs.

References

[1] Dermawan, B., Nakamura, T., Yoshida, F.: 2011, *PASJ*, **63**, S555.
[2] Nakamura, T., Dermawan, B., Yoshida, F.: 2011, *PASJ*, **63**, S577.