Size Distribution of Main-Belt Asteroids with High Inclination

TERAI, Tsuyoshi (NAOJ)
ITOH, Yoichi (University of Hyogo)

Asteroids in the main-belt region between the Mars and Jupiter orbits have been fractions of the remnant planetesimals. Main-belt asteroids (MBAs) undergo collisions and disruption with each other. Their size distribution is primary determined by the impact strength (critical specic energy per unit mass required to catastrophically disrupt the target) [1]. The impact strength increases with size, and the degree of the increase affects a slope of the size distribution in the size of observable asteroids (larger than sub km).

In the early Solar system, MBAs' orbital eccentricities and inclinations are pumped up via dynamical excitation due to the planetary perturbation [2]. They cause higher relative velocities than the present. It has been indicated that the size-impact strength relation depends on impact velocity [3]. MBAs possibly have a different collisional evolution under collisions with impact velocities much higher than the present mean value (~4 km sec^{-1}).

We investigate the size distribution of high-inclination MBAs which collide with an asteroid at high velocity (~10 km sec^{-1}). The size distribution of small MBAs around 1 km in diameter with high inclination remains unknown. We performed a wide-field observation for them using Subaru telescope with Suprime-Cam on high ecliptic latitude region of $\beta \sim +25°$. The archival data of Suprime-Cam was also used. We obtained the dataset of 9.0 square-degree in total.

As the result of data reduction for moving objects, more than 600 candidates of MBAs were detected. Using the sample of uniform detection probability, the cumulative size distributions (CSDs) are measured from the two groups: one includes asteroids with inclination lower than 15° and the other includes asteroids higher than 15°. We found that the latter has a shallower CSD. Furthermore, we provided continuous CSD from 0.7 km to 50 km in diameter using the Asteroid Orbital Elements Database (ASTORB) and Sloan Digital Sky Survey Moving Object Catalog (SDSS MOC). CSD is generally written as a power-law of $N(>D) \propto D^{-b}$, where D is diameter. The obtained CSDs show b = 1.79 ± 0.05 for the low-inclination sample and b = 1.62 ± 0.07 for the high-inclination sample. We conrmed that CSD of high-inclination MBAs has a shallower slope than that of low-inclination MBAs [4].

This result indicates the fact that large asteroids is more resistant to destruction under hypervelocity collisions. Massive bodies could have been more dominant in the main belt region during the dynamical excitation phase at the early Solar system.

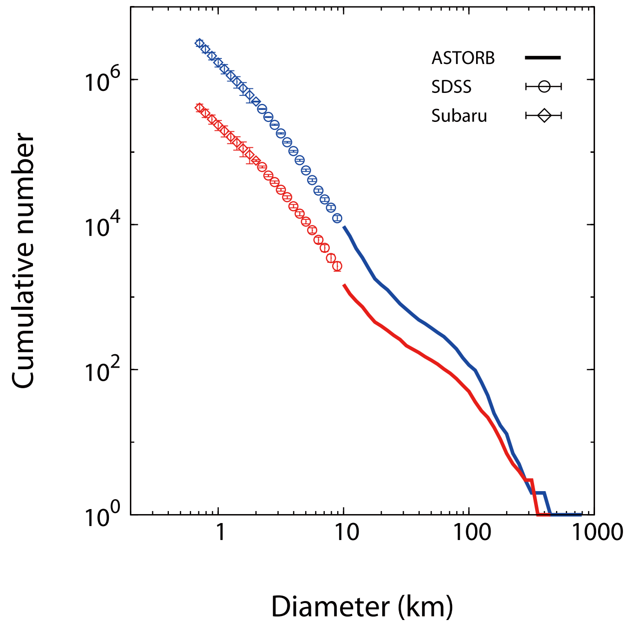

Figure 1: Cumulative size distributions of main-belt asteroid populations with inclination lower than 15° (blue) and higher than 15° (red) using the data from Asteroid Orbital Elements Database (solid lines), Sloan Digital Sky Survey Moving Object Catalog (open circles), and this study (diamonds).

References

[1] O'Brien, D. P., Greenberg, R.: 2003, *Icarus*, **164**, 334.
[2] Bottke, W. F., et al.: 2005, *Icarus*, **179**, 63.
[3] Jutzi, M., Michel, P., Benz, W., Richardson, D. C.: 2010, *Icarus*, **207**, 54.
[4] Terai, T., Itoh, Y.: 2011, *PASJ*, **63**, 335.