Size distributions of faint asteroids: Main-belt asteroids and Trojans

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We report here the results of the first systematic investigation of sub-km MBAs using the 8.2m Subaru telescope; we call this survey SMBAS (Sub-km Main-belt Asteroid Survey). Asteroids belonging to this size region in the main-belt has never been explored before, due to their faintness.

Recent theoretical works and laboratory experiments on collisional evolution of asteroids highlight the importance of sub-km MBAs from the two viewpoints:1) the majority (70-80%) of the near earth asteroids (NEAs) are sub-km-sized and are supposed to be originated from the main-belt, and 2) this size region lies near the border-line size separating the two catastrophic impact mechanisms, namely those in the strength regime and the gravity regime. Therefore, the research of the sub-km MBAs contributes to the estimation of the production rate of NEAs in the main-belt, and furthermore could give us clues on the mechanism of the collision evolution among the small bodies.

For the analysis of this survey, we developed a method to derive the size distribution of sub-km MBAs, based on statistical estimates of the semi-major axis (a) and inclination (I) for each detected asteroid, because the traditional determinations of orbits for sub-km MBAs by follow-up observations are practically impossible owing to strict telescope-time of the Subaru telescope or other 8-10m large telescopes. Hence, our SMBAS cannot determine other orbital elements except the a and I. In addition, we cannot avoid some errors in our a- and I-estimates, caused by the lack of information on eccentricity (e). Therefore, we evaluated those errors from Monte Carlo simulations by adopting Bowell's equations which assume e=0. We confirmed that these errors could vary the slope of Cumulative Size Distributions (hereafter CSD) for the main-belt asteroids (MBAs) detected from the SMBAS within the range of only +/- 0.1. It is found that the slope of the CSD from our statistical method has a precision comparable to that from the past MBAs survey observation. Then we applied the above estimation of errors to analyze our SMBAS data, which were taken in February 2001.

The main results of the survey observations are summarized as follows:

(1) The sky number density of MBAs is found to be ~290 per deg2 down to R ~24.4 mag near opposition and the ecliptic.

(2) The slope of the CSD for small MBAs ranging from a few km to sub-km seems to be fairly shallower (1.2) than that for large MBAs obtained from the past asteroid surveys (1.8). This means that the number of sub-km MBAs is much more depleted than a result extrapolated from the size distribution for large asteroids.

(3) The CSD in the inner-belt is steep (1.4) and one in the outer-belt is shallow (1.0).

Finally, the implication for depletion of sub-km MBAs is discussed in relation to collisional mechanisms such as the formation of rubble pile asteroids. The difference of the CSDs between inner- and outer-belt may reflect the distribution of S- and C-type asteroids in the main-belt. So, we carried out the color observation to distinguish S- and C-type asteroids, which we are now analyzing.

And we also found 51 Trojan asteroids in the data above-mentioned, and obtained their CSD. In our talk, we argue the similarity in the CSDs between MBAs and Trojans.