Color and size distributions of main belt asteroids obtained by the Subaru/Hyper Suprime-Cam

*Natsuho Maeda[1], Tsuyoshi Terai[2], Keiji Ohtsuki[1], Fumi Yoshida[3,4], Kosuke Ishihara[1,2,5], Takuto Deyama[1,6]

1. Graduate school of science, Kobe University , 2. National Astronomical Observatory of Japan, 3. Chiba Institute of Technology, 4. University of Occupational and Environmental Health, 5. The Graduate University for Advanced Studies, 6. NTT Data MSE Corporation

S-type and C-type asteroids are two of the most major types in the main asteroid belt (e.g., DeMeo & Carry 2014). S-type asteroids are thought to have a stony composition, while C-type asteroids are characterized by carbonaceous composition and hydrous minerals (e.g, DeMeo et al. 2015; Usui et al. 2019). Although S-type asteroids and C-type asteroids are thought to have different compositions and origins in this way, their evolution paths are still not well understood.

The size distribution of a population of asteroids strongly reflects the process of their collisional evolution (e.g., Bottke et al. 2015). In the collision equilibrium, the size distribution is primarily determined by the size dependence of impact strength (O’ Brien & Greenberg 2003). Therefore, by comparing size distributions of asteroids with different spectral types, we can obtain information about the relation between their type and their impact strength. This is essential information to reveal their collisional evolution. Although some previous observational works studied size distributions of asteroids with different spectral types (Ivezić et al. 2001; Yoshida & Nakamura 2007), the understanding is still far from complete.

In this work, we performed a survey observation of small main-belt asteroids with the wide-field camera, Hyper Suprime-Cam installed on the 8.2 m Subaru Telescope. Using data acquired with two types of filters, *g*-band (0.40-0.55 μm wavelength) and *r*-band (0.55-0.70 μm wavelength), we measured *g-r* color for 3459 main-belt asteroids detected in 14 deg^2 of the sky. From the asteroids we obtained above, we selected a statistical sample consisting of 1814 asteroids with absolute magnitude brighter than 20.3 mag to remove a detection bias. We classified them into two groups, i.e., reddish “S-like” asteroids and bluish “C-like” asteroids based on the boundary color derived from the previous survey data (The fourth release of Sloan Digital Sky Survey Moving Object Catalog, Ivezić et al. 2010). We converted the absolute magnitude of each sample into a diameter assuming an albedo of 0.21 for S-like and 0.07 for C-like asteroids, respectively, which are the mean values of the S- and C-type main-belt asteroids measured by the infrared astronomical satellite AKARI (Usui et al. 2013). We found that the shapes of the size distributions of the S-like and C-like samples agree well with each other within statistical errors for the diameter range from 0.4 km to 1.5 km. The similarity between the size distributions of the S-like and C-like asteroids indicates that their size dependences of impact strength are also similar at least in the size range from several hundred meters to several kilometers. Namely, the impact strength of asteroids in this size range is likely to be dominated by any other factors rather than their compositions. On the other hand, spin periods of most asteroids in this size range have an upper limit of 2.2 hours, the so-called “spin-barrier” (e.g., Chang et al. 2015). This is interpreted as showing that the asteroids in this size range are rubble-piles, i.e., they consist of numerous pieces of components held together by their self-gravity. The similarity of the size distributions between the S-like and C-like asteroids seems to support the view that most of them have a rubble-pile structure. Also, Itokawa and Ryugu, which were explored by Hayabusa/Hayabusa2, are both several hundred meters in diameter and are considered to

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have a rubble-pile structure (Fujiwara et al. 2006; Watanabe et al. 2019). Our result is also consistent with this view.

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