Small Jupiter Trojans Survey with the Subaru/Hyper Suprime-Cam

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Jupiter Trojans (JTs) are asteroids that share the orbits with Jupiter and make swarms near the Lagrangian points L4 (leading) or L5 (trailing) of Jupiter. They are a major small-body population located in the middle region between the main belt asteroids (MBAs) and trans-Neptunian objects (TNOs). Recent dynamical models suggest that JTs have formed between/beyond the outer planet regions and were captured into Jupiter's co-orbital region during the dynamical instability phase induced by planetary migration. Investigation of the origin and evolution of JTs is useful for understanding the radial mixing processes of small bodies in that phase.

Here, we focus on the size frequency distribution (SFD) of JTs as a tracer of their origin, but it remains uncertain in the small size range. The SFD includes two kinds of information regarding the accumulation process and collisional evolution process in the large and small size ranges, respectively. These are important clues for the formation region of JTs. Owing to the large aperture of the Subaru Telescope, we detected the smallest sized JTs obtained by the present ground-based telescopes, and investigated the detail SFD of small JTs, which is characterized by the impact strength properties.

We performed an asteroid survey covering ~26 deg^2 of sky area near the Jupiter L4 point using the Hyper Suprime-Cam attached to the Subaru Telescope and detected 631 JTs [1]. The detection limit is 24.4 mag in r band, which is corresponding to ~2 km in diameter assuming a geometric albedo of 0.07 [2]. Considering the detection limit and heliocentric distance of each object, we selected 481 objects as the unbiased sample. The number of sample is more than three times larger than that of the previous surveys [3,4]. We found that the SFD exhibits a single-slope power law over the diameter range of ~2 km to ~10 km and has no feature such as a break and roll-over, though the previous surveys reported a broken power-law or double power-law slopes in the similar size range. The best-fit power-law index of the absolute magnitude distribution $N(H) \propto 10^{\alpha H}$, where H is absolute magnitude, is estimated to be $\alpha = 0.37 \pm 0.01$. This value is consistent with that of the faint end slope presented by Wong & Brown (2015) [4].

Combining the cataloged L4 JTs and our survey, we finally show the entire SFD of L4 JTs down to 2 km in diameter (see Figure 1). We confirmed that JTs' SFD has a power-law transition at diameter of ~10 km but does not show a "wavy" structure which is significantly seen in that of MBAs. This indicates a discrepancy in the impact strength properties between JTs and MBAs, suggesting that these two populations have different composition/collisional evolution. Therefore, it is likely that they originated from different formation regions.

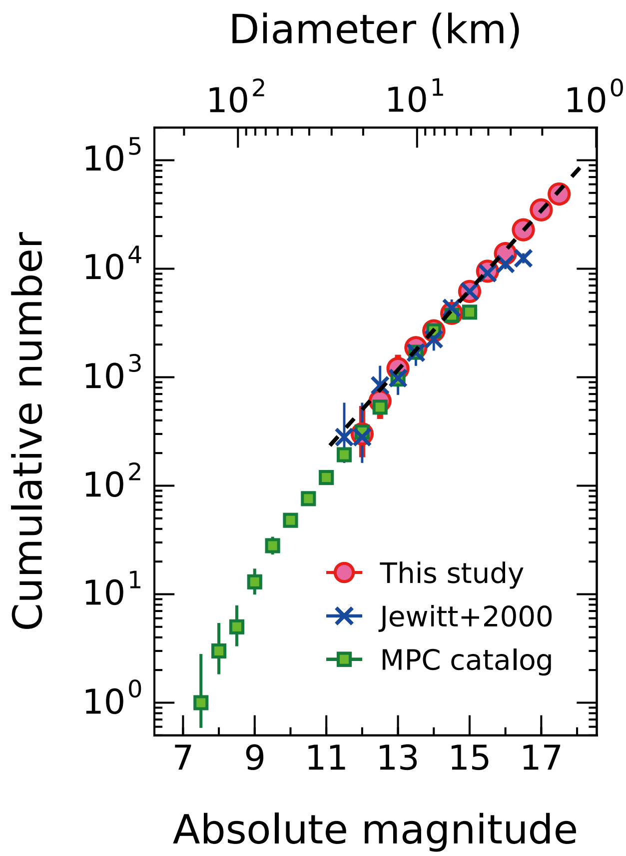

Figure 1: Cumulative SFDs of L4 JTs combined with the data from the Minor Planet Center catalog (squares), Jewitt et al. (2000) [5] (crosses), and this work (circles). The dashed line shows the best-fit power law of our data.

References

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