Multi-band Photometry of Trans-Neptunian Objects in the Subaru Hyper Suprime-Cam Survey

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Trans-Neptunian objects (TNOs), a small body population orbiting beyond the Neptune, have been known to exhibit a diversity in visible color, which is likely to reflect their formation environment. The color distribution of TNOs is helpful to study the formation and evolution of small bodies in the outer region at the early stage of our solar system.

We performed a visible multi-band photometry of TNOs [1] using the data acquired by the Subaru Telescope with Hyper Suprime-Cam (HSC) through the Subaru Strategic Program survey [2]. From the five broad-band (g, r, i, z, and Y) imaging data covering ~500 deg^2 of sky within ± 30° of ecliptic latitude, we identified 30 known TNOs. Based on the dynamical classification scheme presented by Lykawka and Mukai (2007) [3], these objects are classified into the four dynamical groups: 13 cold classical, 6 hot classical, 7 scattered, and 4 resonant populations. Our color measurements showed that the hot classical and scattered populations with orbital inclination (I) of $I > 6°$ (hereinafter, "high-I population") share similar color distributions, while the cold classical population with $I < 6°$ (hereinafter, "low-I population") contains a more amount of reddish objects in the short wavelength range compared to the high-I population. In addition, we confirmed a significant anti-correlation between g-r/r-i colors and inclination in the high-I population as previous studies pointed out.

We also found that the sample objects are separated into two swarms in the g-i vs. eccentricity (e) plot (see Figure 1), i.e., the red/low-e and neutral/high-e groups. Although most of the high-I objects are contained in the neutral/high-e group, four of them are located in the red/low-e region. This fact suggests that the high-I objects consist of two sub-populations, which could provide a useful clue for better understanding the dynamical evolution history of TNOs in the early solar system.

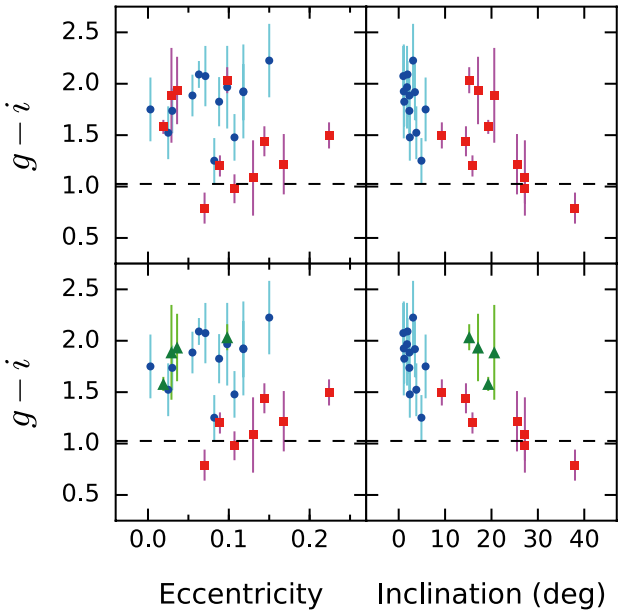

Figure 1: Top: g-i color vs. eccentricity/inclination of the low-I (circles) and high-I (squares) populations. The dashed lines show the solar color. Bottom: The same plot as the top panels, but the red high-I objects are marked with triangles.

References

[1] Terai, T., et al.: 2018, *PASJ*, **70**, S40.
[2] Aihara, H., et al.: 2018, *PASJ*, **70**, S4.
[3] Lykawka, P. S., Mukai, T.: 2007, *Icarus*, **189**, 213.