

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

*寺居 剛¹、吉田 二美^{2,3}、大槻 圭史³、ソフィアリカフィカ パトリック⁴、高遠 徳尚¹、樋口 有理可¹、伊藤 孝士¹

*Tsuyoshi Terai¹, Fumi Yoshida^{2,3}, Keiji Ohtsuki³, Patryk Sofia Lykawka⁴, Naruhisa Takato¹, Arika Higuchi¹, Takashi Ito¹

1. 国立天文台、2. 千葉工業大学、3. 神戸大学、4. 近畿大学

1. National Astronomical Observatory of Japan, 2. Chiba Institute of Technology, 3. Kobe University, 4. Kindai University

Trans-Neptunian objects (TNOs) are a primordial small-body population consisting of icy/rocky bodies located in a region beyond the Neptune's orbit called the Kuiper Belt. The physical and dynamical properties of TNOs provide us useful clues for investigating the orbital evolution processes of outer planetesimals in the early solar system. Several models based on the migration of the giant planets from Jupiter to Neptune suggest that gravitational scattering by the planetary migration induces a significant radial mixing of small bodies all over the solar system. The orbital and spectral distributions of TNOs obtained from the previous observations strongly indicate two kinds of their formation sites: near the present location and the inner regions of the planetesimal disk. It is also pointed out that there is a correlation between the orbital parameters, in particular inclination (I), and visible colors/spectra. A more detailed study of the color diversity of TNOs can provide a unique constraint on not only their origin and evolution but also those of other small-body populations such as Jupiter Trojans, Hilda group asteroids, and irregular satellites.

We performed a photometric measurement of TNOs using the wide-field multi-band imaging data acquired with the 8.2-m Subaru Telescope and Hyper Suprime-Cam (HSC), a gigantic mosaic CCD camera with a wide field-of-view of 1.5 deg in diameter, in the framework of the HSC Subaru Strategic Program. The five broadband (g , r , i , z , and Y) colors over the wavelength range from 0.4 μm to 1.0 μm for 30 known TNOs were obtained from the survey data covering about 500 square degrees. We found that high- I objects ($I > 6$ deg) classified as the hot classical and scattered populations share similar color property that the reflectance spectra are approximately linear. On the other hand, the cold classical population ($I < 6$ deg) exhibits reflectance spectra with a steep slope within 0.6 μm . We also found a significant anti-correlation between $g-r/r-i$ colors and inclination in the high- I population, as well as a possible bimodality in the $g-i$ color vs. eccentricity plot.

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