Transneptunians as probes of planet building: The Plutino size distribution

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Planetesimals that formed during planet formation are the building blocks of giant planet cores; some are preserved as large transneptunian objects (TNOs). Previous work has shown steep power-law size distributions for TNOs of diameters > 100 km. Recent results claim a dramatic roll-over or divot in the size distribution of Neptunian Trojans (1:1 resonance with Neptune) and scattering TNOs, with a significant lack of intermediate-size $D < 100$ km planetesimals [1,2,3]. One theoretical explanation for this is that planetesimals were born big, skipping the intermediate sizes, contrary to the expectation of bottom-up planetesimal formation.

Exploration of the TNO size distribution requires more precisely calibrated detections in order to improve statistics on these results. We have searched a 32 sq.deg. area near $RA = 2$ hr to an r-band limiting magnitude of $m_r = 24.6$ using the Canada-France-Hawaii Telescope. This coverage was near the Neptunian L4 region to maximise our detection rate, as this is where Neptunian Trojans reside and where Plutinos (and several other resonant populations) come to perihelion. This program successfully detected and tracked 77 TNOs and Centaurs for up to 17 months, giving us both the high-quality orbits and the quantitative detection efficiency needed for precise modelling.

Among our detections were one Uranian Trojan, two Neptunian Trojans, 18 Plutinos (3:2 resonance with Neptune) and other resonant objects. We test TNO size and orbital-distribution models using a survey simulator, which simulates the detectability of model objects, accounting for the survey biases. We show that the Plutino size distribution cannot continue as a rising power law past $H_r \sim 8.3$ (equivalent to ~ 100 km). A single power law is found rejectable at 99.5 % confidence, and a knee (a broken power law to a softer slope) is also rejectable. A divot (sudden drop in number of objects at a transition size), with parameters found independently for scattering TNOs by Shankman et al. [2], provides an excellent match. Due to our study's high-quality detection efficiency and sensitivity to H magnitudes well past the transition, we will show that the Plutino population shares an abrupt deficit of TNOs with D slightly below about 100 km.

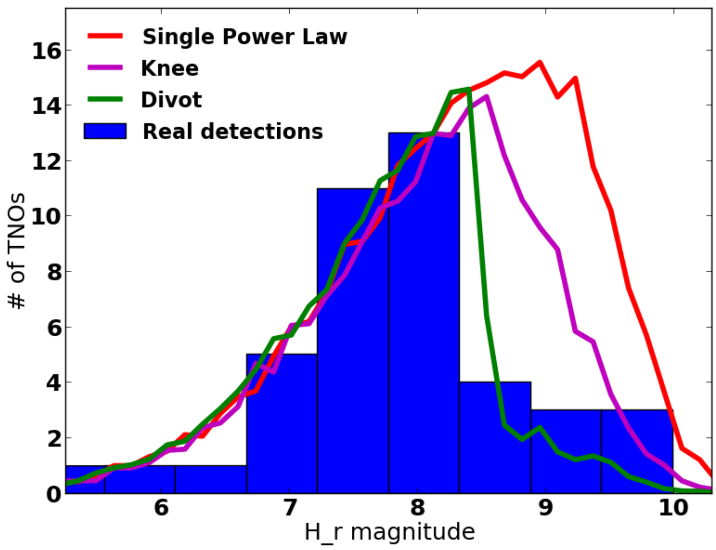

Figure: Differential H-magnitude distribution of the real Plutinos from combining our new survey with CFEPS (blue), as well as simulated detections assuming a single power-law size-distribution (red), a broken power-law size-distribution (magenta) and a divot size distribution (green).

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References: [1] **Sheppard, S. and Trujillo, C.** (2010), *ApJL* **723**, L233-L237. [2] **Shankman, C.** et al. (2013), *ApJL* **764**, L2. [3] **Alexandersen, M.** et al. (2014), *In preperation.*