Comparing the size distributions of Jupiter Trojans and Kuiper Belt Objects with DEEP

Luis Salazar Manzano[1], *Kevin Napier*[1], *David Gerdes*[1], *Hsing-Wen (Ed) Lin*[1], *Fred Adams*[1], *and the DEEP collaboration.*

[1]*University of Michigan.*

Introduction

- Jupiter Trojans (JTs) were likely captured during the migration of the giant planets in the early Solar System (Morbidelli et al., 2005). The Size Frequency Distribution (SFD) of JTs share the same parent distribution of hot Kuiper Belt Objects (KBOs) (Fraser et al., 2014), however this analysis was limited to only large and bright objects.
- The latest constraint on the JT SFD is provided by the Hyper Suprime Cam on the Subaru telescope: $m_r{\sim}24.4,\ H_r{\sim}17.4,\ D{\sim}2\ km$ (Uehata et al., 2022; Yoshida and Terai, 2017).
- Claims suggest a 2nd break in the SFD around $H{\sim}15.5\ -D{\sim}6\ km$ (Wong and Brown, 2015; Yoshida and Nakamura, 2005). Recent models of JTs' collisional evolution predict a turnover in the SFD between $1-10\ km$ (Marschall et al., 2022).
- **We need to push the size distribution to the sub-km regime** to: (1) test observational and theoretical proposition regarding the faint-end break and (2) extend the comparison between JTs and KBOs SFDs to fainter regimes.

Data

- The DECam Ecliptic Exploration Project (DEEP) is a large-scale survey aimed at discovering and measuring orbits of thousands of KBOs down to $m_r{\sim}26$ (Trilling et al., 2024; Trujillo et al., 2024; Bernardinelli et al., 2024; Napier et al., 2024; Strauss et al., 2024; Smotherman et al., 2024).

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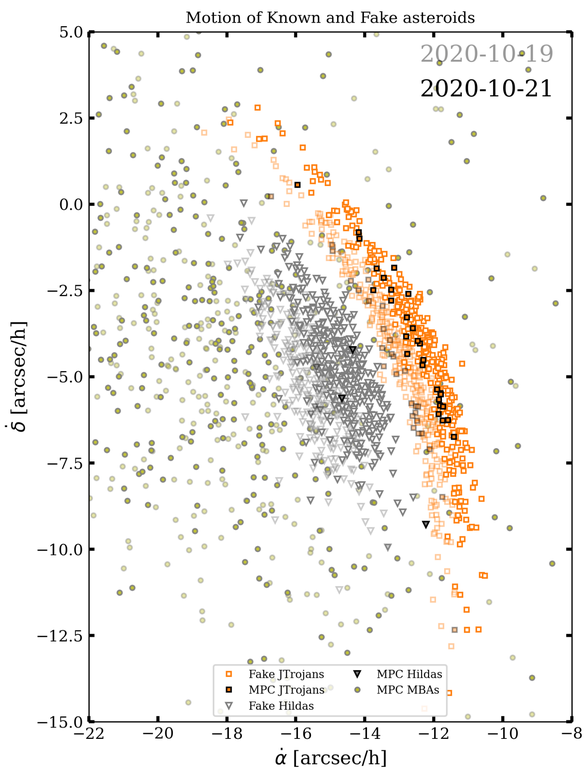
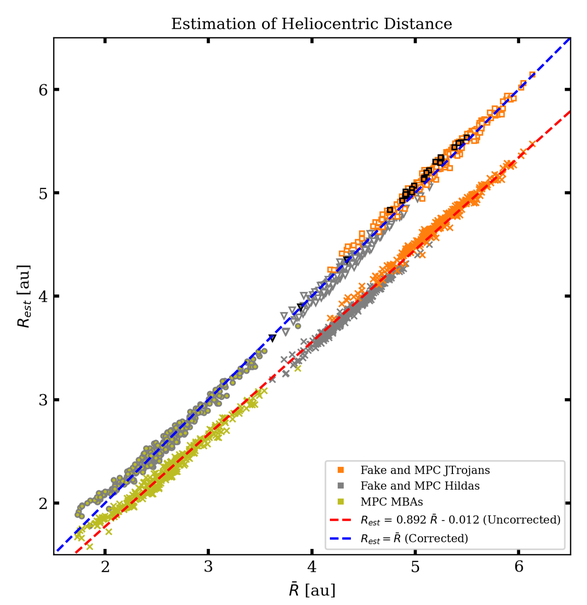
- The six DECam pointings of the 2020 B1 patch overlap with the L_4 JT cloud. Each field (FOV of 2.7 deg^2) consist of ~100 consecutive 120-second VR-band exposures in a ~4-hour long stare.
- We focus on the B1d field, observed in 2020-10-19 and reobserved 48 hours later in 2020-10-21. It is ~6 deg from the L_4 center and ~35 deg from opposition.

Methodology

- Despite the field not being at opposition, JTs can be distinguished from Hildas using their rates of motion.

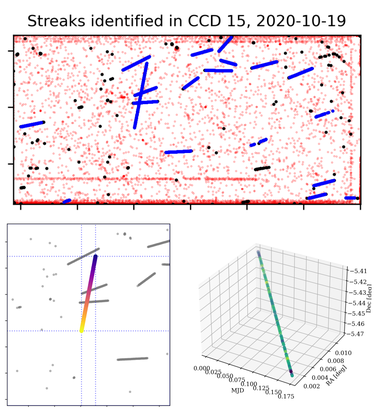


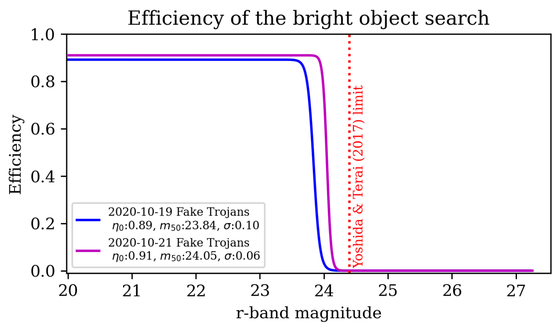
- Initial determination of the heliocentric distance can be obtained with the ecliptic rates of motion of the object on both nights, assuming circular orbits.

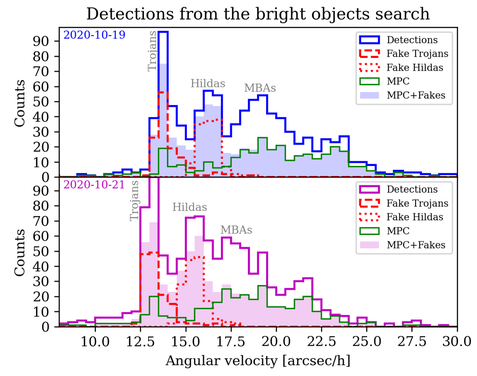


Bright end detections

- Detection of moving objects from transient-level catalogs resulted in ~1000 streaks per night with ~500 being either fakes or MPC asteroids down to $m_r{\sim}24$.
- ~50 JTs are preliminary identified with ongoing efforts to determine the bright end of the JT SFD (regime of previous measurements).

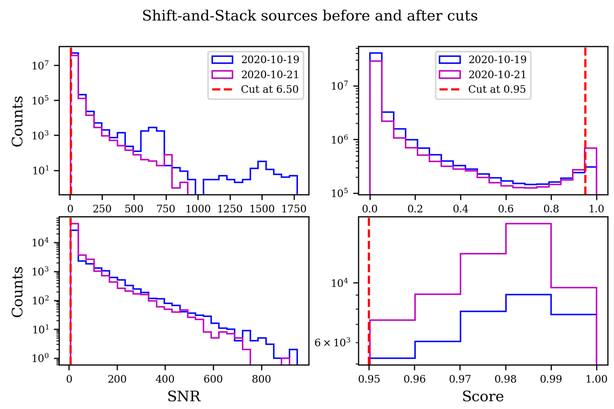


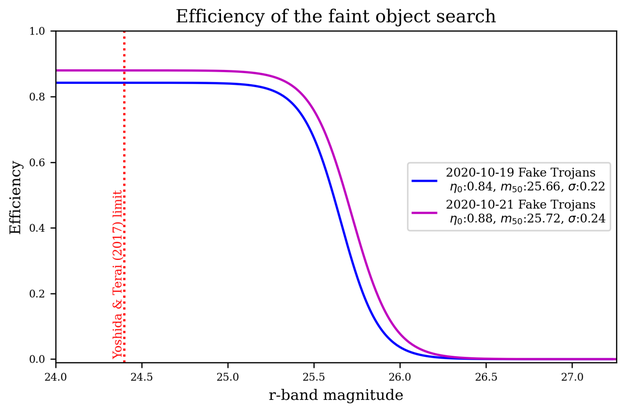




Faint end detections

- Shift-and-Stack on a hexagonal grid resulted in ~10^7 sources, which, after cuts on SNR, PSF score and rates, reduces to more manageable ~10^4 catalogs.
- Preliminary estimation of the JT detection efficiency suggest ~85% efficiency and ~25.7 magnitude limit.
- Ongoing efforts are being made to clean the sample of sources by linking between both nights.





Discussion

- This project aims to perform a comprehensive determination of the JT SFD, from bright moving objects $m_r{\sim}24,\ Hr{\sim}16.5,\ D{\sim}2.7\ km$; to ultra-faint JTs $m_r{\sim}25.7,\ Hr{\sim}18.2,\ D{\sim}1\ km$.
- For the first time, the shift-and-stack technique is applied to JT SFD measurements probing JTs in the sub-km regime.
- Our measurement, combined with recent constraints on the KBOs SFD, will allow us to extend the SFD comparison of both populations to fainter and smaller objects.
- We have been granted time on Magellan and DECam to measure the L_5 JT SFD with a dedicated survey.

Questions?

I'm here to talk!!

You can also reach out to me via lesamz@umich.edu

UNIVERSITY OF MICHIGAN