

Hubble Asteroid Hunter: Analysing asteroid trails in HST images

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HST reveals faint asteroids that are not typically accessible from the ground. Their sizes and orbital parameters allows us to study the size distribution of asteroids at the smallest scales and put constraints on Solar System formation and evolution models.

The Asteroid Hunter Project (Kruk et al. 2022) has used a novel combination of Citizen Science and Machine Learning techniques to identify serendipitous asteroid trails in Hubble images, finding 1,701 of them. **1,031 of these trails correspond to unknown Solar System Objects**, not matching any entries in the Minor Planet Center database. This project aims to analyse in detail these potentially new asteroids and use them to improve our current Solar System creation and evolution models.

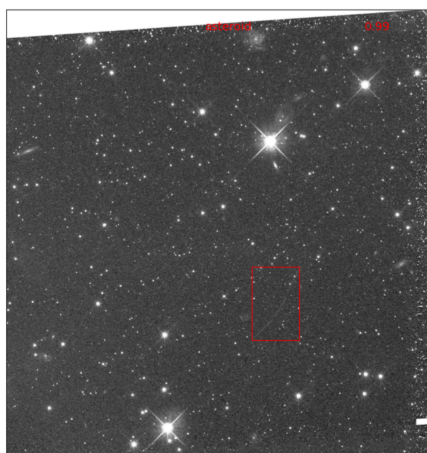


Figure 1: Example of asteroid trail identified by Hubble Asteroid Hunter project

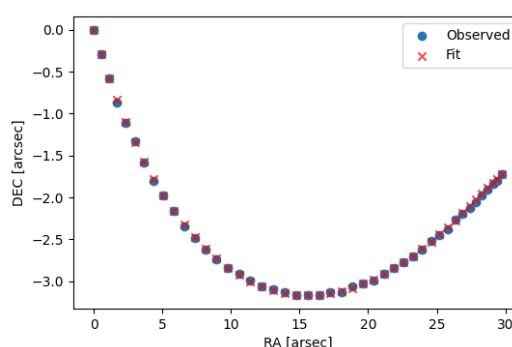


Figure 3: Real trail (blue) and fit (red) for its best parallax-distance solution (red)

Our algorithm generates simulated trails for different distance solutions taking into account HST trajectory and the orbital motion of the object as seen from Earth. The best-fit solution regarding the trail is considered as the distance to the object (Example in Figure 3).

We tested and validated our algorithm using 21,280 known asteroids ephemeris from JPL Horizon. The differences between the parallax-calculated distance and objects' JPL ephemeris are shown in Figure 4.

Our aim: determine the distance to these new asteroids, their sizes and put constraints on their orbits. Asteroid trails appear curved because of HST orbit. This parallax in the shape of the trail can be "reversed" to obtain the **distance** to the asteroid (Evans et al. 1998). Using the distance, we are able to determine their **absolute magnitudes** and estimate their **sizes**. We are also able to **put constraints on their orbital parameters**.

Figure 2: HST sees asteroids as trails (fixed target pointing)

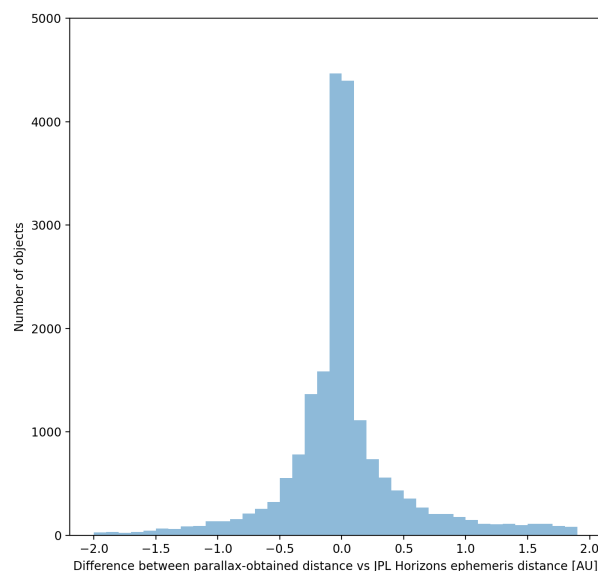
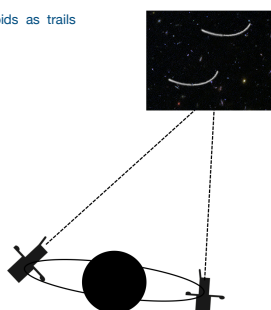


Figure 4: Difference between parallax-calculated distance vs JPL Horizons ephemeris distance for 21,280 known objects