Hubble Asteroid Hunter part 2 – Analysing asteroid trails in Hubble Space Telescope images

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Introduction: ESA's Hubble Archive contains 102 Tb of data. All these images were used in the past conduct major breakthroughs in Astrophysics, but we still can find hidden treasures laying within them. The Asteroid Hunter Project used a novel combination of Citizen Science and Machine Learning techniques to identify serendipitous asteroid trails in Hubble images, finding 1,701 of them (for the whole ACS/WFC and WFC3/UVIS instrument archives)[1] (Kruk et al. 2022, accepted).

1,031 of these trails correspond to unknown asteroids (or Solar System Objects), not matching any entries in the Minor Planet Center database. This second (and current) part of this project aims to analyse in detail these potentially new asteroids and use them to improve our current Solar System creation and evolution models.

Section-1: : Our main goal is to compute the orbital parameters of the unknown asteroids found by the Asteroid Hunter project. Asteroid trails appear curved in Hubble images because of the parallax induced by the telescope motion around the Earth. Taking into account Hubble's trajectory, the parallax effect can be "reversed" to obtain the distance to the asteroid and its approximate orbital parameters[2] (Evans et al. 1998).. Once we know the objects distances, we are able to obtain their absolute magnitude and, combined with an estimated albedo, we can get a size distribution model for this big set of unknown objects.

Given Hubble's resolution and clear view, we are expecting to find a big amount of main-belt small asteroids (diameter <1 km), a faint population difficult to image from ground-based observatories and yet poorly understood. Asteroids are living relics from ancient stages of our Solar System, improving our knowledge about their population and size distribution is key to better understand our Solar System formation and evolution processes.

In addition, some of these unknown objects present clean lightcurves (or slices of them) that could be used to infer the shape of these asteroids, very helpful for better assessing their type and origin.

For the technical part, we use Google Cloud platform: AutoML Object Detection for identifying trails in HST Archive (used in the first part of this project[1]) and a cloud-based pipeline for conducting the calculations from the discretized trail positions (currently work in progress). This may serve in the future as a prototype "proof of concept" for an automated detection and analysis pipeline in large astronomical archives or surveys.

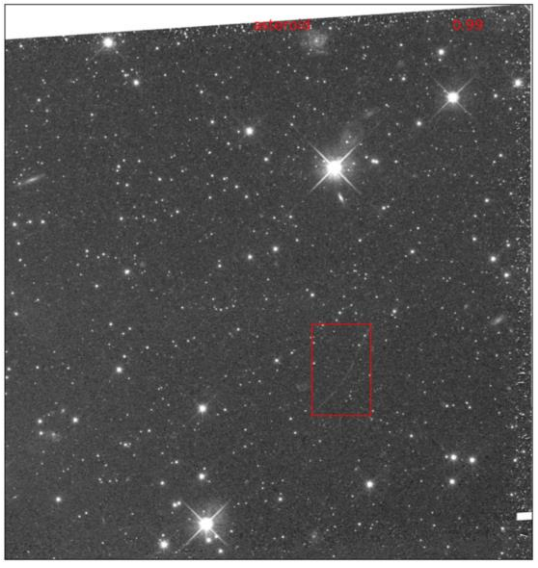

Figure 1: Example of asteroid trail identified by Hubble Astroid Hunter project