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Lightcurve Analysis of Imminent Impactors for Planetary Defense Using Innovative Trail Technique

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At the time of writing this abstract, eleven asteroids had been discovered in the sky prior to their impact on Earth. The first one was detected in 2008, but in 2024 alone, four were discovered. This shows that the number of detection is steadily increasing, and we should expect this trend to continue in the coming years with the ongoing improvement of observational techniques and the development of new surveys dedicated to planetary defense, such as the Flyeye telescopes [1, 2].

The detection and analysis of imminent impactors are critical for planetary defense. We present here a new processing pipeline to extract accurate flux measurements from trailed observations of fast-moving near-Earth objects. This method was developed to address the observational challenges inherent from the characteristics of small impactors. Indeed, these objects are generally small (and thus faint), become bright only when they are close to Earth (and thus move very fast across the sky), rotate very quickly (due to their small size), and have poorly characterized orbits at the time of observation.

Our new approach consists of observing NEOs using sidereal tracking and long exposures. The asteroid moves accross the field of view and appears as a trail, while background stars remain sharp. This allows for precise astrometric and photometric calibration using standard circular apertures for the stars, while photometric data from the asteroid's trail are extracted using rectangular apertures. The flux from the object can then be extracted along the trail, using ephemeris information for time calibration.

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Using this method we analyzed the lightcurve of several imminent impactors (2022 EB5, 2023 CX1, 2024 BX1, 2024 RW1, 2024 XA1) and found that they usually rotate very quickly, with rotation periods shorter than any other objects in the solar system.

In this talk we will review the trail observation technique and analysis [the method was published here 3] and discuss the results found for these imminent impactors. We will also highlight what lightcurve information can reveal about the physical characterization of these objects and their relevance to planetary defense.

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