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New aperture photometry technique for fast moving fly-by NEOs: detection of the 2.58s rotation period of 2024 BX1.

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Circular aperture photometry, is a crucial method utilized in astronomical observations for measuring the flux emitted by point sources [1]. Its utility spans diverse astronomical phenomena, encompassing tasks such as determining the absolute magnitude and spin period of asteroids [2]. In conducting traditional circular aperture photometry on objects in motion, it's essential to adjust the exposure time to prevent both the moving object and the stars from appearing elongated in the image.

When dealing with near-Earth objects (NEOs) traditional aperture photometry is challenging due to their rapid motion on the sky (from several arc-seconds per minute to several arc-degree per minutes during close fly-bys). Such rapid angular motion necessitates brief exposure times, resulting in a significant portion of observation time being consumed by CCD read-out rather than actual on-sky observations. This limitation has hindered the detection of extremely rapid rotation periods. The quickest rotation period, P = 2.99 s, was identified using a rapid read-out camera [3].

Hence, when limited to a CCD with slow read-out time, the most straightforward and dependable method for acquiring high-quality data on these fast moving objects is to conduct sidereal tracking observations, enabling the asteroid to appear as a trail in the images.

We are presenting here a novel aperture photometry method to obtain photometric measurements on trailed observations of asteroids. Our strategy capitalizes on the rapid motion of the object across the sky while keeping the stars sharp. This enables us to employ standard circular apertures for the stars, facilitating both photometric and astrometric field calibration. As for the asteroids, they are spanning hundreds of pixels on the image as we need a new approach to extract their photometric variation.

For conducting aperture photometry on trailed asteroid observations, we employ a square or rectangular aperture oriented parallel to the direction of the NEO's trail. This method optimizes the signal-to-noise ratio of the extracted photometry within a limited portion of the trail. Subsequently, we traverse along the trail to gather photometric data over time.

We applied our new technique on three recently observed targets at the Schiaparelli observatoty and with the TRAPPIST-North telescope [4]. The first two targets, 2023 CX1, 2024 BX1, impacted the Earth shortly after our observations while 2024 EF perfomed a very close fly-by.

For 2023 CX1, minimal photometric variation was noted, suggesting either a spherical shape or minimal rotation during our observation span. A double-peaked phase curve was obtained for a spin period of 18.33 seconds. In contrast, our analysis of the 2024 BX1 observations revealed it to be the fastest rotating asteroid to date, with a measured period of 2.5888 +- 0.0002 seconds. The 0.7 magnitude amplitude suggest an elongated shape.

For 2024 EF, we detected a rotation period of around 3.95 minutes through standard asteroid tracked observations. However, we demonstrate that photometry extracted from a single 90-second exposure trailed image aligns accurately with the regular observations when phased.

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