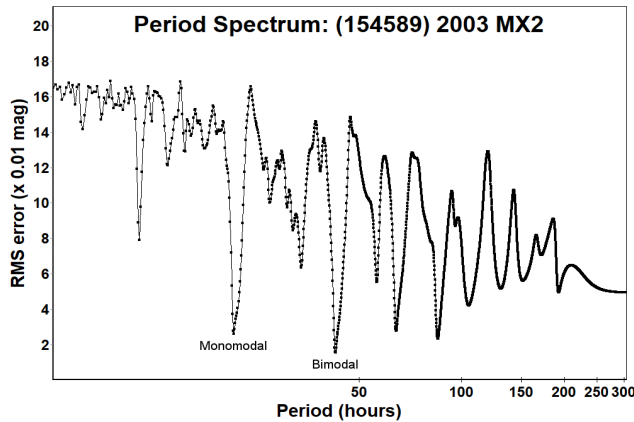
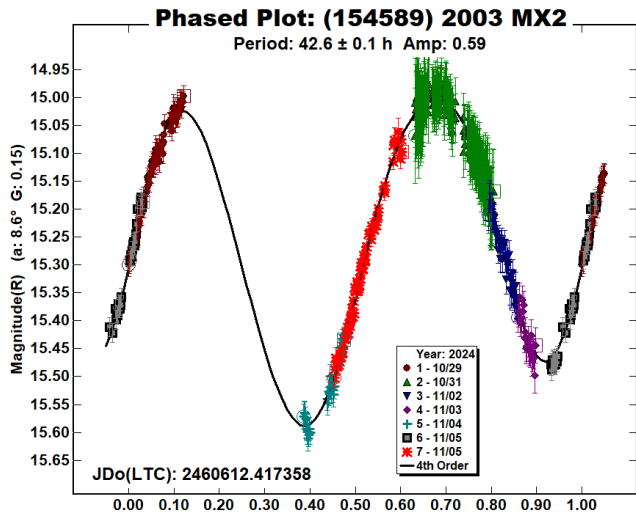


(154589) 2003 MX2 is an Amor Near-Earth asteroid. Collaborative observations were made over six nights. We found a bimodal solution with a synodic period of $P = 42.6 \pm 0.1$ h and an amplitude $A = 0.59 \pm 0.03$ mag. This solution differs from the one found by Warner (2018; 1.611 ± 0.002 h).



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PHOTOMETRY OF NEAS (187026) 2005 EK70 AND (152787) 1999 TB10

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Near-Earth asteroids (187026) 2005 EK70 and (152787) 1999 TB10 were observed over five nights in February 2024 and four nights in March 2024, respectively, using the Prompt 3 telescope at the Cerro Tololo Inter-American Observatory. The rotational period for (187026) 2005 EK70 is 6.966 ± 0.001 hours and the lightcurve amplitude is 0.20 ± 0.02 magnitude. The rotational period for (152787) 1999 is 2.876 ± 0.001 hours and the amplitude is 0.29 ± 0.05 magnitude. A search of the Asteroid Lightcurve Database provided no previously published results for either NEA.

Observations

LINEAR at Socorro discovered NEA (187026) 2005 EK70 on 2005 March 08, and NEA (152787) 1999 TB10 on 1999 October 07. We obtained CCD photometric observations during the close approach of (187026) 2005 EK70 on 2024 February 25-29, and during close approach of (152787) 1999 TB10 on 2024 March 25-28. Neither of these NEAs have published photometric data in the Asteroid Lightcurve Database (Warner et al., 2009).

Observations were collected from Prompt 3 at the Cerro Tololo Inter-American Observatory (CTIO) (MPC: code 807). Prompt 3 is a 0.6m f/6 Planewave Ritchey-Chrétien on a Planewave HR200 with a FLI 13.5 μ m 2048 $\times$ 2048 camera. Images were taken using the broadband Clear filter and binned 2 $\times$ 2. The exposure times for (187026) 2005 EK70 were 20-30 seconds, and (152787) 1999 TB10 exposure times were 30-40 seconds. The observing cadence was separated by the read-out time of the CCD. A total of 3,294 science images of (187026) 2005 EK70 were acquired, and we included 2,681 in our analysis. Similarly, for (152787) 1999 TB10, we obtained a total of 1,323 science frames and included 1,010 images in our analysis. A total of 926 images were excluded due to star contamination, wind or meridian flip-induced trails, and intermittent clouds. Flat, bias, and dark frames were obtained each night under similar operating conditions as the science frames. The dark frame exposures were 80 seconds and taken sets of ten using

Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
187026	2005 EK70	2024 02/25-02/29	28.4-43.6	143	-17	6.966	0.001	0.20	0.02	NEA
152787	1999 TB10	2024 03/25-03/28	45.3-44.6	158	2	2.876	0.001	0.29	0.05	NEA

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. LPAB and BPAB are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

the Clear filter with a dark scale correction applied that matched the exposure length. Bias frames were 0.0 second exposures and taken in a set of ten. Dawn flats were acquired in the Clear filter and in a set of ten. The total time imaging (187026) 2005 EK70 and (152787) 1999 TB10 was ~6 and ~3 hours, respectively.

Data Calibration/Analysis

The science frames were bias-, dark-, and flat-field calibrated using the *AstrolImageJ* image reduction software according to the standard CCD calibration equation (Howell, 2006). Following data calibration, the images were imported to *MPO Canopus* and a photometric analysis of the data was performed. Each night contains multiple sessions due to the asteroid's velocity with the telescope's field of view rapidly changing along with the asteroid crossing the meridian. The *MPO Canopus Light Curve Wizard* combined each night's segments consisting of 16 sessions across five nights for (187026) 2005 EK70 and 8 sessions spanning four nights for (152787) 1999 TB10.

In general, each image's analysis involved the selection of five stars (non-variable) for magnitude standards. *MPO Canopus* performs a least-squares analysis to determine the relationship between the magnitude and the log of the total counts. For the background correction, a 9×9-pixel circular aperture was utilized to determine counts of the CompStars/Background. For each NEA/Background, a 7×7-pixel circular aperture was deemed the best size for both targets. The data were light-time corrected using the JD at the start of each exposure.

We plotted all segments of usable data as lightcurves, however, the rapid motion of the observed NEAs resulted in the sky and background comp stars changing in each session. This introduced some uncertainty in the magnitudes of the comparison stars. To correct this, we used the *deltacomp* function to adjust the magnitudes and bring them into agreement with the magnitudes of our first data set for both asteroids.

Results

(187026) 2005 EK70. We produced a composite lightcurve (Fig. 1), and least-squares fit the lightcurve with a Fourier series including five harmonics. A phase angle change of 15.2° resulted in a slight periodic shape change, which can be observed by the misalignment of session 8 with session 16.

We calculated the rotational period at 6.966 ± 0.001 hours with an amplitude of 0.20 ± 0.02 magnitude. There are two maxima and minima present per rotation.

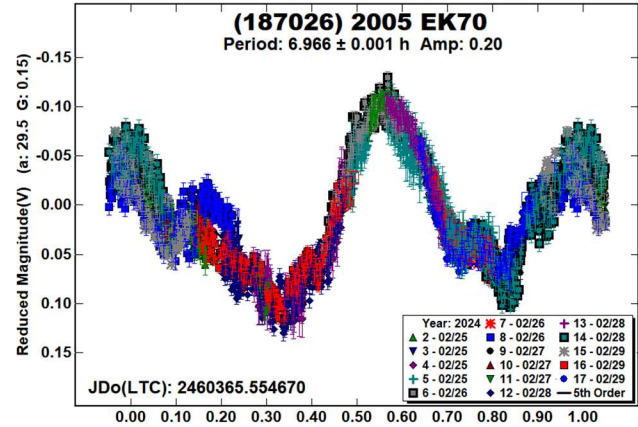


Fig. 1: NEA (187026) 2005 EK70 rotational period of 6.966 ± 0.001 hours with an amplitude of 0.20 ± 0.02 magnitude.

(152787) 1999 TB10. We produced a composite lightcurve (Fig. 2), and least-squares fit the lightcurve with a Fourier series including five harmonics.

The calculated rotational period is 2.876 ± 0.001 hours with an amplitude of 0.29 ± 0.05 magnitude. There are two maxima and minima present per rotation.

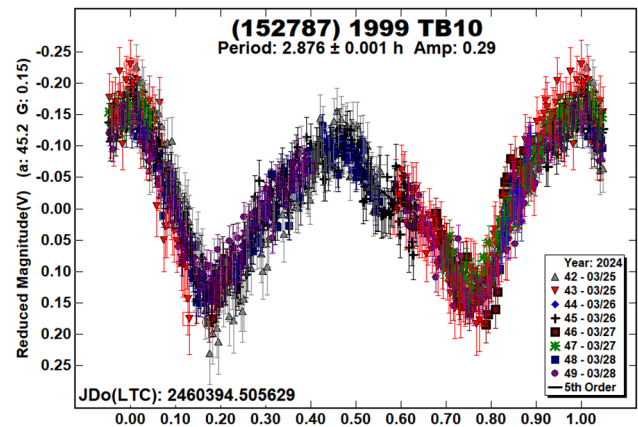


Fig. 2: NEA (152787) 1999 TB10 rotational period of 2.876 ± 0.001 hours with an amplitude of 0.29 ± 0.05 mag.

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LIGHTCURVES OF NEAR-EARTH ASTEROIDS 2024 ON, 2024 MK AND 1998 ST27 AS OBSERVED FROM TRAPPIST

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We report photometric observations of three near-Earth asteroids: 2024 ON, 2024 MK, and 1998 ST27. The observations were performed between June and October 2024 during their close approaches to Earth using the TRAPPIST network. Applying lightcurve analysis, we determined that the rotation period and amplitude of 2024 ON are $P = 6.0116 \pm 0.0003$ h and $A = 0.94 \pm 0.05$ mag. For 2024 MK we found two possible rotation periods. In the first case $P_1 = 0.5028 \pm 0.0001$ h with $A_1 = 0.67$ mag ± 0.02 , and $P_2 = 0.3663 \pm 0.0001$ h with $A_2 = 0.45$ mag ± 0.02 . In the second case $P_1 = 0.7301 \pm 0.0011$ h with $A_1 = 0.503$ mag, and $P_2 = 0.5031 \pm 0.0005$ h with $A_2 = 0.643$ mag. For 1998 ST27 we obtain $P = 3.56 \pm 0.02$ h and $A = 0.07 \pm 0.01$ mag. All measurements have been submitted to the ALCDEF database.

The telescopes used to obtain the lightcurves of 2024 ON, 2024 MK and 1998 ST27, are the TRAPPIST twins, 0.6-m Ritchey-Chrétien telescopes operated under the COMETA team of the University of Liège (Jehin et al., 2011). TRAPPIST-North (TN; MPC code Z53) is located in Morocco - Oukaïmeden, and TRAPPIST-South (TS; MPC code I40) is located in Chile - La Silla. The TN camera is an Andor IKONL BEX2 DD (0.59 arcsec/pixel) and the TS camera is a FLI ProLine 3041-BB (0.66 arcsec/pixel).

All images recorded were reduced by using standard image calibration with multiple darks, bias and flat frames taken every night onto the twilight sky. For creating calibration frames that are temperature matched, exposure and filter matched, and applying them, we used the internal pipeline of TRAPPIST, *Triton*. All the images that were affected by weather conditions or had any light source interference within 12 pixels with the asteroid due to their movement within the star fields, were excluded.

For the zero-point calibration and lightcurve construction, we used *Photometry Pipeline* (Mommert, 2017). The differential photometry and magnitude calibration was done with the PanSTARRS DR1 catalog with approximately 100 solar reference stars per image.

2024 ON was discovered on 2024 July 27 by the ATLAS network located in Mauna Loa, Hawaii, with a measured absolute magnitude of $H = 20.3$ (Herman et al., 2024). The asteroid has been categorized as a PHA due to its absolute magnitude that would translate to an approximate size of 350 m, and its MOID of 0.003 au (JPL, 2024a). Two months after its discovery, 2024 ON had a close approach to Earth on September 17 around 10:19 UT with a minimum distance of 0.0066 au or two and a half LD (JPL, 2024a). Observations by the Goldstone Solar System Radar on September 16 revealed that the asteroid is a contact binary (NASA/JPL-Caltech, 2024a).

During this close approach, we successfully observed the asteroid for a total of 10 nights, using both TN and TS. The asteroid was observed with TS using a Rc filter and binning 2×2 for many hours each night between September 19 and October 1. The data consists of 1355 photometric images, for a total of 26.6 hours spread during 8 nights. The exposure time was adjusted each night in order to obtain the best SNR and avoid trails on several pixels. The asteroid was too low on the horizon to be observed with TN during its closest approach but we managed to get data for two nights on September 30 and October 01, when the asteroid was fainter with $V = 17.2$, also using binning 2×2 .