LIGHTCURVES, ROTATIONAL PERIODS AND SPECTRAL CLASSIFICATION OF TWO NEAR-EARTH ASTEROIDS OBSERVED WITH TRAPPIST: 2020 WG AND (458122) 2010 EW45

Brankica Apostolova
MAUCA - Master track in Astrophysics
Université Côte d'Azur & Observatoire de la Côte d'Azur
Parc Valrose, 06100 Nice, FRANCE
brankica.apostolova@oca.eu

Mohamed Amine Miftah
Space Sciences, Technologies & Astrophysics Research (STAR) Institute, Université de Liège, Liège, BELGIUM
Cadi Ayyad University (UCA), Oukaïmeden Observatory (OUCA), Faculté des Sciences Semlalia (FSSM), High Energy Physics, Astrophysics and Geoscience Laboratory (LPHEAG), Marrakech, MOROCCO

Emmanuël Jehin, Elisabeta Petrescu
Space Sciences, Technologies & Astrophysics Research (STAR) Institute, Université de Liège, Liège, BELGIUM

Marin Ferrais
Florida Space Institute, University of Central Florida
Orlando, Florida, USA

Abdelhadi Jabiri, Zouhair Benkhaldoun
Cadi Ayyad University (UCA), Oukaïmeden Observatory (OUCA), Faculté des Sciences Semlalia (FSSM), High Energy Physics, Astrophysics and Geoscience Laboratory (LPHEAG), Marrakech, MOROCCO

(Received: 2025 June 7)

We observed two near-Earth asteroids (NEAs) with TRAPPIST-North and TRAPPIST-South from October 2024 to January 2025. We obtained their lightcurves and estimated their synodic rotational periods and amplitudes, which have not been previously reported – 2020 WG: (0.5927 ± 0.0003 h) and (0.36 ± 0.02 mag); (458122) 2010 EW45: (2.4880 ± 0.0008 h) and (0.11 ± 0.01 mag). We also performed calculations of their color indices B-V, V-R and V-I, and according to them, classified the asteroids into spectral types – 2020 WG: S-type, 2010 EW45: Q-type. The acquired data have been submitted to the ALCDEF database.

We conducted CCD photometric observations of NEAs 2020 WG and (458122) 2010 EW45 with the TRAPPIST-North (TN; IAU code Z53) and TRAPPIST-South (TS; IAU code I40) robotic telescopes (Jehin et al., 2011), which are installed at the Oukaïmeden Observatory in Morocco and the ESO La Silla observatory in Chile, respectively. Both are 0.6-m Ritchey-Chrétien telescopes operating at f/8 on German Equatorial mounts. The TN camera is an Andor IKONL BEX2 DD (0.60 arcsec/pixel), and the TS camera is an FLI ProLine 3041-BB (0.64 arcsec/pixel).

All observations used for the lightcurves were made using a R filter. Additional observations in B, V and I filters were conducted in order to calculate the color indices, to infer spectral types. The raw images obtained with the two telescopes were calibrated with a Python script using standard flat fields, dark and bias frames. The aperture photometry was carried out with Photometry Pipeline developed by Mommert (2017), which integrates zero-point calibration by matching field stars with reference catalogs. The rotational periods were determined using the software *Peranso* (Paunzen and Vanmunster, 2016), utilizing the FALC method described by Harris et al. (1989).

The phased lightcurves are shown in Figure 1 and Figure 2. We display the variation of the magnitudes subtracted by the average magnitude. The associated errors are from the quality of the photometry. We fitted the data with a Fourier series of the form $F_n(\phi) = a_0 + \Sigma(a_n\cos(2\pi n\phi) + b_n\sin(2\pi n\phi))$, where ϕ is the rotational phase normalized between 0 and 1, and n refers to the different harmonic orders of the Fourier series. The residuals between the data and the fit are shown on the bottom of the figure. The amplitudes reported are from the Fourier series model. The color indices were calculated by taking the mean of the magnitudes in each filter for each night, then taking the mean of each index from all nights. Table 1 and Table 2 summarize the observation details and results.

2020 WG is an NEA that is categorized as a Potentially Hazardous Asteroid (PHA) belonging to the Apollo class (NASA/JPL, 2025). It was observed for five nights with TN and TS in October 2024 and November 2024 with a total time on target of 19.8 hours. The best-fitting period found is 0.5927 ± 0.0003 h, revealing a fast rotator (35.6 min), with a quite large amplitude of 0.36 ± 0.02 mag. The shape of the lightcurve shows shifting to a lower phase from the first to the second night, then consecutive shifting to a higher phase each night, with a magnitude drop during the last two nights. This can be attributed to the large phase angle change in the observing period – from 64.1° to 25.4° from October 25 to October 31, which is then followed by an increase of up to 34.0° on November 4. The colors of 2020 WG were calculated using observations with TN over two nights. The estimated color indices are B-V = 0.85 ± 0.01, V-R = 0.52 ± 0.01 and V-I = 0.87 ± 0.01. These values point to an asteroid of the S-type according to the Tholen classification (Dandy et al., 2003).

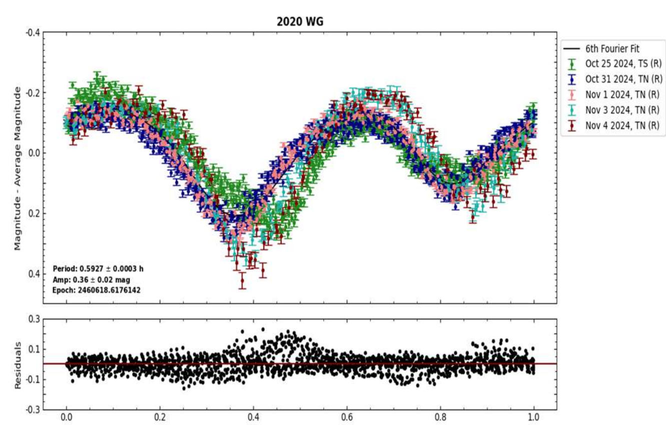

Fig. 1. Asteroid 2020 WG. Top: lightcurve, bottom: residuals.

Number	Name	yyyy	mm/dd	Pts	Phase angle (°)	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp (mag)	A.E.
	2020 WG	2024	10/25-11/04	1708	64.1, 34.0	32	12	0.5927	0.0003	0.36	0.02
458122	2010 EW45	2024-2025	12/23-01/06	2600	53.3, 24.3	92	-4	2.4880	0.0008	0.11	0.01

Table I. Observation details and results of the lightcurve photometry. Pts is the number of data points, i.e., number of images from which we acquired photometric magnitudes and phase angle corresponds to the first and last date (NASA/JPL, 2025). L_{PAB} and B_{PAB} represent the approximate phase angle bisector longitude/latitude at the midpoint of the observation period (Harris et al., 1984). We report the results for the rotational period and amplitude along with the uncertainties.

Number	Name	yyyy	mm/dd	Pts_B	Pts_V	Pts_R	Pts_I	(B-V)	σ_{B-V}	(V-R)	σ_{V-R}	(V-I)	σ_{V-I}	Spect. Type
	2020 WG	2024	11/03-11/04	8	7	18	8	0.85	0.01	0.52	0.01	0.87	0.01	S
458122	2010 EW45	2024-2025	12/23-01/15	33	32	61	30	0.84	0.02	0.45	0.02	0.71	0.02	Q

Table II. Observation details and results for the color indices and spectral type classification. We give the number of data points in each of the BVRI filters. We report the values of the color indices along with the uncertainties, as well as the asteroid spectral type.

(458122) 2010 EW45 is also an Apollo PHA (NASA/JPL, 2025; Bressi et al., 2010). Radar observations from Goldstone have shown that 2010 EW45 is a binary asteroid (*https://echo.jpl.nasa.gov/asteroids/Alinda.goldstone.planning.2024.html*). We observed it for 11 nights with both TN and TS from December 2024 to January 2025, with a total time on target of 35.5 hours. We found a best-fitting period of 2.4880 ± 0.0008 h and amplitude 0.11 ± 0.01 mag. Using BVRI observations from eight nights, the color indices were estimated to be B-V = 0.84 ± 0.02, V-R = 0.45 ± 0.02 and V-I = 0.71 ± 0.02, indicating a Q-type asteroid.

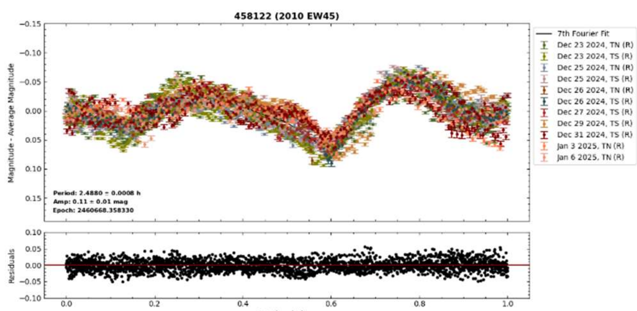

Fig. 2. Asteroid 2010 EW45. Top: lightcurve, bottom: residuals.

Acknowledgements

TRAPPIST is a project funded by the Belgian Fonds (National) de la Recherche Scientifique (F.R.S.-FNRS) under grant PDR T.0.120.21. TRAPPIST-North is a project funded by the University of Liège (Belgium), in collaboration with Cadi Ayyad University in Marrakech (Morocco). E. Jehin is FNRS senior Research Associate. The TRAPPIST project can be visited at the website *https://www.trappist.uliege.be*. Author Brankica Apostolova thanks Observatoire de la Côte d'Azur, the COMETA team at Université de Liège and the Erasmus+ program for making this joint research work possible.

References

Bressi, T.H.; Holvorcem, P.R.; Schwartz, M.; Kowalski, R.A.; Ahern, J.D.; Beshore, E.C.; Beshore, E.C.; Boattini, A.; Garradd, G.J.; Gibbs, A.R; Grauer, A.D.; Hill, R.E.; Larson, S.M.; McNaught, R.H.; Birtwhistle, P. (2010). "2010 EW45." *Minor Planet Electronic Circulars*, MPEC 2010-F05.

Dandy, C.L.; Fitzsimmons, A.; Collander-Brown, S.J. (2003). "Optical colors of 56 near-Earth objects: trends with size and orbit." *Icarus* **163(2)**, 363-373.

Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57(2)**, 251-258.

Harris, A.W.; Young, J.W.; Bowell, E.; Martin, L.J.; Millis, R.L.; Poutanen, M.; Scaltriti, F.; Zappalà, V.; Schober, H.J.; Debehogne, H.; Zeigler, K.W. (1989). "Photoelectric observations of asteroids 3, 24, 60, 261, and 863." *Icarus* **77(1)**, 171-186.

Jehin, E.; Gillon, M.; Queloz, D.; Magain, P.; Manfroid, J.; Chantry, V.; Lendl, M.; Hutsemékers, D.; Udry, S. (2011). "TRAPPIST: TRAnsiting planets and PlanetesImals small telescope." *The Messenger* **145(2)**, 2-6.

Mommert, M. (2017). "PHOTOMETRYPIPELINE: An automated pipeline for calibrated photometry." *Astronomy and Computing* **18**, 47-53.

NASA/JPL (2025). HORIZONS System. Jet Propulsion Laboratory, California Institute of Technology. Accessed: April 26, 2025. *https://ssd.jpl.nasa.gov/horizons/*

Paunzen, E.; Vanmunster, T. (2016). "Peranso–light curve and period analysis software." *Astronomische Nachrichten* **337(3)**, 239-245.