

Acknowledgements

Thanks is directed to Prof Richard Binzel who brought to the attention of these mutual events through his notification at Binzel (2024).

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PHOTOMETRIC DETECTION OF THE 2024 OCTOBER 23-24 MUTUAL EVENT OF THE PATROCLUS-MENOETIUS BINARY JUPITER TROJAN AT SOPOT ASTRONOMICAL OBSERVATORY

Vladimir Benishek

Belgrade Astronomical Observatory
Volgina 7, 11060 Belgrade 38, SERBIA
vlaben@yahoo.com

(Received: 2024 November 3)

A single lightcurve partially covering the 2024 October 23-24 superior mutual event was obtained for the binary Jupiter Trojan asteroid system 617 Patroclus - Menoetius from Sopot Astronomical Observatory (K90) in Serbia.

During its 11.89-year long heliocentric orbital period, the orbital plane of the binary Jupiter Trojan asteroid system 617 Patroclus - Menoetius (PMS) twice reaches a favorable position in relation to the Earth, allowing observations of mutual eclipses and occultations (mutual events) of the system components. Such a favorable observational geometry of PMS mutual events occurs in the time span 2024 February - 2025 January.

Following the call for observations of PMS mutual events by Binzel (2024) during 2024 September - October, CCD photometric observations of the superior (Patroclus closer to the Sun than Menoetius) mutual event predicted for 2024 October 23-24 (19:22 - 01:11 UT) by Brozovic et al. (2024) were carried out at Sopot Astronomical Observatory (K90) in Serbia. For this purpose, a 0.35-meter (f/6.3) Meade LX200GPS Schmidt-Cassegrain telescope, equipped with a SBIG ST-10 XME CCD camera operating in 2×2 binning mode, was employed. No photometric filters were used. The integration time for individual CCD frames was 180 seconds to achieve satisfactory level of signal-to-noise ratio enabling the required photometric precision of 0.01 mag. or better for individual data points (Binzel, 2024). Aperture photometric reduction with multiple comparison stars of near solar color ($0.5 \leq B-V \leq 0.9$) was conducted using *MaxIm DL 6* software by Diffraction Limited. Internal calibration of comparison stars was done using the Carlsberg Meridian Catalog 15 (VizieR, 2024) Sloan r' magnitudes and converted to Cousins R-band magnitudes according to the transformation formula: $R = r' - 0.22$. Prior to photometric reductions, all the images were corrected using master dark and master flat field calibration frames. Time synchronization on the data collection computer was performed using Windows Network Time Protocol (NTP) server (time.windows.com).

A total of 95 photometrically usable image frames were acquired in the time interval between ~ 18:42 and ~ 23:50 UT on 2024 October 23. The photometric session termination was determined by the obstruction of the target by local objects on the descending horizon. The weather conditions during the observation time interval are characterized by mostly clear skies with only the occasional appearance of transient thin cirrus clouds. All the frames that were judged to be even slightly affected by weather conditions were removed from the data set.

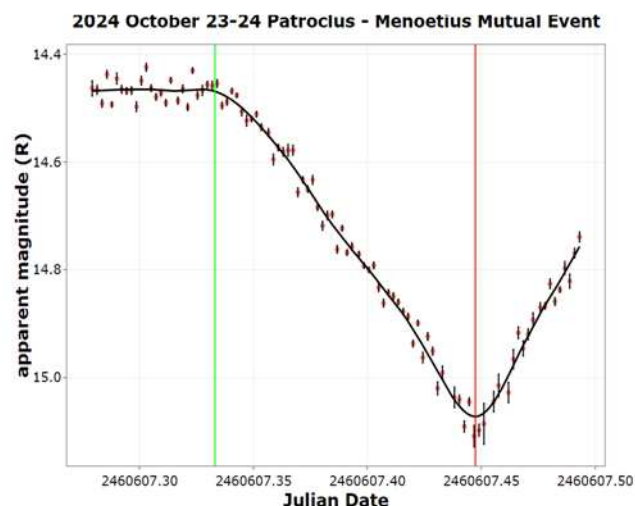
The obtained data have been uploaded to the Asteroid Lightcurve Data Exchange Format (ALCDEF) database (<https://alcdef.org/>).

The Resulting 2024 October 23-24 Mutual Event Lightcurve

Shown here is the resulting lightcurve constructed from the photometric data with no light-time corrections applied. A smooth cubic spline function with knots at each data point was fitted through the data in order to estimate as accurately as possible the moment of first contact and the maximum of mutual event time, as well as the total intensity drop in magnitudes. Mathematical and statistical procedures were performed in the *R programming language* (R Core Team, 2024) using the *Stats* and *Inflection* libraries for fitting the corresponding functions and finding the inflection points related to the characteristic times of the mutual event.

For the time of the first contact corresponding to the knee of the fitted function, the point of noticeable incurvation with respect to the flat lightcurve continuum (indicated by the green vertical line on the lightcurve plot), the following instant in Julian days was estimated: JD 2460607.33311, which rounded to one minute is: ~ 20:00 UTC, 2024 October 23). The minimum point of the fitted function, taken as the point of minimum light (red vertical line), corresponds to the time instant of JD 2460607.44742 (~ 22:44 UTC, 2024 October 23). The moment of the last contact is not covered by the data.

The maximum brightness (intensity) drop (Δm) is determined as the difference between the intensity of the fit minimum (minimum light) and the mean of the fit of the flat lightcurve continuum up to the first contact time. A value of $\Delta m = 0.61$ magnitudes is estimated for the maximum brightness drop.



Superior mutual event, with Menoetius in behind of its primary component Patroclus. Timings are Earth-centric; no light-time correction has been applied.

Acknowledgements

Observational work at Sopot Astronomical Observatory is generously supported by Gene Shoemaker NEO Grants awarded by the Planetary Society in 2018 and 2022.

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