

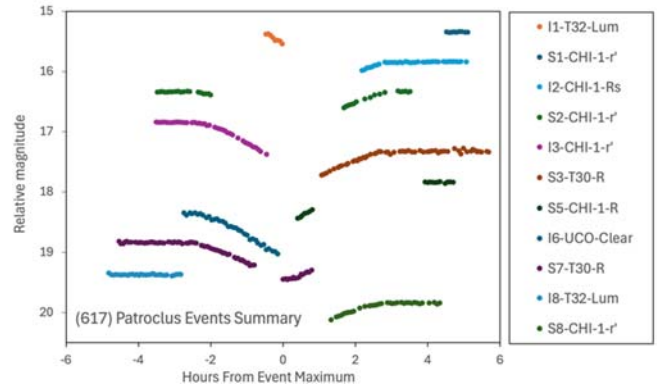
OBSERVATIONS OF (617) PATROCLUS MUTUAL EVENTS IN SUPPORT OF THE LUCY MISSION TO THE TROJAN ASTEROIDS

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We present lightcurves of mutual events of the L5 binary Trojan (617) Patroclus and its companion Menoetius during 2024 Sep-Oct. A total of nine events were observed using four telescopes, with two additional baseline observations.

NASA's Lucy Mission will explore Trojan asteroids in both the L4 and L5 camps in 2027-28 and 2033, respectively. The science goals include determinations of mass, volume, density and surface composition, as well as the search for rings and additional satellites (Levison et al., 2021). The hypothesis that any original Trojan objects have been lost during an early period of planet migration, and later capture of objects from the outer protoplanetary disk repopulated the Trojan swarms will be tested (Morbidelli et al., 2005; Nesvorný et al., 2013). (617) Patroclus and its satellite Menoetius form a binary of similar sizes that exhibit mutual events observable from Earth in two seasons per 12 yr orbital period. Precise orbital predictions for the locations of Patroclus and Menoetius are required for accurate pointing of the camera and other instruments of the Lucy spacecraft when it reaches the pair in March 2033, and our observations were performed in response to the call by Binzel (2024) to assist in this effort. Predicted start, maximum, and end times were made available by Brozović et al. (2024), who provided tables of 8 inferior and 8 superior events which occur in alternation about 2 days apart. For convenience, we have labeled these events I1, S1 through I8, S8 in Table I as well as in our lightcurve legends.

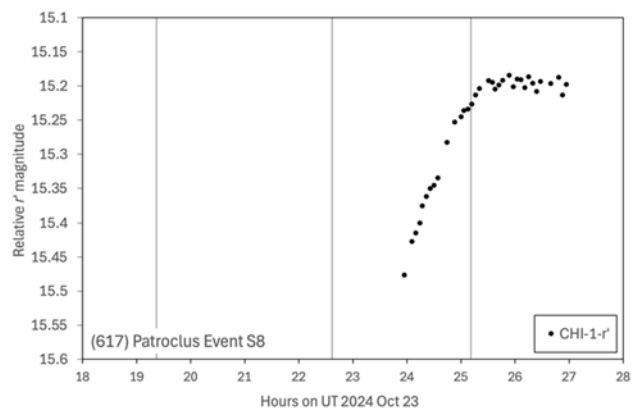
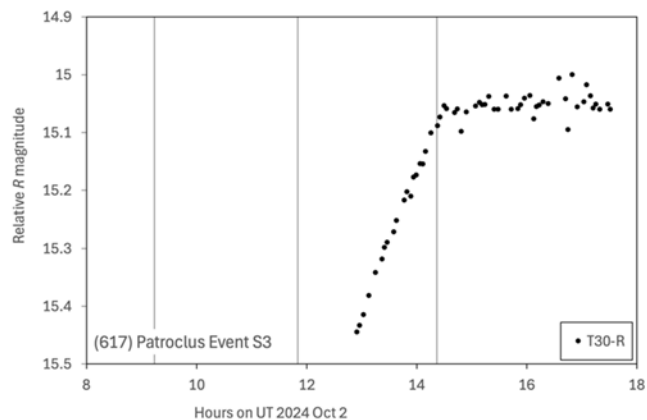
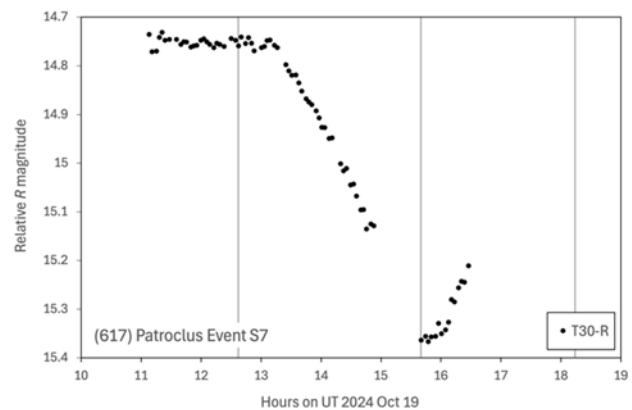
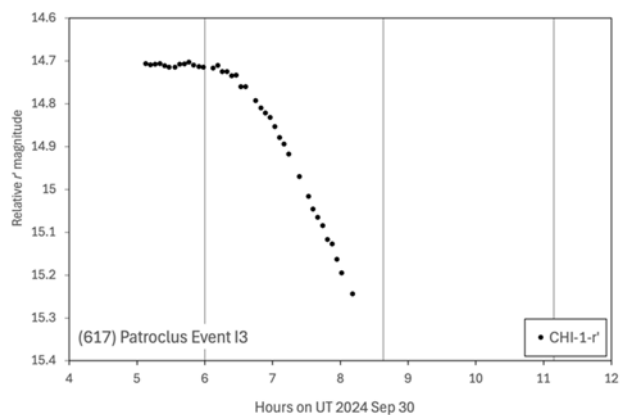
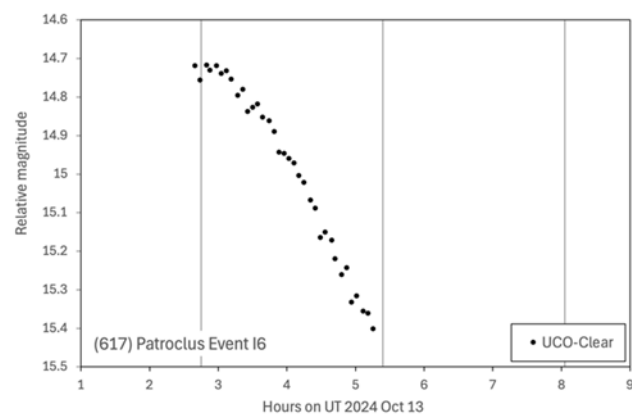
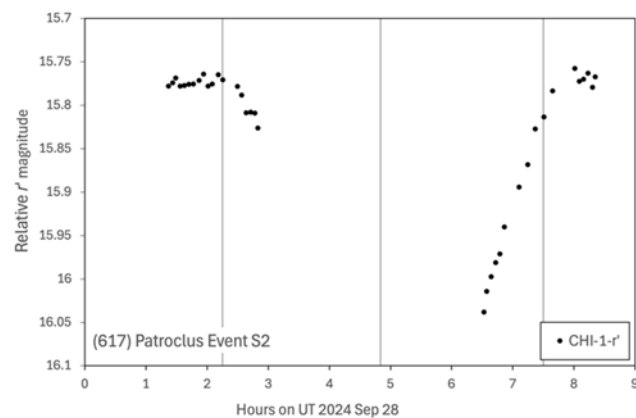
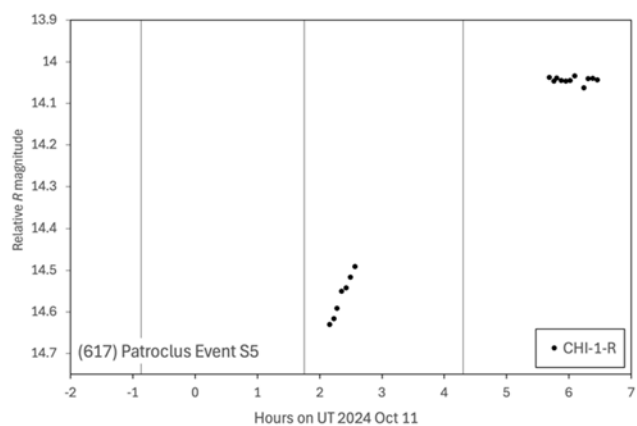
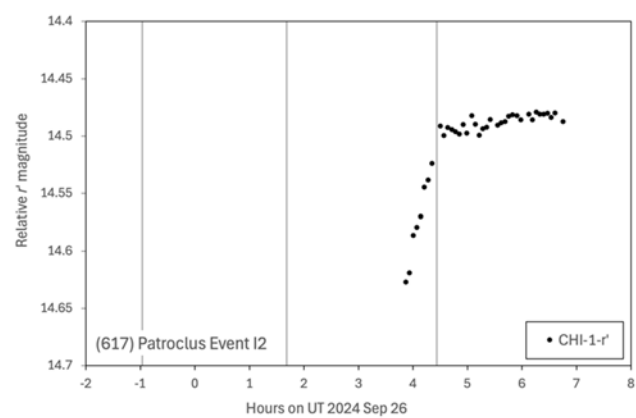


Observations were conducted at remote telescopes on two networks: iTelescope.net and Telescope.Live, as well as at the Union College Observatory. Telescopes and cameras are described in Table II. Filters and telescopes used for individual nights are given in the figure legends. All images were processed for bias, dark, and flat field corrections. We extracted photometric measurements from the images using *AstroImageJ* (Collins et al., 2017).

To visualize the overall coverage at the same time and magnitude scale, we have subtracted the predicted maximum event time for each observation and placed them in a summary figure, using arbitrary vertical offsets for visibility. The timing predictions of Brozović et al. (2024) were given in UTC (“Earth-centric”), so we have not applied any light-time corrections. All of our observations are partial due to clouds during reserved full observations. However, for event S2, a gapped full, we obtain an event duration of 5.36 h which exceeds the predicted duration by ~7 minutes. From event S7, an ingress+maximum, we obtain a depth of 0.586 mag. Further analysis of our results will be done in combination with additional observations contributed by other observers to obtain updated solutions for the system physical parameters to assist in Lucy Mission planning (Binzel, 2024).

Event	Start Date (UTC)	Start	Event Max	Stop	Events	Observation coverage
I1	2024 09 21	16:04	18:45	21:48	PO, PO+PE, PE	ITO
S1	2024 09 23	19:17	21:51	24:51	PO, PO+PE, TO, PO+PE, PE	Post-B
I2	2024 09 25	23:02	01:41	04:26	PO, PO+PE, PE	Egr
S2	2024 09 28	02:15	04:50	07:30	PO, PO+PE, TO, PO+PE, PO	Gapped-F
I3	2024 09 30	06:00	08:38	11:09	PO, PO+PE, AO+PE, PO+PE, PO	Ing
S3	2024 10 02	09:14	11:50	14:22	PO, PO+PE, TO, PO+PE, PO	Egr
I4	2024 10 04	12:58	15:30	18:07	PO, PO+PE, AO+PE, PO+PE, PO	-
S4	2024 10 06	16:12	18:48	21:20	PO, PO+PE, TO, PO+PE, PO	-
I5	2024 10 08	19:57	22:26	25:05	PO, PO+PE, AO+PE, PO+PE, PO	-
S5	2024 10 10	23:08	01:45	04:18	PE, PO+PE, TO, PO+PE, PO	ITO+B
I6	2024 10 13	02:45	05:24	08:03	PE, PO+PE, PO	Ing
S6	2024 10 15	05:52	08:42	11:16	PE, PO+PE, PO	-
I7	2024 10 17	09:29	12:22	15:01	PE, PO+PE, PO	-
S7	2024 10 19	12:37	15:40	18:14	PE, PO+PE, PO	Ing+Max
I8	2024 10 21	16:14	19:20	21:58	PE, PO+PE, PO	Pre-B
S8	2024 10 23	19:22	22:37	25:11	PE, PO+PE, PO	Egr

Table I. Mutual Events Season 2024. The first column indicates inferior (I) or superior (S) event and sequence number. Columns 3-5 give the predictions of Brozović et al. (2024). In column 6, possible events include: PO--Partial Occultation, PE--Partial Eclipse, PO+PE--Partial Occultation and Partial Eclipse with overlap, TO--Total Occultation, AO--Annular Occultation. Column 7 Observation Coverage includes B--Baseline, Ing--Ingress, Egr--Egress, F--Full, ITO--In Transit Only.



Name	Site	Telescope	Camera	Array	Filter	FOV (')	Scale ("/pix)
UCO	Schenectady, NY	0.50-m f/8.1	SBIG STXL-11002	2004×1336×9μm	<i>Clear</i>	30×20	0.93
T30	Coonabarabran, Aus	0.50-m f/6.8	ML16200	3072×2048×9μm	<i>R</i>	28×42	0.81
T32	Coonabarabran, Aus	0.43-m f/6.8	Moravian G4-16000	4096×4096×9μm	<i>Lum</i>	43×43	0.64
CHI-1	Rio Hurtado, Chile	0.61-m f/6.8	QHY 600M Pro	9576×6382×3.8μm	<i>r'</i>	31×21	0.395

Table II. Telescopes and Cameras. Filters: *R*: Cousins *R*; *r'*: Sloan *r'*; Lum: Luminance; Clear: Clear-uv block.

Acknowledgements

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