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## LIGHTCURVE ANALYSIS OF (415029) 2011 UL21

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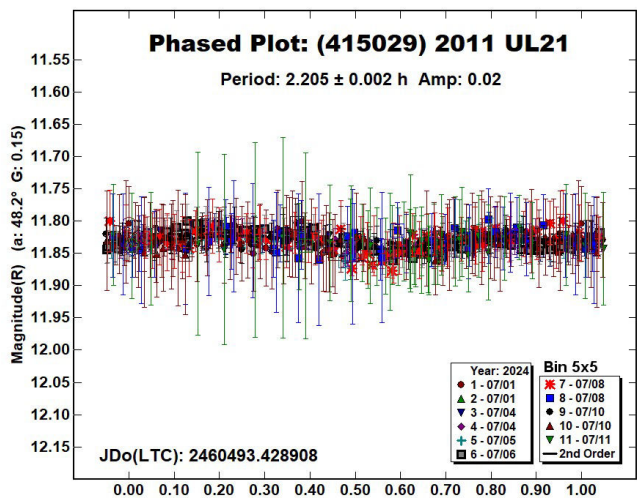
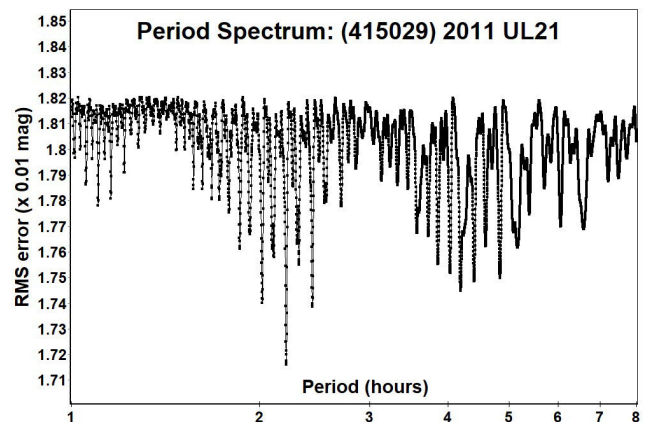
Collaborative photometric observations were carried out for the near-Earth asteroid (415029) 2011 UL21 by the Italian Amateur Astronomers Union group. We find a synodic rotation period of  $2.205 \pm 0.002$  hours, amplitude  $0.02 \pm 0.02$  magnitudes.

(415029) 2011 UL21 is an Apollo Near-Earth asteroid, classified as Potentially Hazardous Asteroid (PHA). Collaborative observations were made over seven nights, following its close approach to the Earth by the Italian Amateur Astronomers Union (UAI; 2024) group. Table I shows the observing circumstances and results, while Table II describe the used instrumentation.

Lightcurves analysis was done with *MPO Canopus* (Warner, 2023). All the images were calibrated with dark and flat frames and converted to standard magnitudes using solar colored field stars from CMC15 and ATLAS catalogues, distributed with *MPO Canopus*.

The low amplitude of the lightcurve in this apparition makes it difficult to determine the rotation period with certainty. The period spectrum shows a deeper solution with  $P = 2.205 \pm 0.002$  h and an amplitude  $A = 0.02 \pm 0.02$  mag. This solution differs from the previous periods found by Warner (2018a;  $1.562 \pm 0.001$ , 2018b;  $2.732 \pm 0.002$ , 2021;  $3.31 \pm 0.01$ ).

Goldstone (2024) radar observations place an upper bound of 2.5 h on the primary rotation period, which is in good agreement with our result. Furthermore, Goldstone imaging on June 27, 2024, revealed that (415029) 2011 UL21 is a binary system. However, no mutual events were observed in the lightcurves during our observation campaign; probably, the illumination geometry was not favorable for their observation.



## References

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Number	Name	2024 mm/dd	Phase	L <sub>PAB</sub>	B <sub>PAB</sub>	Period(h)	P.E.	Amp	A.E.	Grp
415029	2011 UL21	07/01-07/10	48.1, 42.4	265	19	2.205	0.002	0.02	0.02	NEA

Table I. Observing circumstances and results. The first line gives the results for the primary of a binary system. The second line gives the orbital period of the satellite and the maximum attenuation. 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. L<sub>PAB</sub> and B<sub>PAB</sub> 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).

Observatory (MPC code)	Telescope	CCD	Filter	#Sessions
Virgil Observatory (M60)	0.30-m NRT f/4.0	ASI 533 MM	C	3
Iota Scorpii (K78)	0.40-m RCT f/6.1	CMOS QHY 268	Rc	2
Osservatorio Astronomico Margherita Hack (A57)	0.35-m SCT f/8.3	SBIG ST10XME (bin 2×2)	Rc	2
HOB Astronomical Observatory (L63)	0.20-m SCT f/6.0	ATIK 383L+ (bin 2×2)	C	1
M57 (K38)	0.35-m RCT f/5.3	SBIG STT1603ME	Rc	1
Osservatorio Serafino Zani (130)	0.40-m RCT f/6.5	Moravian C4-16000 (bin 2×2)	C	1

Table II. Observing Instrumentations. NRT: Newtonian Reflector, RCT: Ritchey-Chretien, SCT: Schmidt-Cassegrain.

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