(24495) 2001 AV1 – A SUSPECTED VERY WIDE BINARY

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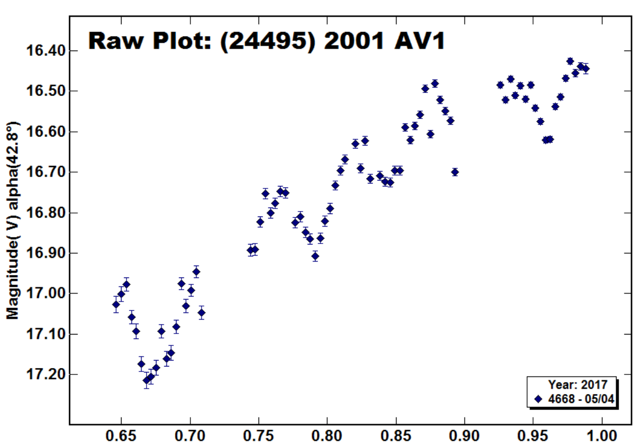
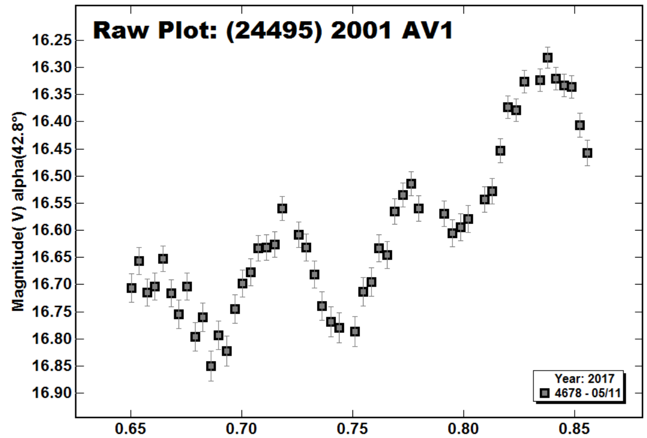
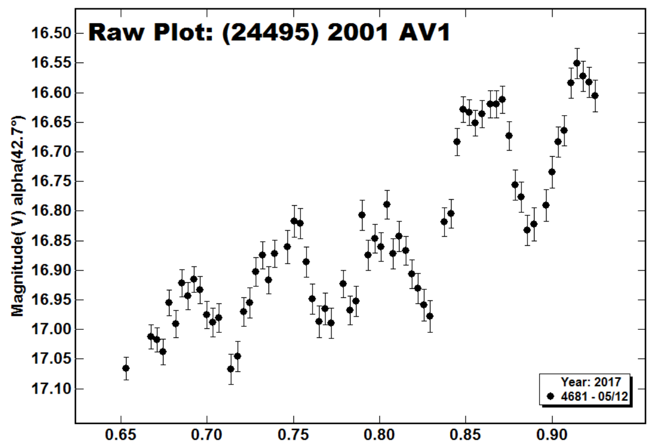
We report that asteroid (24495) 2001 AV1 is a binary asteroid. It is another candidate for the special case of very wide binaries. The primary lightcurve has a period of 24.083 ± 0.005 h and an amplitude 0.58 ± 0.05 mag. and the secondary lightcurve has a period of 2.7375 ± 0.0001 h.

The Mars crosser (24495) 2001 AV1 was initially observed by Stephens using a 0.40-m Schmidt-Cassegrain telescope with Finger Lakes ProLine ML-1001E CCD camera from the Center for Solar System Studies (U82) located in Landers California.

The analysis of the first few sessions showed the signature of another possible candidate for a special case of very wide binaries (see Jacobson *et al.*, 2014, Warner 2016). This is where the primary period belonging to the main body is long with a large amplitude and the secondary period is short with a low amplitude. For wide binaries, the chance of observing a *mutual event* (eclipse or occultation) would be very rare because of the long primary period. In the case of (24495) 2001 AV1, each of the first sessions showed a trend of brightening over the course of the night with a secondary frequency less than three hours superimposed on the upward trend.







From the angle of the slope of the ascension and the lack of a clear extrema in any session, it appeared the main dominant, primary period was close to a multiple of the Earth's rotation with the most likely period being near 48 h.

A call for observations were made to several observers located in Europe, about 110°-150° in longitude from the CS3 observatories in California. Aznar from his observatory in Valencia, Spain was able to observe the asteroid on several nights. Benishek observed the asteroid two nights overlapping Aznar's data. Table 1 gives the telescopes and CCD cameras used for observations. Exposures were unfiltered and ranged from 240 to 300 seconds. Table II gives the dates and session numbers in the lightcurves for each observer.

The raw images were flat-field and dark subtracted before being measured in *MPO Canopus*. Night-to-night linkage was aided by the Comp Star Selector utility which helps find near-solar color comparison stars, thus reducing color difference issues. Stars were chosen from the CMC-15 catalog (*http://svo2.cab.inta-csic.es/vocats/cmc15/*). Generally, needed zero points adjustments are within ±0.05 of one another, but larger adjustments can be required to minimize the RMS value from the Fourier analysis.

Observer	Telescope	Camera
Stephens	0.40m SCT	FLI Proline 1001E
Aznar	0.35m SCT	SBIG STL-1001E
Benishek	0.35m SCT	SBIG ST-8X ME

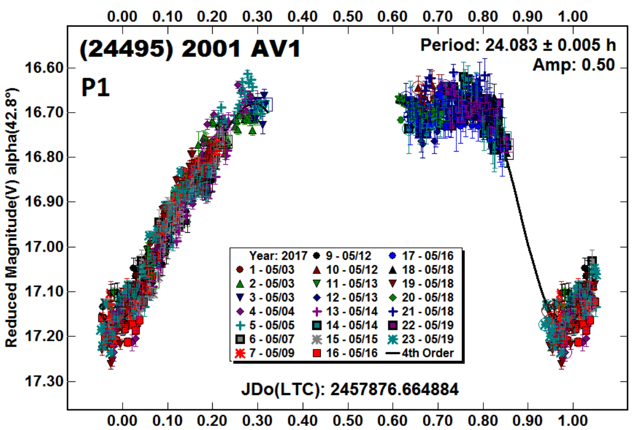
Table I. List of observers and equipment. SCT: Schmidt-Cassegrain.

Observer	Telescope	Sess
Stephens	0.40m SCT	1,2,3,4,5,6,7,8,9, 11,13,15,16,19,23
Aznar	0.35m SCT	10,12,14,17,18,21
Benishek	0.35m SCT	20,22

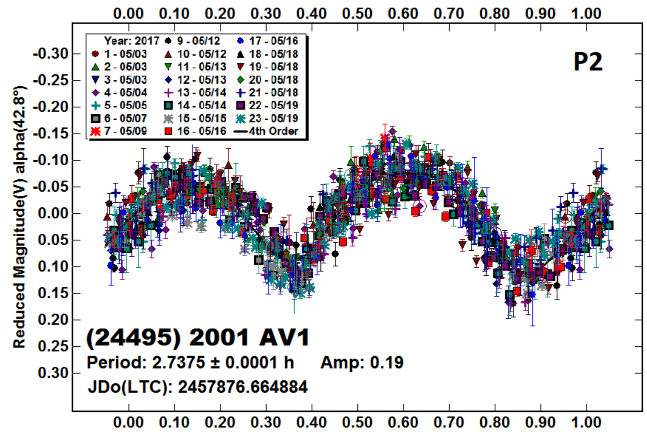
Table II. List of observation and session numbers in the lightcurves for each observer.

Period Analysis

Period analysis was done using *MPO Canopus*, which employs the FALC Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989). *MPO Canopus* can do a dual-period search process. The program first finds an initial value for the dominant (usually shorter) period. The Fourier model lightcurve is subtracted from the data set in the succeeding search for a second period. The Fourier curve for that second period is then subtracted from the data set in a new search for the dominant period. The iterative process continues until both periods stabilize and it produces reasonable lightcurves.



The dual period analysis found a primary lightcurve belonging to the main body of P_1 = 24.083 ± 0.005 h, A_1 = 0.50 ± 0.02 mag ("P1" plot). Assuming an equatorial view of the asteroid, this leads to an a/b ratio of the asteroid's silhouette of 1.6:1. As expected, subtracting this lightcurve from the data set and doing a period search found a solution that showed no *mutual events* (occultations and/or eclipses) due to a satellite ("P2" plot). The lightcurve has a period of P_2 = 2.7375 ± 0.0001 h, A_2 = 0.19 mag. In the case of a Very Wide Binary, the larger amplitude is assumed to be for the main body. "The amplitude of the longer period if it were due to the secondary with about a magnitude of "dilution" from the primary, it would have to have an unphysically great elongation plus being viewed almost exactly equatorially in order to produce the "diluted" amplitude that large. The inferred size ratio comes from the secondary having extracted almost all of the angular momentum of the primary spin but not quite escaping." (Harris *private communication*).



Conclusion

Because the primary period is so close to an Earth day, it was not possible to get a complete lightcurve for P1. This asteroid should be a prime target for follow up at its next opposition in January 2020 when the northern hemisphere nights will be much longer.

Acknowledgements

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