2207 ANTENOR: A SUSPECTED JOVIAN TROJAN BINARY

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We report that asteroid 2207 Antenor is a very likely binary asteroid candidate. If confirmed, it would be the fifth known binary Jovian Trojan asteroid. The primary lightcurve has a period of 7.96436 ± 0.00006 h and an amplitude 0.22 to 0.23 mag. A secondary orbital period could not be determined.

The Jovian Trojan 2207 Antenor was initially observed by Stephens on 2018 January 23 as part of an ongoing study of the Jovian Trojan family. Deviations from the lightcurve suggestive of mutual events from a binary system were quickly found. Help was sought from Aznar and Benishek who are at significantly different latitudes. Table I gives the telescopes and CCD cameras used for observations. Exposures were unfiltered and ranged from 240 to 300 seconds.

Observer	Telescope	Camera
Stephens	0.40m SCT	FLI Proline 1001E
Aznar	0.35m SCT	SBIG 10XME
Benishek	0.35m SCT	SBIG ST-8 XME
Kučáková, Kusnirak Hornoch	0.65m Reflector	MI G2-3200

Table I. Observers and equipment. SCT: Schmidt-Cassegrain.

Antenor has been observed several times in recent years, each time with a reported rotational period near 7.9645 h (Mottola et al., 2011; Stephens et al., 2016, 2017; Waszczak et al., 2015). The raw images were flat-field and dark subtracted before being measured. For the Stephens, Aznar and Benishek observations, night-to-night linkage was aided by the Comp Star Selector utility which helps find near solar-color comparison stars. Stars were chosen from the APASS (Henden et al., 2009) or CMC-15 catalog (*http://svo2.cab.inta-csic.es/vocats/cmc15/*), or the MPOSC3 catalog which is based on the 2MASS catalog (*http://www.ipac.caltech.edu/2mass*). Generally, needed zero points adjustments are within ±0.05 mag of one another, but larger adjustments can be required to minimize the RMS value from the Fourier analysis. The Kučáková, and Hornoch observations were calibrated in the Cousins R band.

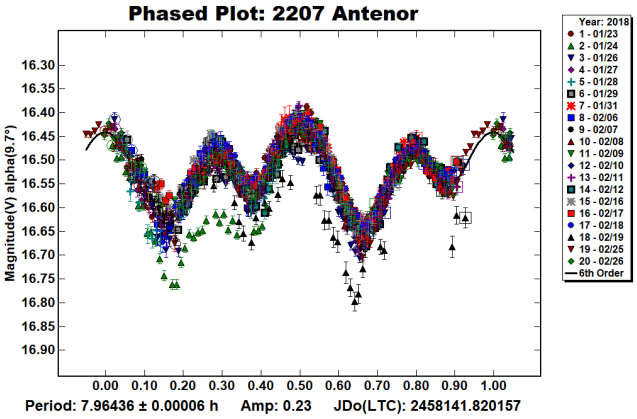

Figure 1. The raw lightcurve over the observing run between 2018 Jan 23 to Feb 26. During this period, Antenor passed from phase angle 10° to 5°. The first attenuation event was seen on 24 Jan 2018.

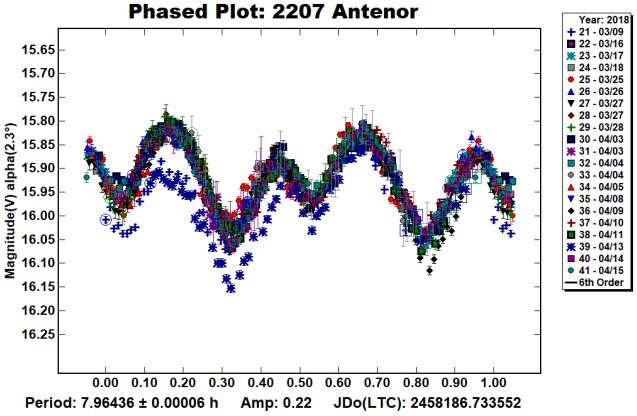

Figure 2. The raw lightcurve over the observing run between 2018 Mar 9 to 28. During this period, Antenor passed from phase angle 2° to 6°.

Number	Name	2018/mm/dd	Pts.	Phase	L_{PAB}	B_{PAB}	Period	P.E.	Amp	A.E.
2207	Antenor	01/23-05/22	3,041	10,1,11	179	2-3	7.96450	0.00007	0.19-0.24	0.02

Table II. Observing circumstances and results. Pts is the number of data points. Phase is the solar phase angle for the first and last date. If there are three values, the middle value is the minimum phase angle. L_{PAB} and B_{PAB} are, respectively, the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984).

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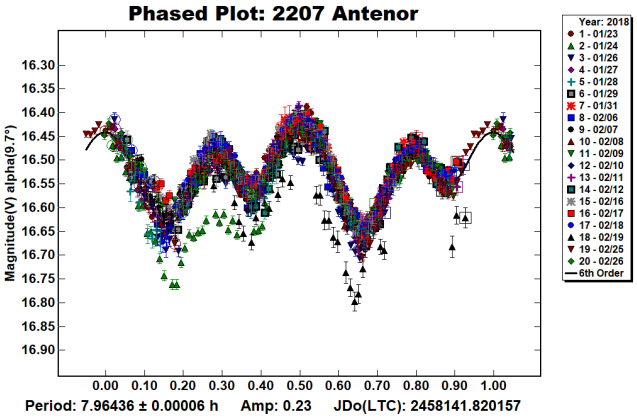

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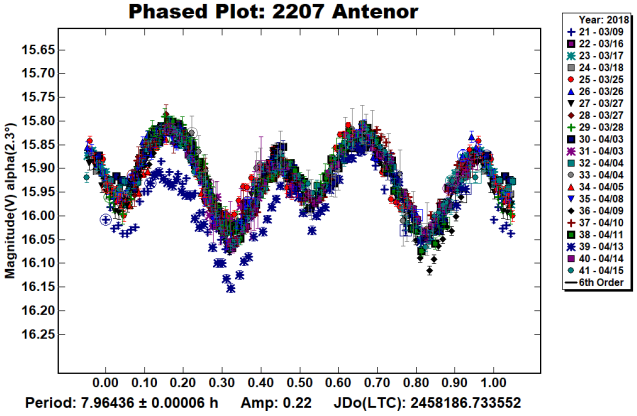

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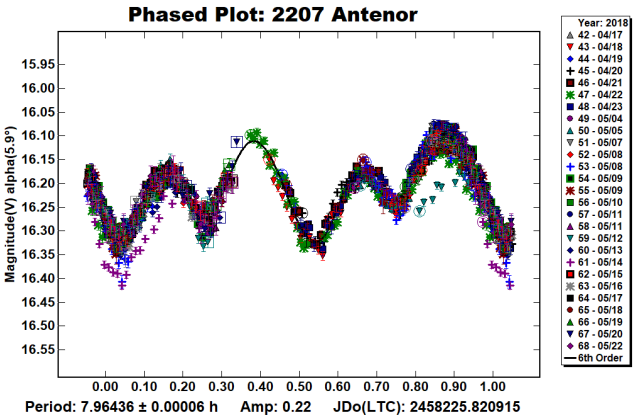

Figure 3. The raw lightcurve over the observing run between 2018 Apr 14 to May 22. During this period, Holt passed from phase angle 6° to 11°.

Period Analysis

All data were sent to Petr Pravec, whose software solves for the primary and secondary period simultaneously. The dual period analysis found a primary lightcurve of 7.96436 ± 0.00006 h (Figures 1, 2, and 3). The amplitude changed from 0.19 to 0.24 mag over the course of the observing run.

The mean H_R of the whole system (outside events) is 8.58 ± 0.04 was determined from the Ondřejov Cousins R Data assuming G = 0.12 ± 0.08, which is the mean G for CGBFPTD types (Warner et al., 2009). Since Antenor has been determined to be a D type, we get H = 9.04 ± 0.05 using the mean color index (V - R) = 0.455 ± 0.033 for D types (Pravec et al. 2012). Using Antenor's effective diameter of D_{eff} = 91 km, which is the mean of the three diameter estimates obtained by AKARI, SIMPS and WISE, we obtain and albedo of p_V = 0.052. The uncertainty is about ± 0.010, which is dominated by the uncertainty of D_{eff}, not H.

As many as five prominent events and a few shallower ones were observed. The orbital period is likely on the order of a few hundred hours, but we could not get all of the five events to line up with any secondary period. Either there are multiple satellites or some of the five prominent events might be spurious.

Antenor is a very strong binary candidate, but without having derived its orbital period, it is not a complete detection of a binary asteroid. Its binary status will be confirmed only when its orbital period can be resolved in the future.

Because of the unusual nature of this Trojan, and because there are only four other known Trojan binaries, Antenor should be a prime candidate for future observations. It will be well placed for observations from the Northern Hemisphere in 2019 and for the Southern Hemisphere in 2020 through 2022. With a relatively bright magnitude (V~16), it can be easily observed with small telescopes.

Acknowledgements

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