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41.

CCD PHOTOMETRY OF 523 ADA

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The asteroid 523 Ada was observed on 4 different nights in 1996 February and March. The best synodic period derived from all these observations is 9.800 ± 0.002 hours with an instrumental V magnitude amplitude of 0.65 -0.70.

523 Ada was discovered by R.S. Dugan in January 1924. It is a main-belt asteroid with a 2.966 AU orbital semi-major axis and a 0.178 eccentricity (Williams 1989). IRAS observations yield a diameter of 36.7 ± 1.3 km and an albedo of 0.18 ± 0.01 (Tedesco 1989). We chose to observe 523 Ada because it has no known lightcurve or period determination, and it was well placed for viewing during the observation period.

Observations of 523 Ada were made as part of a Department of Physics cadet research project at the U.S. Air Force Academy Observatory (latitude = $39^{\circ}00'24''$ N, longitude = $104^{\circ}53'30''$ W, altitude = 2233 meters). A Photometrics (PM512) CCD camera attached to a 61-cm Cassegrain telescope was used to take ten minute exposures of the asteroid through a standard Johnson V-band filter on each night. Table I lists the UT date, phase angle (α), Earth-Ada distance (D_{earth}), Sun-Ada distance (D_{sun}), and number of observations for each night.

All images were processed using NOAO's IRAF package. In each frame, the instrumental magnitude of Ada and at least three comparison stars were measured. Differential magnitudes between the comparison stars and Ada were scaled to a common magnitude offset by evaluating the differential magnitudes between the comparison stars. These differential

magnitudes were then combined using a weighted mean to the calculated magnitude error. Next, a rough calibration of the common magnitude offset for each night was determined by using the Hubble Guide Star Catalog magnitudes (Russell et al. 1990) of at least two of the comparison stars: 805:441 and 805:545 for February 16; 805:176 and 805:94 for February 22; 805:702, 805:716, 805:955, and 805:1182 for February 24; and, 808:908 and 808:1399 for March 22. Finally, these magnitudes were adjusted to common Earth-Ada and Sun-Ada distances (1 AU for both). To ensure that no variable star had been selected as a comparison star and that there were no photometric problems caused by cosmic rays, the differential magnitudes between comparison stars were also examined carefully. The scatter observed in these differential magnitudes were consistent with the calculated magnitude errors.

The synodic period of 523 Ada was calculated for all pairs of nights (except Feb 16 with Feb 22 because there was no overlap in the phases covered during those nights). We adjusted all times to account for the changing light travel time between Ada

and Earth from night to night. The lightcurves were matched up vertically by setting a magnitude offset (due to systematic errors in the GSC magnitudes and phase effects), and then finally matched up horizontally by adjusting the synodic period. The error associated with each synodic period corresponds to the acceptable range of periods determined by visually examining the composite lightcurve. Assuming that Ada has a lightcurve with two equally spaced minima and maxima, the night of Feb 24 considered alone yields a synodic period of approximately 9.3 hours. With this and in consideration of the synodic period calculated between Feb 22 and Feb 24, the only viable synodic period is close to 9.85 ± 0.05 hours. Using all nights, the best synodic period was calculated to be 9.800 ± 0.002 hours. The composite lightcurve using this period (instrumental magnitudes scaled to Feb 16) is shown in Figure 1.

References

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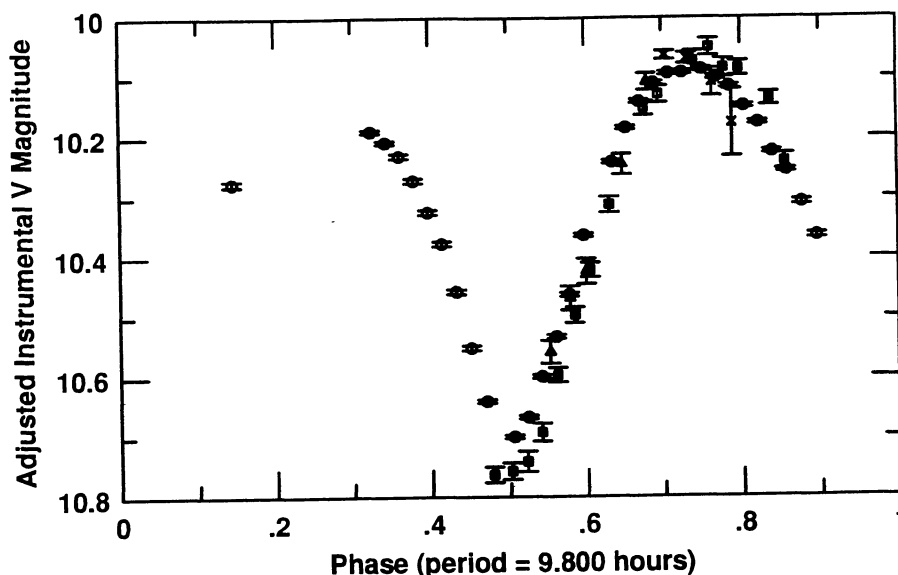


Figure 1. Composite lightcurve for 523 Ada based on 9.800 hour synodic period. 96 Feb 16 - triangles, 96 Feb 22 - x's, 96 Feb 24 - circles, 96 Mar 22 - squares. Zero phase = UT 96 Feb 15, 20:35:40. Lightcurve corrected for light travel time.

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Table I. Observation Circumstances

UT Date	α (deg)	D _{earth}	D _{sun}	#exps
96 Feb 16	17.6	1.593	2.549	5
96 Feb 22	24.7	1.629	2.557	4
96 Feb 24	27.1	1.643	2.560	31
96 Mar 22	55.5	1.907	2.600	16

THE LIGHTCURVE AND PERIOD OF THE MINOR PLANET 193 AMBROSIA

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The minor planet 193 Ambrosia is found to have a photometric rotation period of 0.27420 ± 0.00025 days (6.5807 ± 0.006 hours) and an amplitude in the Kron-Cousins I-band of 0.532 ± 0.013 mag.

The minor planet 193 Ambrosia was selected for photometry after inspection of the list of photometric opportunities in Harris and Zappalà (1995). A total of 592 CCD images were obtained using a Kron-Cousins I-band filter and a Thomson CSF 1024x1024 front-illuminated CCD camera system. The telescope employed was the 0.61-m U.S. Naval Observatory Cassegrain located in Washington, DC.

Very little basic information is known about Ambrosia. Tedesco (1989) gives only the IAU magnitude coefficients which are $H = 9.80$ and $G = 0.014$.

Our photometry was performed on flat-fielded images using the synthetic aperture photometry method of DAOPHOT, Stetson (1987). Nightly differential lightcurves were produced with respect to an ensemble of bright unsaturated stars in the CCD's 8 arc minute field-of-view to reduce random errors in the photometry. All observation times were reduced to the Heliocentric Julian Date of the phenomena (HJD). See Table I for the observing log.

The period determination was done using the phase-dispersion-minimization technique, Stellingwerf (1978). Plots of phase versus normalized magnitude for all the indicated possible periods found in the periodogram were generated and compared. The only possible correct period of those indicated is

the 0.27420 ± 0.00025 day (6.5807 ± 0.006 hours) period.

The I-band lightcurve indicates a peak-to-peak amplitude of 0.532 ± 0.013 mag. The estimated scatter of a single point was 0.009 mag. No points were filtered as outliers. See figure 1 for the lightcurve.

References

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Table I. The 1995 observing log for 193 Ambrosia.

HJD - 2450000.0	Exposure (Seconds)	Phase Angle	Number of Images
63.4536 - 63.6241	90	14.5	150
68.4480 - 68.5849	60	15.8	164
69.4457 - 69.5885	60	16.1	177
107.4966 - 107.6166	90	27.1	101

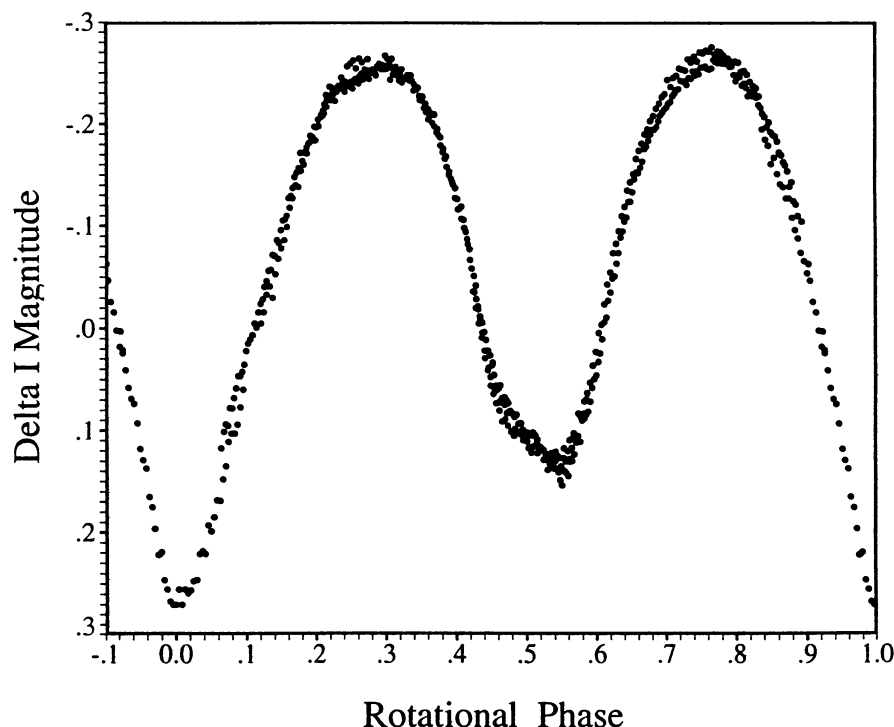


Figure 1. The instrumental I-band photometry rotational variation of 193 Ambrosia phase-folded using the period of 0.27420 days (6.5807 hours).