

PHOTOMETRIC OBSERVATIONS OF (68347) 2001 KB67, (494999) 2010 JU39, AND (455432) 2003 RP8

Steven D. Newcomb
Dept. of Space Studies
University of North Dakota
Grand Forks, ND 58202
steven.newcomb@und.edu

Sherry K. Fieber-Beyer
Dept. of Space Studies
University of North Dakota
Grand Forks, ND 58202

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CCD Photometric observations were obtained of (68347) 2001 KB67, (494999) 2010 JU39, and (455432) 2003 RP8 between June 2018 and August 2019. The rotation rates determined for (68347) 2001 KB67 and (455432) 2003 RP8 were similar to those found in previous research, but the period for (494999) 2010 JU39 differs from previously published results.

Observations

Observations of three near-Earth asteroids were obtained using the University of North Dakota's Space Studies Observatory, located near Emerado, ND. This facility features three telescopes, which are remotely accessible to offsite users. Onsite telescope operators are present to handle hardware and software needs as they arise, and to take flat field images for all remote observers.

The photometric data were obtained using a 16-inch Meade LX200R telescope that is coupled with an Apogee U9000 CCD camera. The observations were conducted over the summers of 2018 and 2019. The data for asteroid 68347 (2001 KB67) were collected on 3, 4 & 6 June 2018. The data for asteroid (494999) 2010 JU39 were obtained on 25 & 26 June 2019. The data for asteroid (455432) 2003 RP8 were obtained 29 & 30 July and 2 August 2019.

The exposure times varied for each asteroid due to their apparent magnitudes. For example, the integration times for (68347) 2001 KB67 were at 120 seconds with a 180 second pause in between each exposure. The integration times for (494999) 2010 JU39 were 100 seconds with a 180 second pause, and the integration times for (455432) 2003 RP8 were 60 seconds with a 180 second pause. All of the images were obtained using a broadband R-filter.

On each night, dark and flat frame calibration images were obtained. The dark frames were taken at the same exposure length and CCD temperature as the science images for each asteroid. The flat frames were obtained by the onsite telescope operators and were taken at either dusk or dawn depending on the sky circumstances.

The data were calibrated (dark- and flat-frame corrected) using *AstrolImage J* version 3.2.0. Data that were of poor quality were excluded from further analysis (weather deterioration, saturation, poor counts, etc.). Differential photometry and asteroid period determination utilized *MPO Canopus* version 10.7.11.1. The calibrated data were imported into *Canopus* for analysis. Because each of the asteroids moved rapidly, the background stars shifted throughout each night of observation. Therefore, during analysis we grouped images that shared comparison stars into individual sessions resulting in the use of multiple sessions for each when determining each period solution.

We utilized the standard circular aperture in *Canopus* for photon and background counts. In particular, we used an 11/11/2/11 aperture size to analyze (68347) 2001 KB67. For (494999) 2010 JU39 and (455432) 2003 RP8, we used the default aperture settings of 13/13/2/11.

Results

MPO Canopus corrected for the time it takes the light to travel from each of the asteroids to the Earth for their respective nights of observation. We plotted lightcurves for each night's usable data. A single lightcurve for each of the asteroids was produced, and then least squares fit with a Fourier series.

(68347) 2001 KB67 is a near-Earth Aten-class object, which is also designated as a potentially hazardous asteroid (PHA). It was observed on 3, 4 & 6 June 2018. Its period was determined using a 3rd order harmonic: 6.3500 ± 0.0446 hours with an amplitude of 0.24 ± 0.02 mag. See Figure 1. This was similar to the period of 6.354 ± 0.004 hours reported by Warner (2018), and the period of 6.357 ± 0.0012 hours found by Loera-Gonzalez et al. (2019).

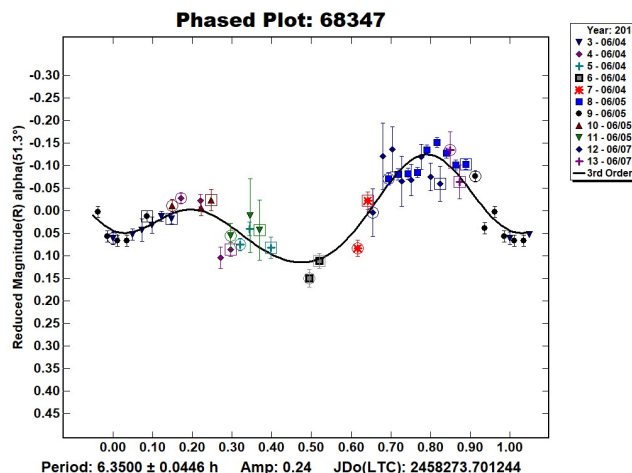


Figure 1. Lightcurve for (68347) 2001 KB67 showing a period of 6.3500 ± 0.0446 hours with an amplitude of 0.24 ± 0.02 mag.

Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.
68347	2001 KB67	2018 06/03-06/07	54.9,46.0	255	27	6.350	0.045	0.24	0.02
494999	2010 JU39	2019 06/25-06/26	41.6,41.0	294	26	2.278	0.016	0.13	0.01
455432	2003 RP8	2019 07/29-08/02	19.7,36.4	299	15	4.200	0.015	0.30	0.02

Table 1. Observing circumstances and results. 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_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984).

(494999) 2010 JU39 is an Aten class near-Earth Asteroid that is also designated as a PHA. It was observed on 25 & 26 June 2019. Its period was derived using a 3rd order harmonic: 2.2782 ± 0.0161 hours with an amplitude of 0.13 ± 0.01 . See Figure 2. This value differs from 30.2 ± 0.1 hours reported by Warner & Stephens (2019), which itself was based on a half-period of 15.11 ± 0.04 hours.

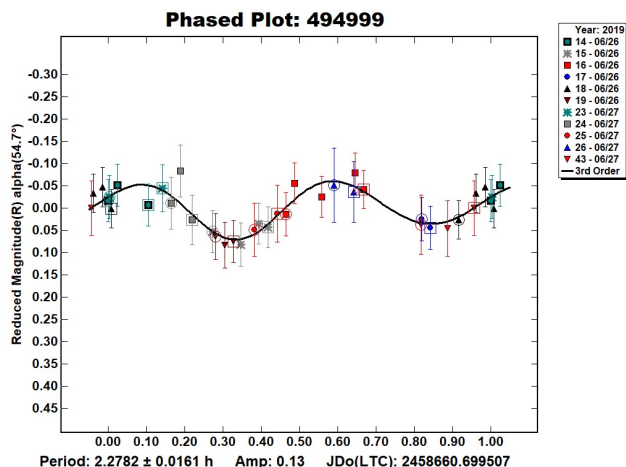


Figure 2. Lightcurve for (494999) 2010 JU39 showing a period of 2.2782 ± 0.0161 hours with an amplitude of 0.13 ± 0.01 mag.

(455432) 2003 RP8 is a near-Earth Amor asteroid that was observed on 29 & 30 July 2019, and 2 August 2019. Its period was derived using a 3rd order harmonic: 4.2000 ± 0.0149 hours with an amplitude of $0.30 \pm .02$ mag. See Figure 3. This value is similar to the 4.2736 ± 0.0007 -hour period reported by Warner & Stephens (2020).

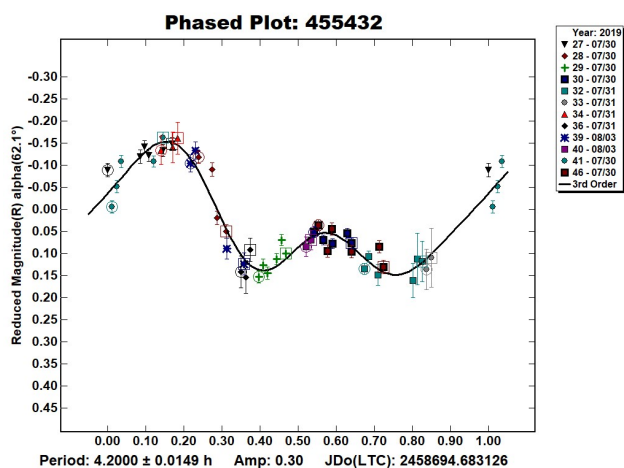


Figure 3. Lightcurve for (455432) 2003 KP8 showing a period of 4.2000 ± 0.0149 hours with an amplitude of $0.30 \pm .02$ mag.

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