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# Lightcurve analysis for 25 candidates to near-Earth binary asteroids

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## Abstract

Photometric data for about 100 near-Earth asteroids (NEAs) were obtained between 2012 and 2019 with the 1-m telescope of Observatório Astronômico do Sertão de Itaparica (OASI). The rotational periods have been determined using a Fourier series analysis and to investigate binary periods we have been used the "Dual Period Search" tool in MPO Canopus software. We have found 25 NEAs with rotational periods concentrating between 2.2 to 2.9 hours and with lightcurve amplitudes between 0.08 and 0.3 mag, of which two are confirmed binaries. In this work, we analyze the lightcurves of these 25 asteroids and we found signs of mutual events or a second period for some them. Then, we derived the primary's rotational period for them and estimated the orbital period and the mean proportion of diameters of components for some of them.

## 1. Introduction

The population of near-Earth asteroids (NEAs) is comprised of small bodies whose orbits have perihelion distances (q) less than 1.3 AU and aphelion distances (Q) large than 0.983 AU. It is estimated that about 15% of the NEAs population large than 0.3 km are to be binaries, while other 15% can be contact binaries with two bodies in contact [2]. Most of the NEAs binaries are asynchronous systems with the primaries having spherical shapes and faster rotations than the orbital period of the secondaries. These systems are important because they provide the means to understand the internal structure of asteroids and, consequently, the mechanisms of formation of them. Besides, bulk densities can be derived from the estimated parameters using Kepler's third law.

## 2 Observations and data reduction

CCD Photometric observations of 100 NEAs were acquired at the Observatório Astronômico do Sertão de Itaparica (code Y28, OASI - Nova Itacuruba) of the IMPACTON project between March 2012 and February 2019. All images were obtained with the 1.0-m f/8 telescope (Astro Optik, Germany) using an R filter. We used a 2048 $\times$ 2048 Apogee Alta U42 CCD camera which provides a field in the focal plane of 11.8 $\times$ 11.8 and an image scale of 0.343 arcsec/pix. Data reduction was performed using the MaxIm DL software following the standard procedures of flat-field correction and sky subtraction. Relative magnitudes were computed to obtain the lightcurves and derive the rotational period of the NEAs. The rotation periods were found using a Fourier series analysis [1] and to investigate binary periods we used the "Dual Period Search" tool in MPO Canopus software which is based in method descript by Pravec and collaborators [3].

## 3 Results

The rotational periods for 25 NEAs were obtained and are presented in Table 1 along with the lightcurve amplitudes, reliability code for the periods determined and the subgroups of each observed asteroid. The lightcurves these NEAs have been analyzed to search signs of binarity and realize the physical characterization. The rotational periods determined are concentrate between 2.2 to 2.9 hours and with lightcurve amplitudes between 0.08 and 0.3 mag. Some possible binaries identified were (7888) 1993 UC, (243566) 1995 SA and 2015 FS332.

For exemple, the binary nature of the (243566) 1995 SA asteroid has not yet been proven, but we have found evidence that this object is a possible binary. It was observed for only 3 nights, during 2014-07-22 to

07-25. We determined a rotational period of 2.3136 ± 0.0005 h and a lightcurve amplitude of 0.16 ± 0.02 mag, suggesting a nearly spheroidal shape of the primary (Figure 1 top). We found what could be a mutual event in binary system on 2014-07-25. The orbital period of the secondary couldn't be determined due to few data acquired and so, only an estimate was determined (Figure 1 bottom).

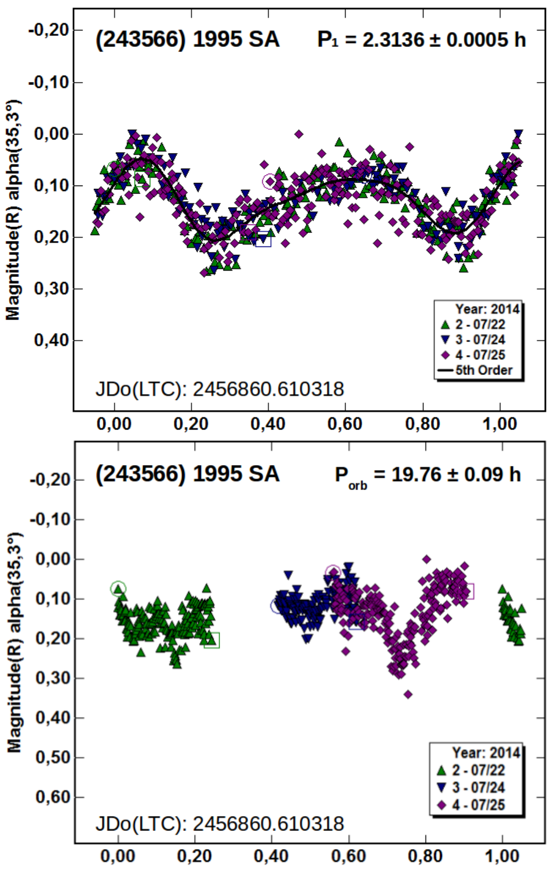


Figure 1: Lightcurves of (243566) 1995 SA. Top: The primary lightcurve component with period of 2.3136 ± 0.0005 h. Bottom: The long-period component showing the mutual event with the primary lightcurve component subtracted.

## 4. Conclusions

In this work, we analyzed the photometric data of 25 NEAs. We determined the rotational periods for them and we investigated the binary nature of these asteroids. For some of them, we identified signs of binarity by the presence of mutual events, and for others,

Table 1: Sample of investigated NEAs.

| Number | Name | Period (hr) | Amplitude (mag) | C Code | Group |
|---|---|---|---|---|---|
| 3352 | McAuliffe | 2.205 ± 0.005 | 0.16 ± 0.01 | 3 | Amor |
| 6456 | Golombek | 2.5013 ± 0.0001 | 0.14 ± 0.01 | 3 | Amor |
| 7888 | 1993 UC | 2.337 ± 0.001 | 0.12 ± 0.01 | 3 | Apollo |
| 12538 | 1998 OH | 2.578 ± 0.002 | 0.15 ± 0.01 | 3 | Apollo |
| 18736 | 1998 NU | 2.475 ± 0.001 | 0.15 ± 0.01 | 3 | Amor |
| 31221 | 1998 BP26 | 2.444 ± 0.002 | 0.14 ± 0.02 | 2 | Amor |
| 31345 | 1998 PG | 2.516 ± 0.002 | 0.14 ± 0.02 | 3 | Amor |
| 85628 | 1998 KV2 | 2.83 ± 0.02 | 0.13 ± 0.03 | 2 | Amor |
| 87684 | 2000 SY2 | 2.808 ± 0.002 | 0.41 ± 0.02 | 2 | Aten |
| 99799 | 2002 LJ3 | 2.684 ± 0.001 | 0.24 ± 0.01 | 2 | Amor |
| 138846 | 2000 VJ61 | 2.822 ± 0.001 | 0.30 ± 0.02 | 2 | Apollo |
| 153957 | 2002 AB29 | 2.442 ± 0.003 | 0.28 ± 0.02 | 3 | Apollo |
| 243566 | 1995 SA | 2.313 ± 0.003 | 0.16 ± 0.02 | 3 | Apollo |
| 251346 | 2007 SJ | 2.719 ± 0.002 | 0.15 ± 0.02 | 3 | Apollo |
| 276397 | 2002 XA40 | 2.43 ± 0.02 | 0.12 ± 0.02 | 2 | Amor |
| 315098 | 2007 EX | 2.447 ± 0.003 | 0.20 ± 0.02 | 3 | Aten |
| 348400 | 2005 JF21 | 2.4181 ± 0.0005 | 0.11 ± 0.01 | 3 | Amor |
| 430544 | 2002 GM2 | 2.635 ± 0.005 | 0.34 ± 0.01 | 2 | Apollo |
| 442243 | 2011 MD11 | 2.427 ± 0.001 | 0.15 ± 0.01 | 3 | Amor |
| 480004 | 2014 KD91 | 2.837 ± 0.001 | 0.17 ± 0.02 | 3 | Amor |
| | 2005 TF | 2.7122 ± 0.0007 | 0.17 ± 0.02 | 3 | Amor |
| | 2015 CA1 | 2.949 ± 0.002 | 0.49 ± 0.02 | 3 | Amor |
| | 2015 FS332 | 2.401 ± 0.002 | 0.49 ± 0.02 | 3 | Apollo |
| | 2016 HL | 2.930 ± 0.002 | 0.15 ± 0.02 | 2 | Apollo |
| | 2016 WJ1 | 2.944 ± 0.002 | 0.08 ± 0.02 | 2 | Apollo |

we found a second period that can be referred to secondary's rotational period. Therefore, these possible binary asteroids need to be confirmed with more observations in the future and thus realize a better physical characterization of them.

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## References


[1] Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., Zeigler, K.: Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863. Icarus, 77, 171-186, 1989.

[2] Margot, J.-L., Pravec, P., Taylor, P., Carry, B., Jacobson, S.: Asteroid Systems: Binaries, Triples, and Pairs. Asteroids IV, 355-374, 2015.

[3] Pravec, P., Scheirich, P., Kusnirák, P., Sarounová, L., Mottola, S., Hahn, G., Brown, P., et al.: Photometric survey of binary near-Earth asteroids. Icarus, 181, 63-93, 2006.