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CCD photometry of Mars crosser asteroids using small robotic telescopes

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Abstract

We present preliminary results of a photometric program aimed to study the rotational properties of the population of Mars-crosser asteroids by means of CCD photometry. We use a set of small robotic telescopes located in the Teide Observatory (Tenerife, Spain) and the Isaac Aznar Observatory (Alcublas, Spain).

A total of 54 Mars Crossers were observed at the moment of writing this abstract. For 51 of them we were able to obtain complete light-curves and accurately derive their rotation period. We also observed 7 near-Earth asteroids and several main belt asteroids that appear in the images of the MCs.

1. Introduction

Mars-crosser (MC) are those asteroids which orbits cross the orbit of Mars but that have perihelion distances $q > 1.3$ AU. They are object in unstable orbits located between the Main Belt and the near-Earth asteroids (NEAs).

Of the more than 13,500 MC known to date, only 331 (less than 2.3%) have well determined rotation period.

Since November 2018 we started a rutinary photometric program using three dedicated robotic telescopes at Teide Observatory with the objective of obtaining light-curves of MCs up to apparent magnitude V=18. We aim to study the rotational properties of the MC population by determining the rotation period of the largest possible number of MCs and deriving information about their shape, e.g. the ratio of sizes between axes *a* / *b*.

2. Observations

Time-series CCD imaging of MCs and NEA asteroids have been obtained, using two 46cm f/D=2.8 (TAR1 and TAR2) and a 40cm f/D10 (TAR3) robotic telescopes at the Teide Observatory (TO, Tenerife, Canary Islands, Spain). Both 46cm telescopes were equipped with a SBIG ST11000 camera, while the 40 cm one has a FLI MicroLine with a E2V CCD47-10. We also used the 35cm f/D=10 equipped with a SBIG STL 1001e CCD of the Isaac Aznar Observatory (IAO, Alcublas, Spain) Images are obtained without filter and typically 60s exposure time is used.

Images are bias and dark subtracted and flat fielded using sky-flats. Aperture photometry is obtained using MPO-CANOPUS. Catalog magnitudes has been obtained from the CMC-15, the APASS or the MPOSC3 catalog, depending on comparison star availability.

3. Results

A total of 54 MCs have been observed, 39 using the telescopes at TO and 15 with that at the IAO. The rotation period of 51 MCs has been derived using the Fourier analysis routines included in MPO-CANOPUS. The phased rotational light-curve of two MCs is shown in Fig. 2 and 3.

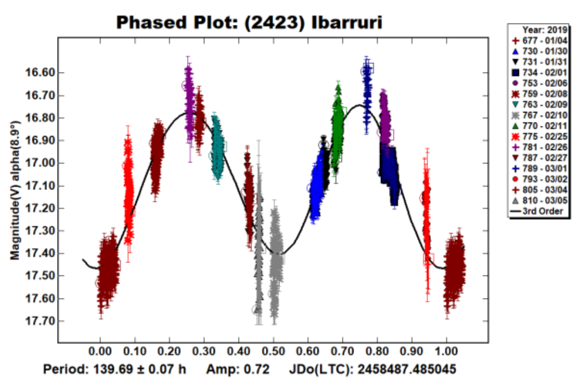

Figure 1: The phased rotational light-curve of MC (2423) Ibarruri based on CCD photometry obtained during 16 nights with the TO telescopes.

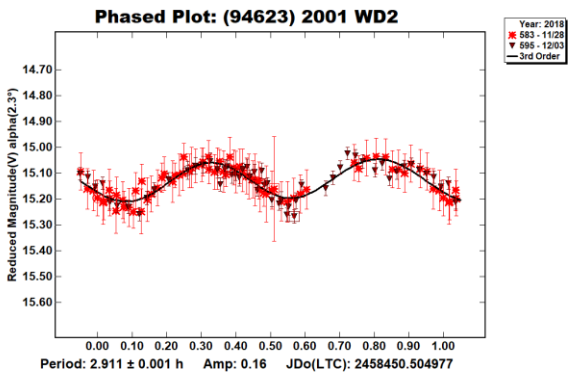

Figure 1: The phased rotational light-curve of MC (94623) 2001 WD2 based on CCD photometry obtained in two different nights with one of the TO robotic telescopes.

The obtained rotation periods of the sample of MC asteroids cover a range between 2.55 and 139.69 hr with a range of absolute magnitudes 11.8 < *H* < 17.3 To illustrate the contribution of our program to the knowledge of the MC rotational properties we present in Fig. 3 the obtained rotation period of our sample of objects vs. their absolute magnitude (*H*) compared to the rotation periods known of the whole MC population.

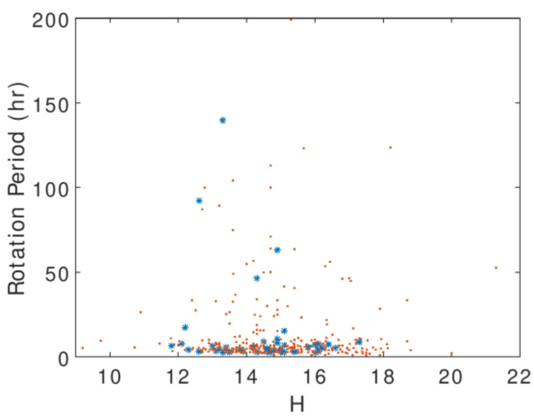

Figure 3: The rotation period vs. absolute magnitude (H) of the observed sample of MC asteroids (blue asterisks) and all the MC population (red points)

4. Summary and Conclusions

We obtained the rotation periods 51 MC asteroids covering a range between 2.55 and 139.69 hr and a range of absolute magnitudes 11.8 < *H* < 17.3

Long term observations using the small robotic telescopes at TO demonstrated to be a very nice tool to study the rotation period of asteroids up to V=18. This work is filling the gap in the photometric surveys of MC asteroids with 16 < *V* <18. Future observations of these targets in different oppositions will allow also to study their shape and pole position.

In particular, a dedicated program using this system allow us to study very slow rotators, determine their rotation period and the amplitude of their light-curves. That's the case e.g. of (2423) Ibarruri (see Fig. 1), with a rotation period of 139.69 hr.

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