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The Mexican Asteroid Photometry Campaigns: Aiming for Asteroids' Rotation Periods

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Abstract. Thousands of new asteroids are discovered every year and the rate of discovery is by far larger than the determination rate of their physical properties. In 2015 a group of researchers and students of several Mexican institutions have established an observational program to study asteroids photometrically. The program, named Mexican Asteroid Photometry Campaign, is aiming to derive rotation periods of asteroids based on optical photometric observations. Since then four campaigns have been carried out. The results obtained throughout these campaigns, as well as future work, are presented.

1. Overview

Currently, more than 760,000 asteroids are known and every year thousands of new ones are discovered. Nevertheless, most of their physical parameters: size, shape, albedo, rotation, taxonomical classification, etc. are unknown. Thus, we need to make a greater effort to increase our knowledge about these objects. Some asteroid properties, such as their rotation period, can be derived from their lightcurve. However, according to the Asteroid Lightcurve Photometry Database (ALCDEF), only a few thousand (∼6000) asteroids have reliable rotation periods. These periods are important because they are related to the cohesion strength of the material from which an asteroid has been made. Figure 1 shows the relation between the asteroid rotation frequency and its size. We can see that fast rotators have sizes smaller than ∼300 m. In addition, 3D asteroid shapes can be inferred from lightcurves obtained at different epochs, since objects are observed from different viewing angles.

In order to contribute to asteroid characterization, in 2015 a group of researchers and students of several Mexican institutions, have established an observational program to study asteroids photometrically. The program, named Mexican Asteroid Photometry

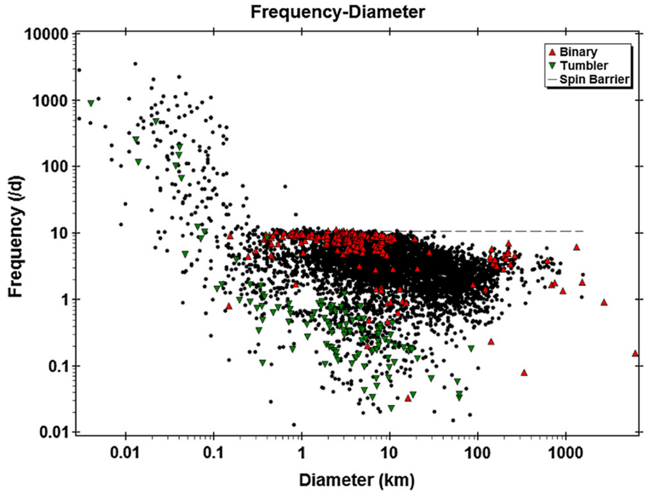

Figure 1. Relation between the asteroid rotation frequency and its size. Figure taken from the ALCDEF web site.

Campaign (CMFA, from the Spanish), is aiming to derive rotation periods of asteroids based on optical photometric observations. This program has been established at an introductory stage to generate the abilities and basic knowledge related to asteroids, allowing us to carry out broader and deeper studies in the near future. The first campaign started during the second half of 2015. Since then, three campaigns have been completed and the fourth is ongoing.

2. Observations, data reduction, analysis and results

The observatories and telescopes involved in the campaigns are the following: i) 0.84-m telescope at the Observatorio Astronómico Nacional at Sierra San Pedro Mártir (OAN-SPM), operated by Universidad Nacional Autónoma de México, at Baja California, ii) 0.40-m telescope at Observatorio Astronómico Carl Sagan (OACS), Universidad de Sonora, Hermosillo, Sonora, and iii) 0.36-m telescope of the Universidad de Monterrey Astronomical Observatory, Monterrey, Nuevo León.

Typically, to obtain complete lightcurves, five to ten nights of observation are dedicated to each asteroid. Exposure times for individual images are in the range of 30 to 240 seconds, depending on asteroid's visual magnitude. Generally, a few hundred images per object are taken during each observing night.

Basic steps in data reduction are performed using IRAF or MaximDL software. For lightcurve extractions and period determinations, MPO Canopus software is used. For crowded stellar fields, first DAOPHOT (Stetson 1987) is used to obtain the photometry and then MPO Canopus is used for deriving the lightcurve and rotation period. Figure 2 shows examples of lightcurves derived using these procedures.

The asteroid sample has been obtained from the Collaborative Asteroids Lightcurve Link (CALL). In general, asteroids with poorly, or unknown, rotation periods were chosen. Only those with declinations $> -30^o$ were observed. In three years more than fifty objects have been observed in four campaigns from which a dozen lightcurves and rotation periods have been published (Sada *et al.* 2016; Sada *et al.* 2017; Sada *et al.* 2018; Haro-Corzo *et al.* 2018). Some data are still under analysis. A sample of derived rotation periods and relevant information are presented in Table 1. Near Earth Asteroids' (NEAs') information is not included because it has been presented in a separate contribution by J.C. Saucedo *et al.* at this same IAU Focus Meeting.

Table 1. Asteroids with reliable period determinations.

Name	Period (h)	Error (h)	Amplitude (mag)	Nights	Group
703 Noemi	11.108	0.014	0.28	11	Flora
1084 Tamariwa	6.195	0.001	0.30	5	Outer Main Belt
1218 Aster	3.1581	0.0002	0.35	7	Flora
1305 Pongola	4.349	0.0003	0.19	8	Outer Main Belt
1491 Balduinus	15.3044	0.0057	0.45	4	Outer Main Belt
1856 Ruzena	5.957	0.001	0.68	11	Main Belt
2022 West	14.1385	0.0031	0.54	7	Outer Main Belt
2535 Hameenlinna	3.2311	0.0001	0.11	10	Flora
2733 Hamina	93.23	0.02	0.36	13	Inner Main Belt
3394 Banno	7.3249	0.0008	0.21	5	Main Belt
3887 Braes	5.81	0.01	0.60	6	Main Belt
4775 Hansen	3.1187	0.0001	0.16	5	Mars Crossing
8433 Svecica	20.9905	0.0015	0.65	10	Outer Main Belt
18301 Konyukhov	2.6667	0.0003	0.15	6	Outer Main Belt

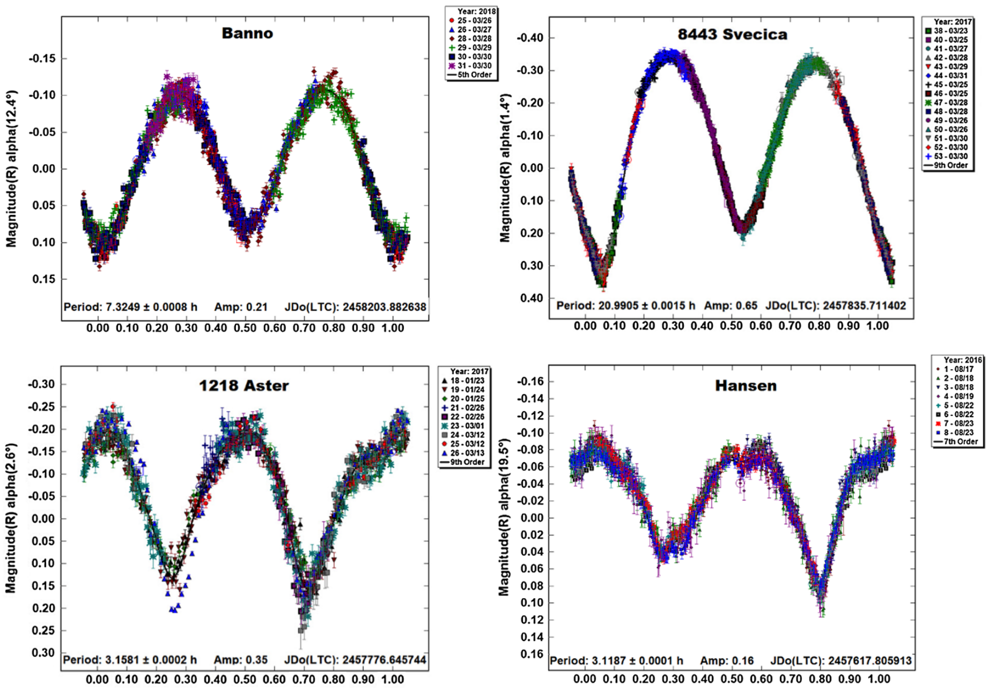

Figure 2. Examples of asteroids' phased lightcurves.

3. Concluding remarks and future work

After three years we have refined observational and analysis methods to derive reliable asteroids' lightcurves. The pace at which we are obtaining and processing photometric data is increasing. However, due to the shortage of trained people, we are reaching our maximum rate of studied objects to about 12 objects per year. Therefore, we are planning to coach a new generation of students and researchers in the observation and analysis techniques. In addition, we plan to improve and increase our observation facilities. In the meantime, we will fulfill the following tasks: i) carry out infrared observations to estimate precise asteroid sizes and albedos, ii) start taxonomical classification of bright objects (V<15), and iii) undertake theoretical studies of asteroids' dynamical behavior.

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