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Preliminary results on the photometric study of two primordial family asteroids

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Abstract

The so-called "primordial family", is a recently discovered collisional family [1] that could be as old as the Solar system. It contains low-albedo asteroids and is located in the inner Main Belt. This family was identified by the V-shape technique [2] and is estimated to be at least 4 Gyr old, meaning that occurred before the giant planet instability [3]. Asteroids 2768 Gorky (1972 RX3) and 9086 (1995 SA3) are members of the primordial family and have been observed in order to determine their rotational period, spin pole and shape, which will give insights about their membership and the family evolution. The photometric data are obtained mainly by the University of Athens Observatory (UOAO) [4]. Models of the asteroids are derived by the lightcurve inversion method, which is stored in the Database of Asteroid Models from Inversion Techniques (DAMIT) [5].

1. Introduction

The so-called primordial family formed by an impact event 4 Gyr ago or even earlier, i.e. before the giant planet instability [3]. The identification of the primordial family has been done by using the V-shape technique [2]. The V-shape in (ɑ,1/D) space is occurred due to the thermal Yarkovsky effect [6, 7, 2], where prograde-rotating asteroids drifting outwards and retrograde ones inward. As only the inward side of the V-shape of the primordial family is well defined, the members should have retrograde spin. Otherwise, the membership of asteroids with prograde spin could be disputed or the contradicting spin sense could be due to YORP cycles or a collision or a close encounter with other asteroid [8, 9]. Thus, it is essential to observe thoroughly the asteroids belonging to the primordial family, in order to determine their rotational state and shape.

2. Observations

Asteroid 2768 Gorky (1972 RX3) is member of the primordial asteroid family of the inner main belt [1]. Its rotational period is 4.507 ± 0.010 h [10], while its spin pole and shape remain unknown. Observations from Sopot Astronomy Observatory (SAO) for 2 nights in September 2019, in phase angle of 32º, are available in Asteroid Lightcurve Photometry Database (ALCDEF)[11] and present a period of 4.445 ± 0.003 h [12]. On the Observatoire de Genève website of R. Behrend [13] rotational period of the asteroid was reported to be 4.5118 ± 0.0007 h. Asteroid 2768 Gorky (1972 RX3) has been observed from UOAO for 5 nights in December 2019, in phase angles between 10º to 14º.

Asteroid 9086 (1995 SA3) is member of the primordial asteroid family in the inner main belt [1]. Its rotational period, spin pole and shape remain unknown. UOAO has been observed this asteroid for 22 nights from October to November 2019, in phase angle ranging between 4º to 22º.

3. Methodology and Preliminary Results

Differential photometry of the asteroid has been obtained for each sky field. All images were dark and flat-field corrected and unguided. The measured values are in magnitudes and have been transformed properly in relative flux. The determination of the rotational period of the two asteroids and the estimation of the spin pole and shape of 2768 Gorky (1972) has been carried out through the lightcurve inversion method stored in DAMIT [5].

3.1 Asteroid 2768 Gorky (1972 RX3)

The lightcurve of asteroid 2768 Gorky (1972 RX3) present a low amplitude of ~0.1 mag (or ~0.1 intensity units), as Figure 1 shows. Generating 50 random spin poles as initial input for DAMIT software, the results have the distribution presented in Figure 2. The plot in this figure constrains the possible spin poles of the asteroid, while the χ^2 value and the dark facet percentage should have the lowest value.

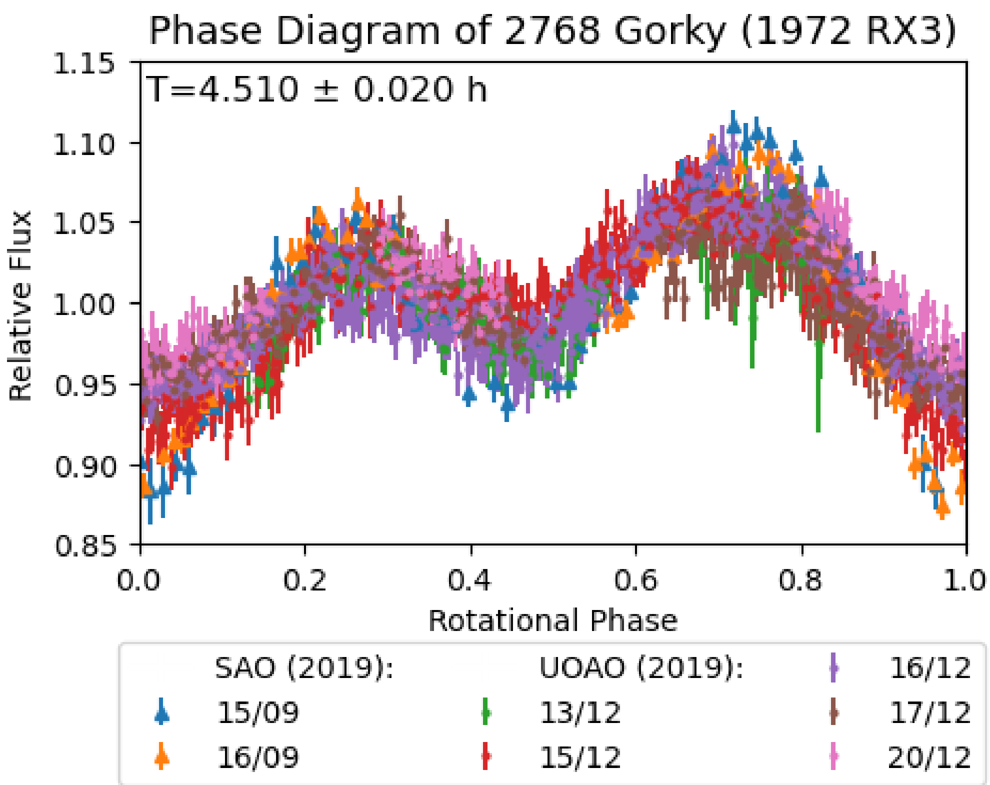

Figure 1: Phase diagram of 2768 Gorky (1972 RX3).

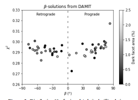

Figure 2: Distribution 50 of spin pole's latitude (β) solutions for 2768 Gorky (1972 RX3) with the best fit in DAMIT along with the calculated dark facet area percentage.

3.2 Asteroid 9086 (1995 SA3)

The lightcurve of asteroid 9086 (1995 SA3) present also a low amplitude of ~ 0.2 mag (or ~0.2 intensity units). The low brightness of the object in combination with the low amplitude of its lightcurve render the detection of its periodicity difficult, due to the background noise. In order to address this problem, the exposures of each night were combined in packs of 3, in order to increase the S/N and make the detection of light variation more prominent. The resulted period spectrum from DAMIT is presenting in Figure 3.

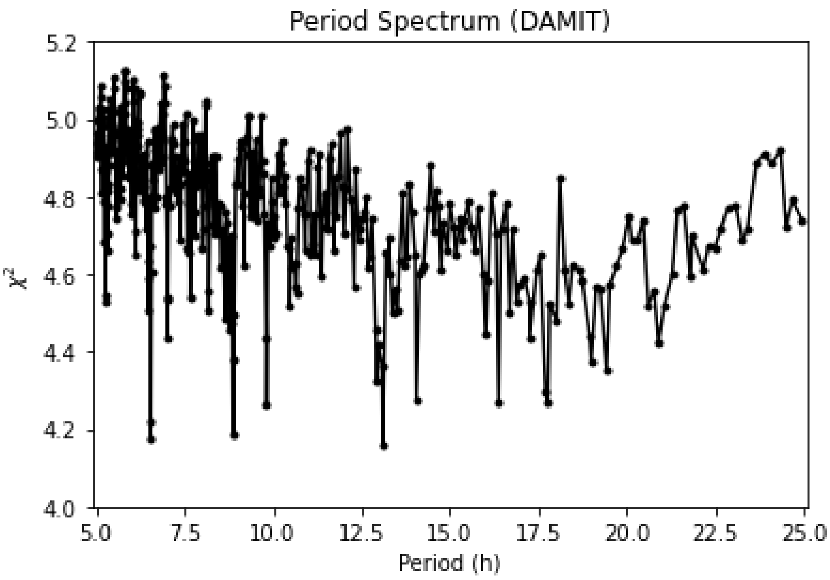

Figure 3: The period spectrum for 9086 (1995 SA3) from DAMIT results.

4. Summary and Conclusions

The rotational period of 2768 Gorky (1972 RX3) has been calculated as 4.510 ± 0.020 h, in agreement with the literature. The spin pole is not defined well enough. It is needed observations from more than one apparition for more robust results. Asteroid 9086 (1995 SA3), despite the extensive observations, does not present a clear lightcurve, as a result to have not unique solution in the period.

5. Further work

The determination of asteroids' rotational state and shape requires observations from more than one apparition. Alternatively, combing the already ground based with sparse data from sky surveys or space-borne could also drive to unique solutions.

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