PHOTOMETRIC SURVEY OF INNER MAIN BELT V-TYPE ASTEROIDS.

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Introduction: Abundant iron and basaltic meteoritic evidence shows presence of the 20-100 differentiated (into distinct mineralogical layers: iron core, basaltic mantle and crust) parent bodies in the Solar System. However the observational evidence of those objects or their collisional remains is missing. Several studies focused on searching for V-type (commonly interpreted as basaltic in composition, parts of crusts and mantles) asteroids in the mid and outer main-belt ([1], [2], [3], [4]). However only very few basaltic V-type asteroids were found leaving the question of 20-100 parent bodies still open.

The only uncharted region of the main belt is the inner main belt region stretching between 2.06 AU - 2.5 AU. This region has not been thoroughly examined with respect to potential traces of differentiation because of the vast challenges it presents. First the inner main belt is interwoven with multiple dynamical resonances making the studies of dynamical history of individual objects and populations in the region very challenging. Second, the inner main belt contains multiple overlaying asteroid families making the family membership of many asteroids in the region dubious. Lastly, the proximity of the asteroid (4) Vesta and its collisional family led to conclusion that most V-types in this region are fragments of asteroid (4) Vesta that were freed from its surface in a violent collisions and then migrated to the inner parts of the asteroid belt.

However some V-types in the inner main belt as highlighted by the fall of the Bunburra Rockhole meteorite (basaltic meteorite originating from the inner asteroid main belt, whose oxygen isotope ratios do not fit those typical for Vesta and most basaltic meteorites) might be fragments of other bodies [5]. Some V-type asteroids in the inner main belt, like for example (908) Lundia [7] also do not show physical and dynamical properties typical for Vesta fugitives (asteroids feed from the surface of (4) Vesta) and may indicate new differentiated parent bodies in the inner main belt.

Nesvorny et al. 2008 [6] simulated the escape paths from Vesta and its family showing that typical Vesta fugitives in the inner main belt have to have retrograde rotations and physical and thermal parameters that maximize the Yarkovsky force in order to evolve to inner main belt orbits within 1-2 Gys (age of the Vesta collisional family). Any prograde V-type objects in the inner main belt could be suspected of non-Vesta origin and contribute to the inventory of other differentiated parent bodies. In this study we focus on determining rotational properties of selected V-type asteroids in the inner main belt.

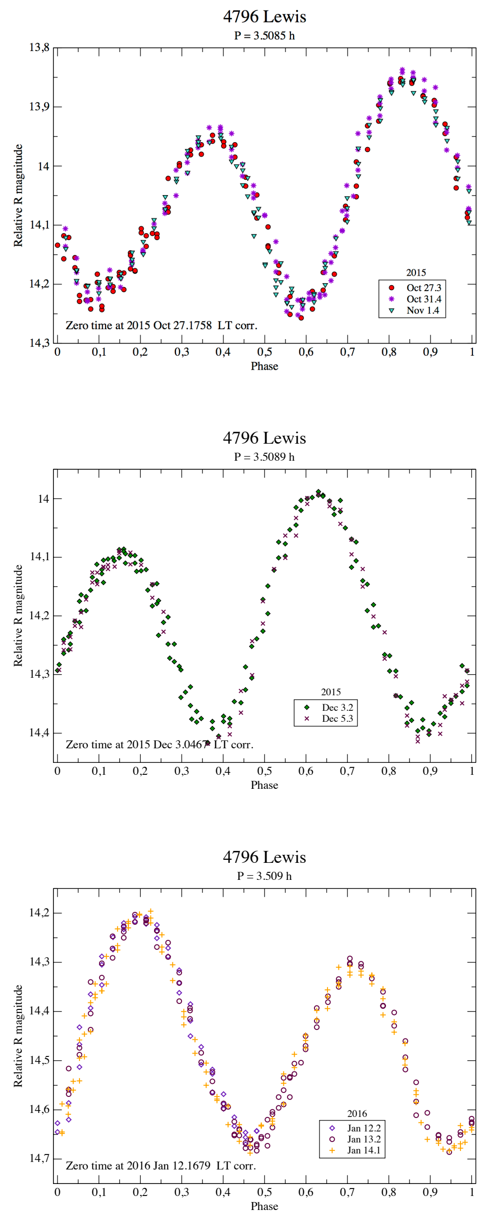

Fig. 1. Lightcurves of asteroid (4796) Lewis observed at three different epochs. Opposition date: 2015/11/07.

Selection of candidates: For this survey we have selected around 30 V-type asteroids outside the Vesta dynamical family. The V-type candidates were selected based on the SDSS data [4]. For practical reasons we focus on asteroids with rotational periods < 12h and objects for which some previous data is available in the LCDB. To perform full light curve inversion data from a minimum 4 oppositions are required. Therefore the entire project will take a few more years to complete. However we are presenting the first results here.

Methods and anticipated results: Typical Vesta fugitives in the inner main belt should have retrograde rotations and physical and thermal properties that maximize the Yarkovsky drift [6]. Retrograde rotators are driven by the Yarkovsky drift inwards towards the Sun, as opposed to prograde rotators which migrate outwards. In the first step of this photometric campaign we will determine senses of rotation by measuring synodic periods of the selected objects before, during and after

opposition. This allows us to see the changes in synodic period as the asteroid moves toward and away from opposition. Prograde rotators have their synodic period increasing when they move away from opposition (minimum at opposition) and retrograde rotators decreasing (maximum synodic period at opposition). The amount of the change in synodic period depends on spin orientation of the rotational pole. In Fig. 1 we present lightcurves of asteroid (4796) Lewis obtained for two epochs. The data are best explained by prograde rotation, however more data are necessary.

Future work: Further plans include obtaining spectroscopy of the prograde and retrograde V-type rotators in the inner main belt and investigating the spectral differences between the two groups as well as asteroid (4), other V-type asteroids and HED meteorites. In addition to spectroscopy we also plan to perform dynamical integration after determining rotational properties of the selected objects.

References:

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