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Determination of the phase curves of V-type asteroids

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1 Introduction

Howardite-Eucrite-Diogenite (HED) meteorites are supposed to have originated from the asteroid (4) Vesta. It is widely accepted that two impacts on Vesta ejected debris and created the Vesta asteroids family in the vicinity of Vesta. Members of the family were then scattered and drifted away through the Yarkovsky effect, encounters with other bodies or dynamical resonances and are known as Vesta fugitives. However, a growing body of evidence suggests that Vesta might not be the only parent body of HED meteorites. Most of them have similar oxygen isotope composition consistent with Vesta however, some show distinct oxygen isotope ratios. This fact supported by other chemical ratios clearly indicates that Vesta is not the parent body of several meteorites. Several V-type asteroids found in the mid and outer main belt due to separation by 3:1 resonance with Jupiter are hardly dynamically conneted to Vesta. Moreover, visible and NIR spectra show V-type asteroids that are not related to Vesta. To study this interesting group of objects we focussed on determination of their phase curves.

2. Observations and data reduction

This project is run in parallel to another programme to study V-type asteroids [1] from which data in the form of the bias, dark, and flat field corrected CCD frames are taken. To be used for phase curves they are measured with the aperture photometry and calibrated to the Johnson R passband. The computations are done with the help of the automatic photometry pipeline package written in python [2]. Since the observations are done with different filters (V, VR, R, clear, r') the calibration is done with the solar analogue stars from the PanStarrs DR1 catalogue.

From each lightcurve an asteroid brightness at maximum light is taken. We do not use average magnitudes as they are influenced by the amplitude – phase angle relation. If we encounter a partial lightcurve, which does not include the maximum we still use it if we can combine with with another lightcurve from the same opposition. This way a correction for the maximum brightness can be applied.

3. Determination of phase functions

After deriving the asteroid maximum brightnesses, corrected to unit distances from the observer and the Sun, they are plotted versus phase angle to get phase curves. The phase curves are then analysed with the PCFit python program developed in house, which fits three different phase functions to the data: (H, G), (H, G_1, G_2), and (H, G_{12}). In case we have phase curves from different oppositions we can use them by shifting them in magnitide so that the scatter of points is minimized. This way we loose the information on the H parameter but keep the G's parameters.

The example phase functions, obtained for (5599) 1999 SG1 V-type asteroid, are presented in Fig. 1. More results will be shown at the conference.

Acknowledgements

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References

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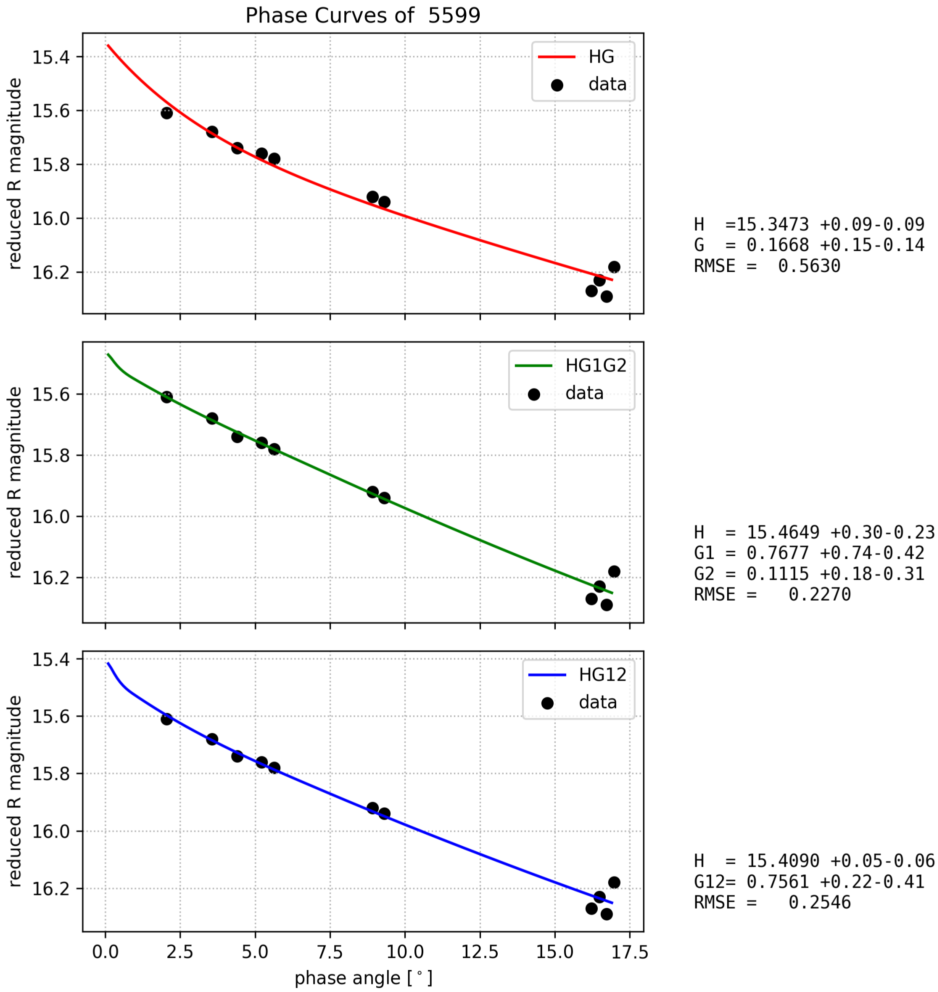

Figure 1: Example phase curve of (5599) 1999 SG1, from 2016 opposition, with three different phase functions fitted to the data.