EPSC Abstracts
Vol. 12, EPSC2018-846, 2018
European Planetary Science Congress 2018

The unusual V-type asteroid (2579) Spartacus

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Abstract

Asteroid (2579) Spartacus is a small V-type object located in the inner main belt (the main delivery region for meteorites). It shows spectral characteristics different from typical values for Vestoids (shifted band centers and deeper absorption bands [1], [2]), which may indicate origin deeper within Vesta then other V-types or a different parent body. We determine physical and dynamical properties of (2579) Spartacus and discuss its possible origin scenarios.

1. Introduction

Most howardite-eucrite-diogenite (HED) meteorites are thought to have originated from the crust of asteroid (4) Vesta. However few show distinct oxygen isotope ratios indicating a different parent body. Among those the Bunburra Rockhole meteorite is particularly interesting. It also shows a distinct oxygen isotope composition ([3], [4]) and thanks to its observed fall, its origin was traced back to the inner main asteroid belt. Bland et al. 2009 suggested that its parent body may still be present in the inner main belt. Due to its distinct spectral features asteroid (2579) Spartacus is a candidate parent body of anomalous HED meteorites such as Bunburra Rockhole.

2. Spin and shape

The pole direction and convex shape models for (2759) Spartacus were obtained using the lightcurve inversion method by [5] [6]. We used 36 lightcurves (27 from the literature, and 9 collected in this work). We obtained a retrograde model with spin axis orientation $\lambda = 312° \pm 5°$, $\beta = -57° \pm 5°$ and a symmetric also retrograde solution $\lambda = 113° \pm 5°$, $\beta = -60° \pm 5°$. The convex shape models are presented in Figs. 1 and 2 respectively. The sidereal period in both models agrees closely to $P_{\rm sid} = 3.63602$ h.

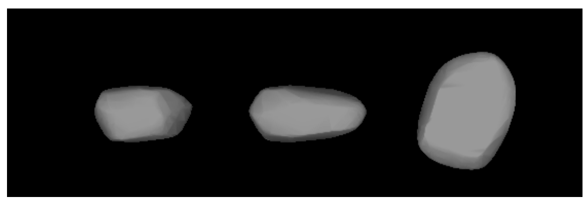

Figure 1: Convex shape model of (2579) Spartacus: Views along the X, Y, Z axis in the asteroid's cartesian frame. Pole coordinates are $\lambda = 312° \pm 5°$, $\beta = -57° \pm 5°$, rotational period $P_{\rm sid} = 3.636028$h

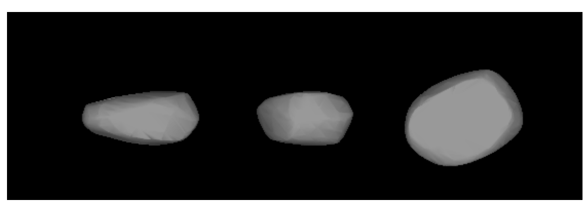

Figure 2: As in Fig. 1, but for a symmetric pole solution $\lambda = 113° \pm 5°$, $\beta = -60° \pm 5°$, $P_{\rm sid} = 3.636027$h.

3. Dynamical properties

To study dynamical evolution of (2579) Spartacus we randomly generated 101 clones with initial orbital elements distributed along the line of variation of orbital elements of (2579) Spartacus. Those clones were then integrated backwards in time for 1 Gy evolving under the influence of the Yarkovsky effect and interacting with the local web of resonances. All the clones had a radius that of (2579) Spartacus, that is 2.302 km. The remaining initial thermal parameters were selected to resemble that of typical V-types asteroids. The final osculating elements were averaged with Gaussian weights. We have considered four cases: (a) model with prograde pole solution of obliquity $\gamma = 0°$, (b) model with retrograde pole solution of obliquity $\gamma = 180°$, and (c, d) retrograde models with the actual pole solutions. In Fig. 3 we plot the final osculating elements for the different obliquity models at -1Gy, current location of asteroid Vesta and its collisional family is also marked. We find that the retrograde models have a drift direction consistent with the origin in Vesta, but after 1Gy integration time none of the models reach the core of the Vesta family.

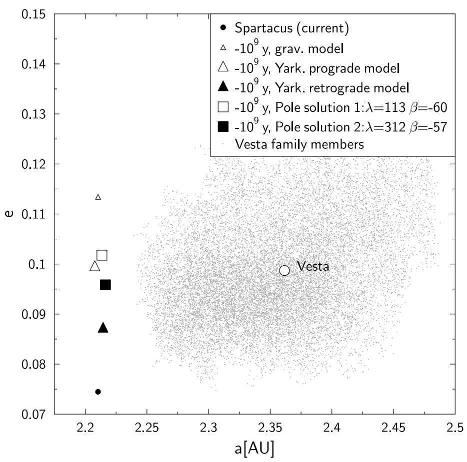

Figure 3: Osculating orbital elements (semi-major axis - a and eccentricity e) at -1Gy for Spartacus assuming different dynamical models and spin orientation.

4. Summary and Conclusions

Based on collected multi-opposition data, we have obtained a retrograde model solution for asteroid (2579) Spartacus. We used estimated size, spin and thermal parameters of Spartacus to investigate its origin and link to (4) Vesta. Dynamical integration shows that the asteroid was drifting from the direction of the Vesta family. We find that at -1Gy the asteroid doesn't yet reach the core of the Vesta family, and longer integration time may be needed for Spartacus to reach the core of the Vesta family. This may indicate that the asteroid originated from an older impact, such as the one that created for example the Veneneia crater (estimated age > 2 Gy).

Acknowledgements

Project supported from National Science Center, Poland grant number 2017/26/D/ST9/00240. Based on observations made with the SMARTS telescope (CTIO), Hall telescope (Lowell Observatory), Nordic Optical Telescope (NOT) and Jacobus Kapteyn Telescope (JKT).

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