Shape model of binary asteroid (90) Antiope reconstructed from lightcurves and stellar occultations

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I will present a shape model of binary asteroid (90) Antiope recontructed form a large set of lightcurves and occultation chords observed in 2008, 2011, and 2015. Parameters of the model will be compared with previous results.

Background asteroid orbit distribution around asteroid pairs

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Asteroid pairs are identified by the similarity of their heliocentric orbits. The method of Pravec and Vokrouhlický (2009; PV09), recently applied in the 5-D space of mean orbital elements, computes the probability that a given candidate asteroid pair is a random orbital coincidence of two genetically unrelated asteroids. If the probability of random coincidence is low, the two asteroids are a statistically significant detection of asteroid pair. The method assumes a locally uniform distribution of background asteroid orbits around the tested pair. We looked into this assumption and studied actual distributions of background asteroid orbits for a sample of 36 pairs. Our motivation was that with an improved description of the distribution of background asteroid orbits, we may extend the method to asteroid pair candidates with a non-uniform distribution of background asteroid orbits.

We tested a presence of gradient in the distribution of orbits around each studied pair. We assumed zero density gradient in the orbital elements Ω and ϖ and we studied the local orbital distribution in the elements a, e, i. We found that in about half of the 36 cases, the local background asteroid orbit density does not significantly differ from uniform. In the other half cases, we obtained significant gradients. We found that the deviations from the uniform background asteroid orbit density had following reasons: a presence of nearby asteroid family, an effect of a nearby mean-motion resonance, or the pair was located close to the ecliptic plane. Families significantly affecting the local background asteroid orbit density were identified and we corrected the calculation of the probability of random coincidence for the non-uniform background asteroid density. Our results will allow us to extend the PV09 method to regions in the space of mean orbital elements where it could not be applied so far (e.g., in outskirts of asteroid families).

New binary candidates among V-type candidates

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Although we have surveyed more than 80 V-type asteroids and their candidates, some signs of brightness attenuation(s) were noticed in the lightcurves of only two such asteroids. In case of (16491) 1990 SA3 only one attenuation was detected. The lightcurve of (15031) Lemus consists of two additive periods. After subtraction of the shorter period the remaining shape of the lightcurve is bimodal with sharp minimum. The second minimum is not covered by observations. It could be a synchronous binary (the orbital period of the satellite and its rotation period could coincide). We also detected two periods for asteroid (7302) 1993 CQ, though in that case no attenuations were observed. No attenuations were seen even for previously known doubly synchronous binary systems (809) Lundia and (854) Frostia. We report our rough estimates of the slope parameter G and absolute magnitude H for all these five asteroids. The survey was not focused on revealing binaries so the true ratio of binaries among V-type asteroids and their candidates could be higher than estimated from our result. Attenuations could be hidden because some asteroids were observed insufficiently and some sessions were noisy. More detailed observations (for example, among those with short rotation period and small amplitude of their lightcurve), covering also other apparitions and larger sample would be required to accomplish that goal. Extended effort would be needed to obtain binaries ratio within the Vesta family as none of the five asteroids mentioned above is located there, while we have surveyed 30 such objects. This work is supported by the VEGA grant 1/0670/13.

Shape models and sizes of large MB primaries from optical photometry and Keck/NIRC2 disk-resolved data

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We use optical lightcurves and disk-resolved images from NIRC2 mounted on the Keck telescope to derive scaled shape models of several large main belt primaries. The size of each asteroid is optimized together with its shape by the All-Data Asteroid Modelling inversion algorithm (ADAM, Viikinkoski et al., 2015, AA, 576, A8), while the spin state of the original convex shape model from the DAMIT database is only used as an initial guess for the modeling. Most recent sets of optical lightcurves are always employed. Thereafter, we combine obtained volume with mass estimates available in the literature (determined from the orbit of the satellite) and derive bulk densities for these asteroids with a typical uncertainty of 10-20%. Moreover, we also use two disk-resolved images from VLT/SPHERE of asteroid Elektra to derive its shape, size, and bulk density.

ASPECT asteroid spectral imaging satellite proposal to AIDA/AIM CubeSat payload

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The Asteroid Spectral Imaging Mission (ASPECT) is a part of the Asteroid Impact Mission (AIM) project, and aims to study the composition of the Didymos binary asteroid and the effects of space weathering and shock metamorphism in order to gain understanding of the formation and evolution of the Solar System. The joint ESA/NASA Asteroid Impact Deflection Assessment (AIDA) mission to binary asteroid Didymos consists of the Asteroid Impact Mission (AIM) by ESA and the Double Asteroid Redirection Test (DART) by NASA. DART is targeted to impact the Didymos secondary component (Didymoon) while AIM monitors the impact effects. This will demonstrate the use of a kinetic impactor to deflect potentially hazardous asteroids. Both spacecraft will be launched in 2020 and will arrive to Didymos in 2022. The AIM mission will also include two or three CubeSats, which will be released in the Didymos system. This arrangement opens up a possibility for secondary scientific experiments. ASPECT is one of the proposed CubeSat payloads. ASPECT is a 3U CubeSat equipped with a spectral imager and it will be used to measure the spectral characteristics of the impact site before and after the DART impact, as the impactor should bring fresh material to the surface. This gives a unique opportunity to study space weathering and shock effects on asteroids.

Binaries by the Bushel – Binary asteroids observed at the Center for Solar System Studies

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The Center for Solar Systems Studies (CS3) is located in the California high desert in Landers, north of Joshua Tree National Park. Currently, ten telescopes are exclusively used to observe asteroids and two more are under construction. The facility is fully robotic with local computers running the telescope/camera software as well opening and closing the roofs via Internet-accessible power strips. The computers are accessed via the Internet using remote desktop software so that we can monitor operations and change scripts to work new targets when needed. Otherwise, the scripts can run for several days without intervention. We started our campaign in 2013 concentrating observing NEAs and members of the Hungaria and Jovian Trojan families. When conditions allowed, we try to obtain dense lightcurves spread over weeks for lightcurve inversion modeling. We are working closely with the radar teams at Arecibo and Goldstone in order to supplement their radar observations with dense lightcurves. As a natural consequence of obtaining dense lightcurves of NEAs and Hungaria family asteroids, many binary asteroids have been discovered. As of April 2016, the asteroid lightcurve database (LCDB; Warner et al., 2009) contains 263 asteroids that are known or suspected binary or multiple systems. Since 2013, CS3 has observed 56 of these known or suspected binary systems or about 21% of the total.