Determination and prediction of binary asteroid orbits

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Binaries are crucial to determine asteroid masses, hence densities. If reflectance spectra is available, we can investigate its bulk composition. This provides constraints on the processes that took part in the formation and evolution of these objects. Over the last few years, we have set up a suite of tools at IMCCE to mine large ground-based telescope archives for high-angular resolution images of binary asteroids. We identify the images, and reduce them with an in-house pipeline. Satellites astrometry and photometry are measured on images where flux from the primary has been self-substracted. If the primary is angularly resolved, we deconvolve the images and extract its 2-D profile on the plane of the sky. We determine orbits from the relative positions of the satellite with respect to the primary using our algorithm GENOID (GENetic Orbit IDentification, Vachier et al., 2012, A&A 543). We construct 3-D shape models from the profiles and optical lightcurves using KOALA algorithm (Carry et al. 2010, Icarus 205). Further, we use these orbits to predict stellar occultations by the satellites. We aim at preparing occultation campaigns for the satellites, which is the most fruitful technique to measure physical properties of very small bodies. We have now very precise orbital solution for a handful of systems, and growing. We will illustrate our work with (107) Camilla, whose satellite was discovered in March 2001 using the HST (Storrs et al., 2001). Previous orbit was obtained by Marchis et al. (2008, Icarus). We use a comprehensive data set of direct imaging from large telescopes: HST and telescopes with AO camera (VLT, Keck-II and Gemini). The orbit we determine fits 48 satellite positions taken over 14 years, with an RMS residual of only 8.6 mas, which corresponds to sub-pixel accuracy. Similarly, the 3-D shape we build fits all LC, and AO profiles to very good levels (0.03 mag and 0.30 pixel, resp.). Combining both provides a very precise density determination.