RADAR CHARACTERIZATION OF BINARY NEAR-EARTH ASTEROID (185851) 2000 DP107

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Introduction:

The ability of radar to resolve near-Earth asteroids (NEAs) that cannot be resolved with other instruments makes it a very powerful tool to discover and characterize binary NEAs. In the year 2000, 2000 DP107 became the first binary NEA to be imaged [1]. During its 2008 return, the radar signal-to-noise ratio was ~20 times higher than that in 2000, which enabled us to obtain detailed images with range resolutions as fine as 30 m. The 2008 observations spanned 16 days during which the asteroid moved ~60 degrees in the sky. This allowed for excellent rotational phase and aspect angle coverage, an ideal situation for shape modeling and binary orbit determination. The data quality also allowed for measurement of the reflex motion of the primary around the system barycenter. The amount of reflex motion is directly related to the mass ratio of the two components. Using the 2008 dataset, we obtained shape models, spin states, masses, and densities for both components, and we fit a mutual orbit to the system. Because of the exquisite radar data, multiple apparitions, and existing lightcurve coverage, 2000 DP107 is one of the best characterized binaries in the solar system.

Results:

We used the SHAPE software [2][3] to fit shape models to the two components with effective resolutions of ~50 m. The equivalent diameters of the primary and secondary are 834 m and 279 m respectively, with 10% uncertainties. The primary has a spin period of ~2.78 hours [4] and shows an equatorial ridge similar to the one seen on the 1999 KW4 primary [5]. However, the ridge is not as regular as that on KW4 and has a ~300 m concavity on it. The secondary has a roughly triangular shape as seen along the spin pole. It is locked in a synchronous spin state with its longest principal axis pointing towards the primary on average, making its spin period equal to its orbital period of 1.75 days ± 1 %. It orbits the primary with a semimajor axis of ~2.7 km and an eccentricity of ~0.03 (uncertainty of 0.01). This non-zero eccentricity should result in forced librations of the elongated and synchronous secondary [6]. During shape modeling, we find that libration amplitudes below 4 degrees are consistent with the radar data. The densities of the two components are comparable and very close to 1600 kg/m^3 (30% uncertainties) indicating similar compositions and interior structures. This is different from the situation with 1999 KW4, where the secondary was reported to be 43% denser than the primary [5]. By combining the datasets obtained in 2000 and 2008, we may be able to fit a model of the mutual orbit evolution over a decade.

We will present these and other physical and dynamical properties of 2000 DP107 at the workshop.

References:

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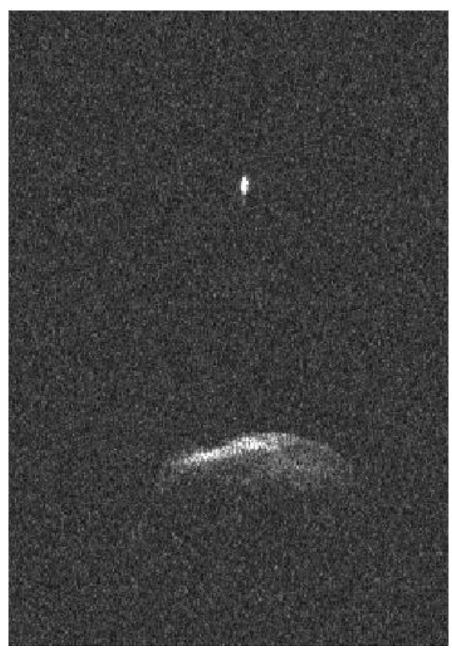

Figure 1: Range-Doppler image showing the two components of 2000 DP107. It was obtained in September 2008 and has a range resolution of 30 m.