

preliminary **Radar-Derived Shape Model of Binary Near-Earth Asteroid**



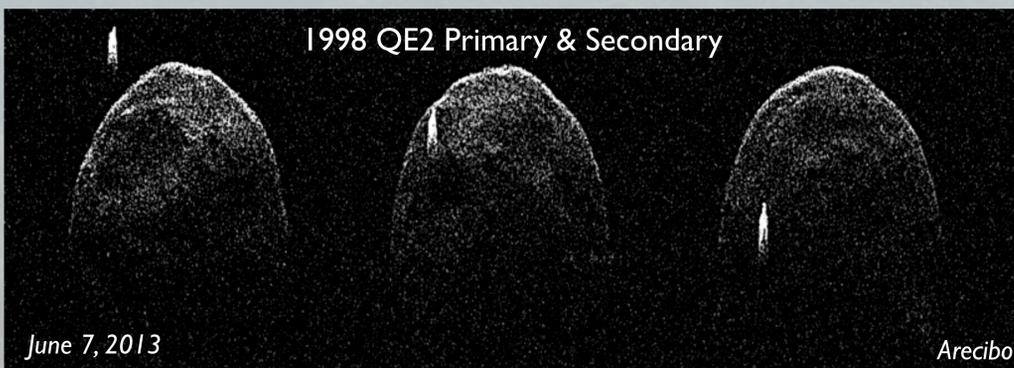
(285263) 1998 QE2



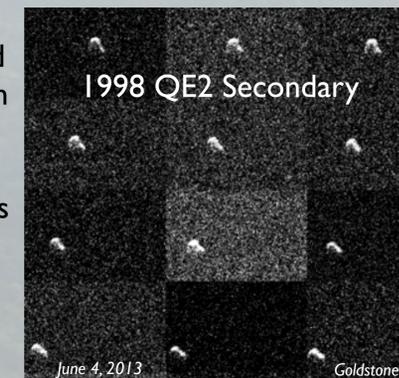
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Inversion of delay-Doppler radar images from Arecibo Observatory and Goldstone to model the size, shape, and system geometry of 1998 QE2 and its moon.

Data

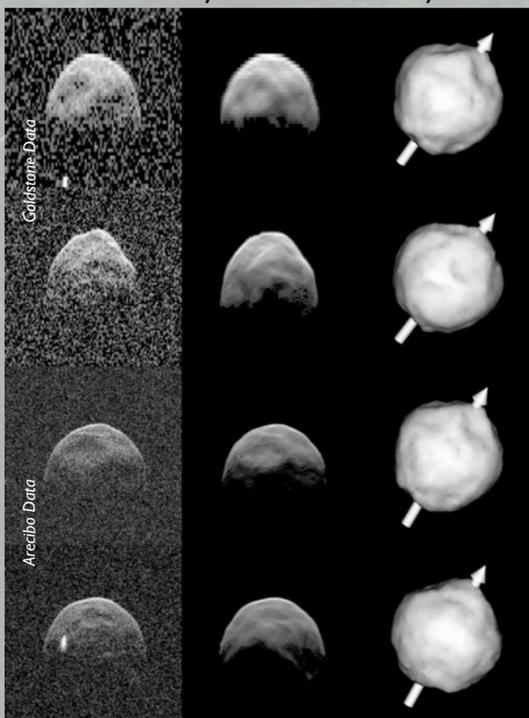


On May 31, 2013, the binary near-Earth asteroid system 1998 QE2 had a 0.04 AU close approach to Earth. We observed the binary system on both sides of close approach with the planetary radar systems at both Arecibo Observatory and Goldstone. The size of the QE2 primary and the short light travel time afforded us an excellent data set of high resolution delay-Doppler images of this asteroid and its moon. In these radar images, the Earth is toward the top of the frames. Highest resolution for Arecibo is 7.5 m/pixel; for Goldstone, 3.75 m/pixel.



Primary Model & Properties

Data Synthetic Data Sky View

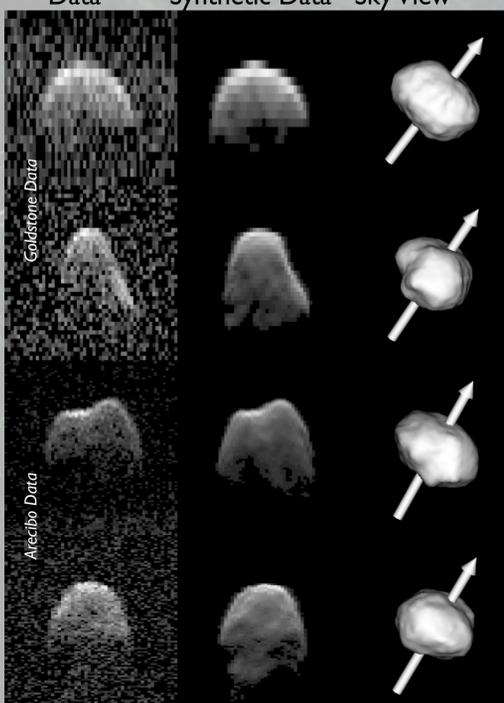


- Diameter: 3.2 ± 0.3 km
- Rotation period: 4.749 ± 0.002 h (*P. Pravec, pers. com.*)
- Rotation sense: prograde
- Spectral class: Xk (*IRTF observations*)
- Optical albedo: 0.03-0.04
- System mass: $1.1 \pm 0.1 \times 10^{13}$ kg
- Density: 0.7 ± 0.2 g/cm³

We fit shape models for both objects using a non-linear iterative inverse process described in Magri et al. (2007) & Hudson (1993). The preliminary primary model is a roughly spherical body with several concavities in the north that may be evidence of cratering. There is no evidence of an equatorial ridge, though some radar-bright spots may be indicative of boulders. Thermal modeling using this derived shape indicates a very low albedo.

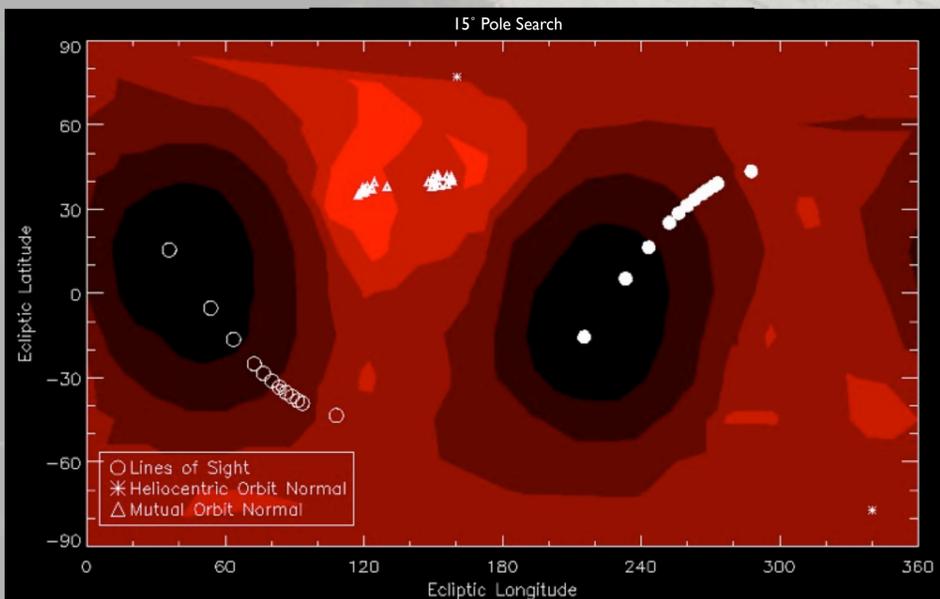
Secondary Model & Properties

Data Synthetic Data Sky View

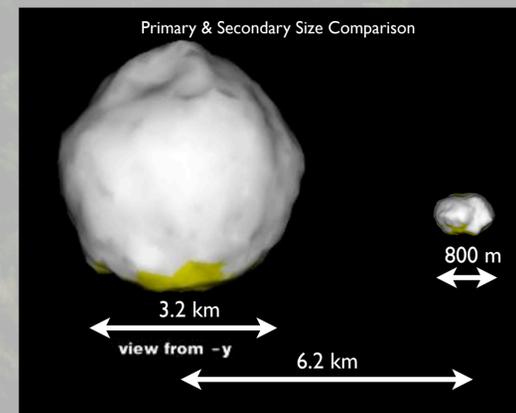


- Effective diameter: 800 ± 80 m
- Orbital period: 31.31 ± 0.01 h
- Semi-major axis: 6.2 ± 0.1 km ($\sim 4 \times R_p$)
- Primary:secondary size ratio: $\approx 4:1$
- Eccentricity: < 0.01

The secondary is in a tidally locked spin state. The orbit is approximately circular, which is typical of most near-Earth asteroid binary system orbits. We assume that the primary and secondary poles are aligned with the best-fit mutual-orbit pole.



Fits to a subset of the radar data suggest a prograde pole direction consistent with, but not as well constrained as, the best-fit mutual-orbit normals. We assume that the mutual orbit is in the equator plane of the primary with the the primary pole at $(119^\circ, +35^\circ)$ in ecliptic coordinates. There is similar region of solutions near $(158^\circ, +41^\circ)$, 30° away, that effectively put the concavities in the southern hemisphere instead of the northern hemisphere (shown here).



For the radar-derived sky view models, yellow patches are regions only seen at grazing incidence for both primary and secondary.

Both primary and secondary models have 1148 vertices, or 6° resolution.

We will continue to refine the shape models for both primary and secondary to further investigate both the physical properties and dynamics of the 1998 QE2 system.

After a two-month hiatus due to a support cable damaged in an earthquake, Arecibo Observatory and the planetary radar system are fully fueled and operational.