COMET 8P/TUTTLE: ARECIBO RADAR OBSERVATIONS OF THE FIRST BILOBATE COMET.

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Introduction: 8P/Tuttle is a Halley-family comet in a 13.5-yr orbit. This comet's close (0.25 AU) passage in early January 2008 afforded a good opportunity for Earth-based radar observations. We made strong detections of Tuttle on four consecutive days (Jan 2–5) with the Arecibo S-band (λ13-cm) radar. CW Doppler spectra were obtained on the first three days and delay-Doppler images were obtained on all four days. These data have yielded the size, shape, rotation period, and radar albedo of the nucleus and produced the surprising finding that Tuttle is a highly bifurcated object (possibly a contact binary) [1]. We also see a broadband component in the Doppler spectrum associated with echoes from large grains in the inner coma.

The Nucleus: The rotation and bilobate shape of the nucleus can be seen in the delay-Doppler image sequence in Fig. 1. Comparison of the images from all four days gives a rotation period of 11.4 hours (correcting the shorter period that we reported earlier [1]). The larger of the two lobes is somewhat elongated, with a major-axis length of 5.6 km; the smaller lobe has a diameter of about 4.4 km. The cleft between the lobes is deep and shows no discernible connecting neck, which is consistent with a contact binary. The radar cross section of the nucleus is 4.8 km^2, which gives a value of 0.15 for the radar albedo. This is more than twice the typical comet nucleus radar albedo [2], which indicates that Tuttle has an unusually well-compacted surface. Comparison of the two circular polarization components of the Doppler spectra suggests that surface rubble may concentrate in the cleft between the two lobes.

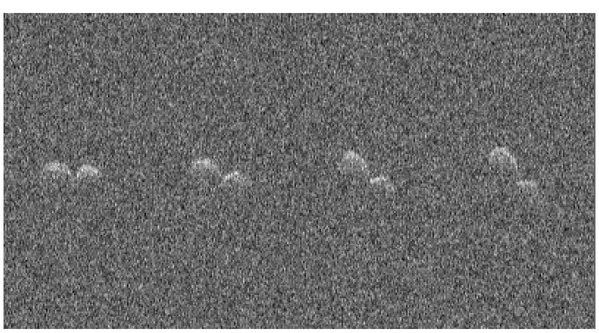

Figure 1: Sequence of four delay-Doppler images of the Tuttle nucleus from January 4, 2008. The time lapse between images is 26 minutes.

The Large-Grain Coma: The Doppler spectrum of the grain-coma echo is shown in Fig. 2. This echo component is associated with backscatter off large ejected grains with radii > 2 cm. The Doppler spread corresponds to ejection velocities of a few meters per second. The spectrum's negative skew indicates the grain motion is preferentially away from Earth. The total radar cross section of 4.9 km^2 implies a substantial rate of large-grain production from this comet. Grains of this very size and speed may be contributing to the Ursid meteor stream currently thought to be associated with Tuttle [3].

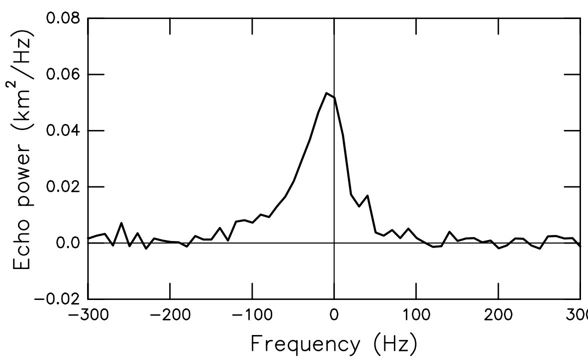

Figure 2: Doppler spectrum of the grain-coma echo (nucleus subtracted) from averaging all CW runs.

Discussion: Although binaries (orbiting or contact) have been identified in the asteroid, Centaur, and TNO populations, no unambiguous binary comets have been found [4, 5]. Comet Tuttle may be the first such case, at least of the contact type. All of our preliminary shape modeling is consistent with a contact binary. Furthermore, the rotation is slow enough for gravitational binding, and the alignment of the binary axis with the long axis of the larger lobe is consistent with a minimum-energy configuration [5]. Tuttle's binarity and short orbital period could make it an attractive target for a spacecraft flyby, although (as with Halley) the grain coma could pose a hazard.

References:

[1] Harmon J. K. et al. (2008) *IAU Circ. No. 8909.* [2] Harmon J. K. et al. (2004) in *Comets II*, edited by Festou M. C. et al., 265−279. [3] Jenniskens P. et al. (2002) *Icarus*, *159*, 197–209. [4] Noll K. S. et al. (2006) *Icarus*, *184*, 611–618. [5] Scheeres D. J. (2007) *Icarus*, *189*, 370–385.