

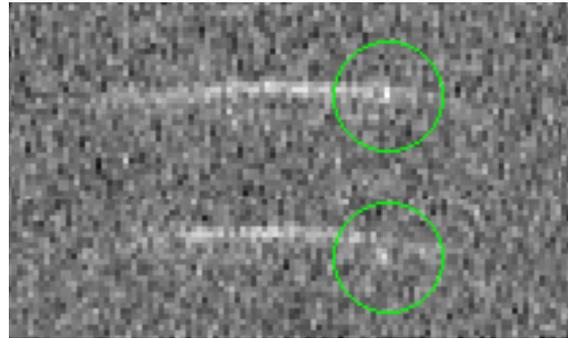
**RADAR AND INFRARED OBSERVATIONS OF BINARY NEAR-EARTH ASTEROID 5143 HERACLES.**

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**Introduction:** An extensive optical lightcurve campaign from 2011 October 21 to December 11 suggested near-Earth asteroid 5143 Heracles is a binary system based on three suspected mutual events [1]. Arecibo radar observations from 2011 December 10-13 unambiguously revealed the presence of a satellite to Heracles [2] in range-Doppler images (Fig. 1). Incomplete coverage of the mutual orbit of the components suggested that the maximum separation is at least 4 km, but the period could be ~15 hours for a tight orbit or ~50 hours for a much wider orbit. Infrared observations with NASA IRTF were also collected during the 2011 apparition on November 28 and December 6. December 2016 presented the first chance to revisit the system to better constrain its properties.

**Observations:** The Heracles binary system was observed with the Arecibo planetary radar for seven days from 2016 December 3-9. Range-Doppler images had resolutions as fine as 75 meters per pixel, though the majority of the data was frequency-only power spectra or 600-meter resolution coarse imaging to reliably locate the secondary component. Radar observations sampled the entire orbit of the secondary about the primary component. Infrared observations with NASA IRTF were also collected over a longer timebase than in 2011, covering October 29, November 2, 12, and 17.

**Results:** Preliminary radar-data reduction suggests a semimajor axis of ~5 km and an orbital period of ~17 hours, and a synchronously rotating secondary, resolving the ambiguities from 2011. Infrared spectra at multiple viewing geometries confirm the Q-type taxonomic class [3] and will constrain the thermophysical properties. We will present refined estimates of the component sizes, spin states, mutual orbit, bulk densities, and reflection properties (albedo, radar albedo, and polarization ratio).



**Figure 1.** Discovery images with 300-meter resolution of the secondary (circled) of 5143 Heracles from 2011 December 11 as it moved away from the radar and the primary (the near-horizontal line of bright pixels).

**References:** [1] Pilcher, F., et al. (2012) *The Minor Planet Bulletin*, 39, 3, 148-151. [2] Taylor, P. A., M. C. Nolan, and E. S. Howell (2012) *CBET 3176*. [3] Binzel, R. P., et al. (2010), *Nature*, 463, 331-334.

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