Circular-polarization ratio variation with rotation for 2006 AM_4

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We obtained radar observations of asteroid 2006 AM_4 using the Arecibo Observatory and the Goldstone Planetary Radar from 2007 January 29 to February 3. We report variation of circular-polarization ratio (μ_C) with rotation, for which direct evidence has not been previously shown.

The circular-polarization ratio is the ratio of two polarization states: the integrated echo power in the same circular sense as the transmitted circularly polarized signal divided by the integrated echo power in the opposite sense. Typically, the published values of μ_C are time- and orientation-averaged.

For 2006 AM_4, $\mu_C = 0.34 \pm 0.25$ has been previously published (Benner et al., 2008). Radar images at 50 ns (7.5-m) resolution taken over two hours on 2007 February 1 showed an elongated irregular object ~ 170 m in longest dimension. Photometric lightcurve observations (Hergenrother and Whiteley, 2011) showed that the asteroid is a well-behaved principal-axis rotator with a period of 304.9 $\pm$ 1 seconds and a lightcurve amplitude of 1 magnitude. Photometric observations at Table Mountain Observatory by M. Hicks show it to be in a stony taxonomic class, S or Sq.

We used dual-polarization radar imaging data to obtain the brightness of the asteroid in a specific polarization state and rotation phase. Sorting μ_C by rotation phase shows that μ_C varies with orientation from 0.10 to 0.35 (see Figure). This is also the typical range of orientation-averaged values of μ_C for stony asteroids. Because the object rotates very rapidly, once in about 5 minutes, there is unlikely much regolith present. We will examine if the variations are likely to arise from larger scale geometric effects such as ”double bounce” from features on the object (e.g., craters) or by smaller scale surface roughness variations.

We will also present a shape model of the object derived from inverse modeling of radar data and a circular-polarization ratio map that will fit the observed values.

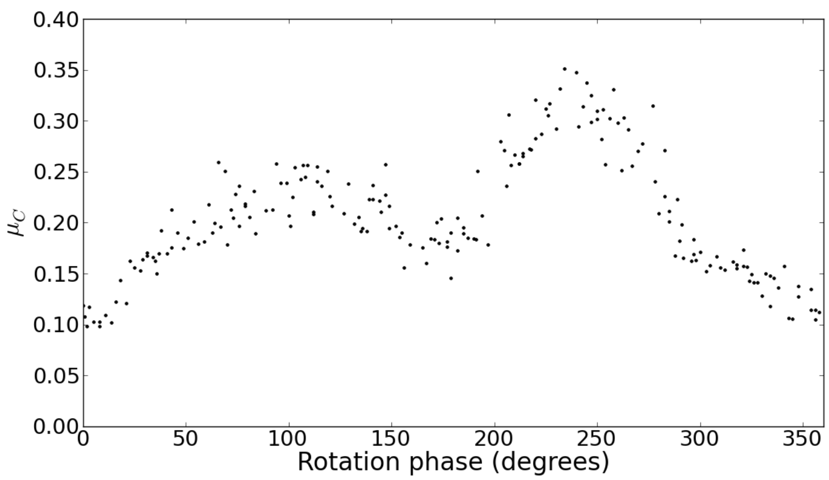

Figure: The circular-polarization ratio as a function of rotation phase for 23 rotations of the asteroid 2006AM_4.

References: L. A. M. Benner, S. J. Ostro, C. Magri, M. C. Nolan, E. S. Howell, J. D. Giorgini, R. F. Jurgens, J.-L. Margot, P. A. Taylor, M. W. Busch, M. K. Shepard, Near-Earth asteroid surface roughness depends on compositional class, Icarus 198 (2008) 294–304; C. W. Hergenrother and R. J. Whiteley, A survey of small fast rotating asteroids among the near-Earth asteroid population, Icarus 214 (2011) 192–209.