

Shape and Spin of Near-Earth Asteroid 308635 (2005 YU55) From Radar Images and Speckle Tracking.

M.W. Busch¹, L.A.M. Benner², M. Brozovic², P.A. Taylor³, M.C. Nolan³, C. Magri⁴, J.D. Giorgini², M.A. Slade², J.S. Jao², C.G. Lee², F.D. Ghigo⁵, W.F. Brisken⁶, J.L. Margot⁷, S.P. Naidu⁷, E.S. Howell³, L.M. Carter⁸, M.K. Shepard⁹, ¹University of California Los Angeles, Department of Earth and Space Sciences, 595 Charles Young Dr. E, Los Angeles CA 90095, USA, mbusch@ess.ucla.edu, ²Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena CA 91109, USA, ³Arecibo Observatory, HC3 Box 53995, Arecibo PR 00612, USA, ⁴University of Maine at Farmington, 173 High Street – Preble Hall, Farmington, ME 04938, USA, ⁵National Radio Astronomy Observatory, Green Bank Telescope, P.O. Box 2, Rt. 28/92, Green Bank WV 24944, USA, ⁶National Radio Astronomy Observatory, Array Operations Center, P.O. Box O, 1003 Lopezville Road, Socorro NM 87801, USA, ⁷University of California Los Angeles, Department of Earth and Space Sciences, 595 Charles Young Dr. E, Los Angeles CA 90095, USA, ⁸NASA Goddard, Mail Code 698, Greenbelt MD 20771, USA, ⁹Department of Geography and Geosciences, Bloomsburg University, 400 E. Second Street, Bloomsburg PA 17815, USA.

Near-Earth asteroid 308635 (2005 YU55), hereafter YU55, was discovered by Spacewatch on 2005 December 28. Radar imaging at the Arecibo Observatory in 2010 showed that YU55 is roughly spheroidal, with a diameter of about 400 m.

On 2011 November 8, YU55 made a 0.00217 AU (0.845 lunar distances, 325000 km) flyby of Earth. This was the closest approach of a known asteroid of YU55's size since 1976 and until 2028. Taking advantage of this exceptional opportunity, we organized an extensive radar observing campaign.

We observed YU55 with the Deep Space Network Goldstone DSS-14 and DSS-13 antennas from Nov. 4 to Nov. 11, Arecibo and the Green Bank Telescope from Nov. 8 to Nov. 11, Arecibo and elements of the Very Long Baseline Array from Nov. 11 to Nov. 13, and Arecibo alone from Nov. 13 to Nov. 18. Over the course of the radar campaign, we reduced the uncertainties in our knowledge of YU55's orbital elements by 89%, showing that this was its closest Earth approach until at least 2075.

We obtained several hundred radar images with resolution as fine as 3.75 m in range at Goldstone (Fig. 1) and 7.5 meters at Arecibo to study YU55's shape and surface features. We also obtained Arecibo/VLBA radar speckle tracking data to constrain its spin state.

The asteroid's surface is strewn with numerous decameter-scale boulders, with an areal density comparable to that seen on Itokawa (Michikami et al. 2008), and also small depressions that may be impact craters. YU55's overall shape is indeed close to spheroidal, with maximum dimensions of 360 ± 40 m in all directions. The single largest surface feature is a 150-200 m long area, raised by about 20 m and aligned with the asteroid's equator. This may be a portion of a relict equatorial ridge from a time when the asteroid was fast-spinning, or simply a local outcropping.

Based on our speckle tracking data (Busch et al. 2010), YU55 spins retrograde, with a spin angular momentum vector of ecliptic lon, lat = $(20^\circ, -74^\circ) \pm 20^\circ$.

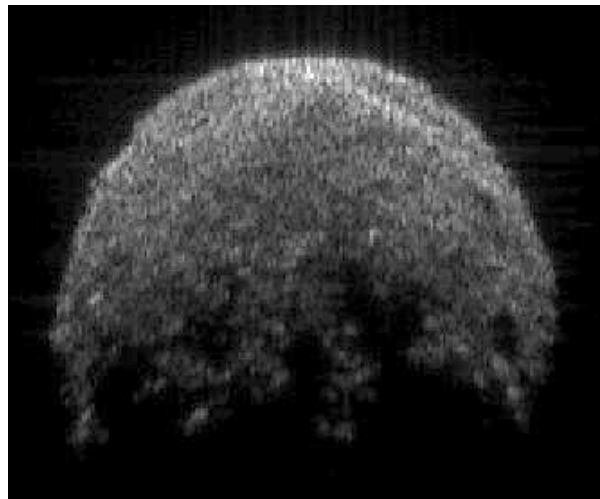


Fig 1: Goldstone radar image of 2005 YU55, obtained at 2011 Nov 9 02:05 UTC. Time delay increases from top to bottom with $0.025 \mu\text{s}$ (3.75 m in range) resolution and Doppler frequency, increases from left to right with 0.0156 Hz resolution. Decameter-scale boulders show as small clumps of bright pixels that are particularly conspicuous in the lower half of the image.

Fits to our radar data and optical lightcurves (B. Warner & P. Pravec, pers. comm.), indicate that YU55 has a spin period of 19.0 ± 0.5 hours. Due to its relatively slow spin, we expected that YU55 might have been torqued into a non-principal axis spin state by terrestrial tides during the flyby. However, both the speckle tracking and radar imaging are consistent with principal-axis rotation; we constrain the amplitude of any non-principal-axis “wobble” to be $<10^\circ$ both before and after the flyby.

The YU55 images are one of the strongest sets of radar images ever obtained. We will present a detailed shape model at the meeting.

References:

- M.W. Busch et al., 2010, *Icarus*, **209**, 534-541.
T. Michikami et al., 2008, *Earth Planets Space*, **60**, 13-20.