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GOLDSTONE/VLA RADAR OBSERVATIONS OF NEAR-EARTH ASTEROID 4179 TOUTATIS IN 2012

Abstract

Near-Earth asteroid 4179 Toutatis is close to a 4:1 orbital resonance with Earth. It has been extensively observed since its discovery in 1989, particularly during close Earth flybys in 1992, 1996, 2000, 2004, 2008, and 2012.

Previous radar observations of Toutatis have shown that the asteroid is a contact binary, 4.5 km long, with an unusual non-principal-axis spin state (the asteroid rotates around its long axis with a period of 5.38 days; the long axis in turn precesses around the overall angular momentum vector with a period of 7.4 days). In 2012 December, Toutatis approached within 0.0463 AU (6.93 million km) flyby of Earth, the last flyby within 0.1 AU until 2069. We conducted an extensive campaign of radar imaging and radar speckle tracking with NASA's Goldstone Solar System Radar and with elements of the Very Large Array. The radar images span December 4 to December 22, and include the time on December 13 when the Chang'e 2 spacecraft flew by the asteroid. Radar astrometry in advance of the spacecraft flyby specified Toutatis' position to ¡1 km. The images on December 12 and 13 achieved delay resolution of 3.75 m/pixel, showing a wealth of surface features including radar-bright specks that correspond to 10-m-scale boulders. These same boulders are visible in the Chang'e 2 images.

As well as presenting the 2012 radar data, we will summarize our current knowledge of the asteroid's shape and rotation. During each orbit, Toutatis' spin state changes by up to 0.1

The unprecedented resolution of the 2012 radar data and Chang'e 2 images will allow us to validate and improve our model of Toutatis' shape, surface properties, spin state, and internal structure.