

Twenty Years of Toutatis

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Abstract

Near-Earth asteroid 4179 Toutatis is near a 4:1 orbital resonance with the Earth. Following its discovery in 1989, Toutatis was observed extensively with the Arecibo and Goldstone radars during flybys in 1992, 1996, 2000, 2004, and 2008. The 1992 and 1996 data show that Toutatis is a bifurcated object with overall dimensions of 4.6 x 2.3 x 1.9 km and a surface marked with prominent impact craters. Most significantly, Toutatis is in a non-principal-axis tumbling rotation state, spinning about its long axis with a period of 5.41 days while that axis precesses with a period of 7.35 days [1, 2, 3].

In 2004, Toutatis passed within 0.0104 AU of Earth. The method of Scheeres et al. 2000 [4] predicts that tidal torques during that flyby should have significantly changed Toutatis' spin state due to its elongated shape and slow rotation. We have analyzed all of the available radar data, developing an improved model of Toutatis' rotation. Between 2004 and 2008, the change in Toutatis' spin state from the flyby accumulated to over 180°. The other flybys were at much greater distances (>0.024 AU), but the asteroid's spin changed measurably after each encounter.

Our model also includes better estimates of Toutatis' shape and moments of inertia. This work is ongoing, but we will discuss the implications of our results for the asteroid's history and internal structure,

particularly if the moments of inertia are consistent with a uniform internal density. Toutatis' last close-Earth-approach for several decades will be in December 2012, when it will be 0.046 AU away. We will make predictions for what radar observations at that time should see.

References

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