PDC 2021
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- ◯ **Key International and Political Developments**
- ◯ **Advancements in NEO Discovery**
- ◉ **New NEO Characterization Results**
- ◯ **Deflection & Disruption Modeling and Testing**
- ◯ **Mission & Campaign Design**
- ◯ **Impact Consequences**
- ◯ **Disaster Response**
- ◯ **The Decision to Act**
- ◯ **Public Education and Communication**

The low thermal conductivity of the super-fast rotator (499998) 2011 PT

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Asteroids smaller than about 150 meters may spin very fast, completing an entire rotation in a period of few tens of minutes. These small and fast rotating bodies are thought to be monolitic objects. The weak gravitational force due to their small diameter is not strong enough to counteract the large centripetal force caused by the fast rotation, and this would cause a break-up of a body with a rubble-pile structure. However, a little is known about their surface and internal composition, and only a few objects with $D < 150$ m have been characterized so far, while the first fly-by of such small asteroid (namely 1998 KY26) will occur in 2031 during the Hayabusa2 mission extension. Knowledge of surface properties are important in modeling either the formation of regolith-like materials, the wakening and degradation of boulders due to thermal shocks, or space weathering processess, as well as being crucial in planning both sample-return or deflection missions. In particular, it is not clear whether small and fast rotating objects are able to keep dust and small particles (regolith) on their surface or not. The presence of regolith is typically suggested by a surface thermal conductivity smaller than ~0.1 W m^{-1} K^{-1}.

In this work we developed a statistical method to set constrains on the surface thermal conductivity K of (499998) 2011 PT, a faint near-Earth object (NEO) with absolute magnitude $H = 24.07 \pm 0.47$ mag that rotates very fast, with a period of 11 minutes [1]. The method is based on the comparison between the Yarkovsky effect predicted by an analytical model, depending on physical properties, and the measurements of the semi-major axis drift obtained from astrometry [2, 3]. The appropriate thermal conductivity is found by matching predictions with observations. A statistical estimation is then produced with a Monte Carlo simulation. Estimations of unknown parameters needed for the analytical model, such as diameter, density and obliquity, can be derived from general NEOs population models [4, 5, 6].

We found that the measured Yarkovsky drift can be achieved only if K is low, with two most likely values at around 0.0001 and 0.005 W m^{-1} K^{-1}, see Fig. 1. Overall, we constrained the thermal conductivity to be smaller than 0.1 W m^{-1} K^{-1} with a probability of at least 95 per cent. Our result may be a clue that the surface of 2011 PT is covered with a thermal insulating layer, composed by regolith-like material similar to lunar dust. This is the first case that a low thermal conductivity solution for a small

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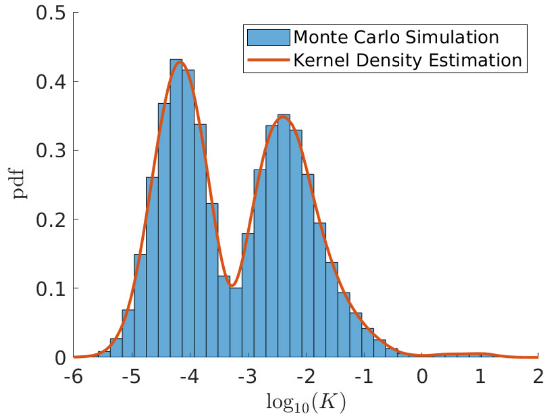

Figure 1: Distribution of the thermal conductivity K of (499998) 2011 PT obtained with the Monte Carlo simulation (blue histogram). The red curve represents the probability density function obtained with the kernel density estimation.

and fast-rotating asteroid has been obtained with such high probability, possibly providing new insights into physical properties of such small bodies.

Comments:

(Oral presentation.)

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