EPSC Abstracts
Vol. 6, EPSC-DPS2011-1505, 2011
EPSC-DPS Joint Meeting 2011

Near-Earth asteroid 162173 (1999 JU3): Constraining size, albedo, shape, spin-axis and thermal properties via thermophysical model techniques

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Abstract

Near-Earth asteroid 162173 (1999 JU3) is a potential flyby and rendezvous target for interplanetary missions because of its easy to reach orbit. We derived key physical parameters such as shape, spin-vector, size, geometric albedo, and surface properties of 162173 (1999 JU3) via thermophysical model techniques.

1. Introduction

Asteroid 162173 (1999 JU3) is currently among the potential targets of future interplanetary exploration missions. The target is relatively easy to reach with state-of-the-art mission capabilities, and it offers high scientific potential [1]. The physical and thermal properties of the asteroid are relevant for establishing the scientific mission goals and also important in the context of near-Earth object studies in general.

2. Methods

With three sets of published thermal observations (ground-based N-band, Akari IRC, Spitzer IRS), we applied a thermophysical model [3] [4] [5] [6] to derive the radiometric properties of the asteroid. The calculations were performed for the full range of possible shape and spin-vector solutions derived from the available sample of visual lightcurve observations. The importance of the thermal inertia in the modelling is visible in the χ^2-solutions (Figs. 1 & 2): the χ^2-values change significantly when going through the whole grid of physically meaningful thermal inertias.

3. Results

The near-Earth asteroid 162173 (1999 JU3) has an effective diameter of 0.87 ± 0.03 km and a geometric albedo of 0.070 ± 0.006 [7]. The χ^2-test reveals

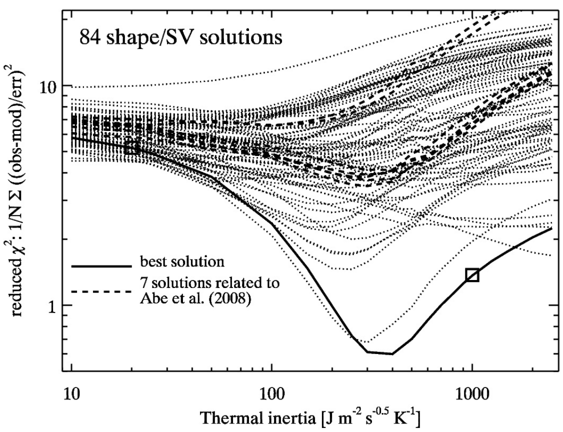

Figure 1: TPM χ^2-optimization process to find robust solutions for diameter, albedo and thermal inertia simultaneously. Each line represents the reduced χ^2 values for an individual shape/spin-vector solution as a function of thermal inertia. Dashed lines refer to previously published solutions [2].

a strong preference for a retrograde sense of rotation with a spin-axis orientation of $\lambda_{\rm ecl} = 73°$, $\beta_{\rm ecl} = -62°$ and $P_{\rm sid} = 7.63 \pm 0.01$ h (see Fig. 1). The most likely thermal inertia ranges between 200 and 600 J m^{-2} s$^{-0.5}$ K^{-1}, about a factor of 2 lower than the value for 25143 Itokawa [8], but not far from the mean value for km-size bodies [9] . This indicates that the surface lies somewhere between a thick-dust regolith and a rock/boulder/cm-sized, gravel-dominated surface like that of 25143 Itokawa.

4. Summary and Conclusions

The example of 162173 (1999 JU3) shows that a combination of visual lightcurves (reflected sunlight) and mid-/far-IR photometry or photo-spectroscopy (ther-

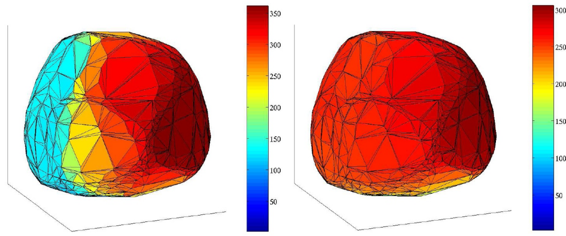

Figure 2: TPM implementation of the shape model with the lowest χ^2-values calculated for the time of the *Spitzer* IRS observations on 2008-May-02 02:01 UT, as seen from *Spitzer* in asteroid-coordinates, i.e., the z-axis goes along the rotation axis. Left: low thermal inertia. Right: high thermal inertia. Both solutions are marked with squares in Fig. 1

mal emission) can improve the quality of shape and spin-vector solutions significantly.

This method has meanwhile also been successfully applied to other near-Earth objects and main-belt objects which have ambiguities in shape and spin-vector solutions. The availability of multiple thermal data for a large number of solar system objects (Akari, WISE, Herschel) will allow in the near future to apply this technique in many more cases where size, shape, spin-vector or thermal properties are of interest.

Acknowledgements

J. D. received grants from the Czech Science Foundation (GACR P209/10/0537) and the Research Program MSM0021620860 of the Ministry of education. S. H. was supported by the Space Plasma Laboratory, ISAS, JAXA.

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