Abstract for 11th Low Cost Planetary Missions Conference
June 9-11, 2015, Berlin, Germany

TO CHANGE THE SPIN OF AN ASTEROID - A KINETIC-IMPACTOR DEMONSTRATION MISSION

L. Drube, A. Harris, German Aerospace Center, Rutherfordstr. 2, 12489 Berlin, Germany
S.R. Schwartz, P.Michel, CNRS, Observatoire de la Cote d'Azur, 06300 Nice, France
A. Falke, K. Engel, U. Johann, Airbus DS G, 88090 Immenstaad, Germany
S. Eggl, IMCCE-Observatoir de Paris, 75014 Paris, France
J. Cano, J. Martin, DEIMOS Space S.L.U., 28760 Tres Cantos, Spain

Introduction: The atmospheric explosion in 2013 of a 18 meter-sized asteroid over the Russian million-inhabitant city of Chelyabinsk, which blew in the windows all over town and made more than a thousand people seek medical attention, showed the world clearly what kind of damage even a small asteroid can generate.

Mission concept: We present a concept for a kinetic impactor demonstration mission, which aims to change the spin rate of an asteroid. The mission would determine the efficiency of momentum transfer during an impact, and help mature the technology required for a kinetic impactor mission, both of which are important precursor measures for a future space mission to deflect an asteroid by collisional means in an emergency impact hazard situation. Most demonstration mission ideas to date are based on changing an asteroid's heliocentric orbit and require a reconnaissance spacecraft to measure the very small orbital perturbation due to the impact. In contrast our concept is a low-cost alternative, requiring only one spacecraft.

Estimating the effect: Changing the spin rate of an asteroid requires a lot less impact momentum for the change to be measureable by Earth-based observers than changing the asteroid's heliocentric orbit. Using Itokawa as an example (Fig. 1), an estimate of the order of magnitude of a possible change in the spin period with such a mission using the law of conservation of angular momentum results in a spin period change of 4 minutes (0.5 %), which could be detectable by Earth-based observatories.

Mission types: The mission can be designed in several ways:

1. An impactor spacecraft only.
2. A two-part spacecraft, which separates before impact into an impactor and a flyby spacecraft. The flyby spacecraft would observe the impact and the resulting ejecta cloud and act as a relay station.
3. The two-part spacecraft with additional small sub-spacecraft being ejected from the impactor to observe the impact and the ejecta cloud from more directions.

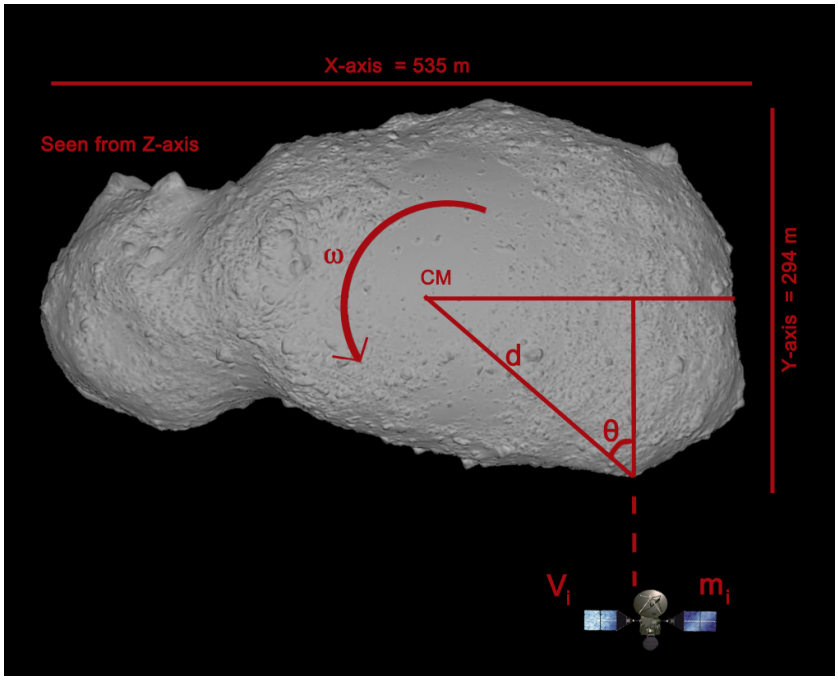

Figure 1. Illustration of a kinetic impactor changing the rotation period of an asteroid. *Credit: Robert Gaskell produced the shape-model of Itokawa used.*

Target: The lack of a reconnaissance spacecraft in this low-cost alternative would reduce the scientific return for a kinetic impactor mission. However using a previously visited asteroid as a target would partially compensate for this since some scientific context for the mission would already be available. Possible targets in this case could include (25143) Itokawa, (101955) Bennu and 1999 JU3.

Mission study: Of these 3 asteroids only Itokawa has been visited to date, and as Itokawa's elongated shape is highly advantageous for the mission proposed here, Itokawa have been chosen as the target for a mission study performed by the NEOShield Consortium in 2014-2015. The study included among other things mission and system design, trajectory calculations, post-impact risk analysis and impact modeling.

Conclusion: Preliminary studies show that a mission concept in which an impactor produces a change in an asteroid's spin rate could provide valuable information for the assessment of the viability of the kinetic-impactor asteroid deflection concept.

Acknowledgments: The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 282703 (NEOShield).