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The asteroid impact threat: instrumentation for mitigation precursor and demo missions, a study from the NEOShield project

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Abstract

The NEOShield project [1], started in January 2012, has been funded by the European Union for a period of 3.5 years. The primary aim of the project is to study in detail the three most promising techniques to mitigate the asteroid impact risk: the kinetic impactor, blast deflection, and the gravity tractor, and to devise feasible demonstration missions. NEOShield also aims to address the issue of a still missing international agreement on how to deal with the impact threat and how to organize, prepare, and implement mitigation plans. Within the NEOShield consortium, the LESIA is the leading institute for what concerns the physical characterization of near-Earth objects (NEOs). We are currently studying which is the appropriate instrumentation for both mitigation precursor missions and mitigation demo missions.

1. Introduction

Given the discovery of an asteroid on a threatening trajectory for the Earth and the necessity to deflect it, the knowledge of a number of its physical properties is essential for the positive outcome of the mitigation mission. In a correlated study [2] we are investigating what properties are relevant to a particular type of mitigation method, the relevance and accuracy of a variety of observational techniques and data types, and ways in which this crucial information can be best provided. Based on this, we study and design appropriate instrumentation for both i) mitigation precursor missions and ii) mitigation demonstration missions. We determine the minimum performance requirements and examine the applicability of developed instrumentation, hence investigate necessary modifications to achieve the required performance.

2. Mitigation techniques and physical properties

As said above, the crucial physical properties of a hazardous asteroid to be primarily investigated, as well as the required accuracies, depend on the considered mitigation technique. For example, within the kinetic impact mission concept (Figure 1), the amount of ejecta from the impact, that might increase its efficiency, strongly depends by the asteroid internal structure. The latter is substantially irrelevant in the case of a gravity tractor mitigation approach, which is the less sensitive technique to the target's physical properties. The corresponding requirements for the instrumentation of a reconnaissance precursor mission will obviously be different.

3. Appropriate instrumentation for mitigation precursor “real” and demo missions

In our study we consider two parallel cases: i) a mitigation demonstration mission that should be feasible and readily implementable by space agencies; ii) a reconnaissance mitigation precursor mission, given the discovery of a real hazardous body. In the latter case we assume that no stringent limits are put on the cost, mass, power, etc. of the mitigation mission, and that the best available technology can be used. On the contrary, for the demonstration mission(s) delivered by NEOShield we optimize the mission payload in terms of scientific return, cost and technological readiness.

A provisional and schematic model payload for an orbiter reconnaissance mission is defined. In our study we consider also the necessity to release one or more lander packages on the surface of the target asteroid, which could bring a number of advantages in its physical characterization, especially in view of a nuclear blast deflection scenario.

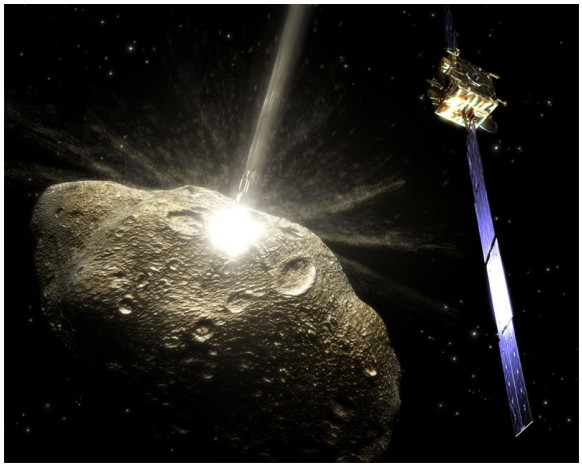

Figure 1: Artist's representation of ESA Don Quijote kinetic impact mission concept (Credit: ESA).

References

[1] Harris, A.W., Barucci, A., Cano, J.L., Fitzsimmons, A., Fulchignoni, M., Green, S.F., Hestroffer, D., Lappas, V., Lork, W., Michel, P., Morrison, D., Payson, D., Schäfer, F.: The European Union funded NEOShield project: A global approach to near-Earth object impact threat mitigation, Acta Astronautica, in press, 2013.

[2] D. Perna, M. A. Barucci, D. Bancelin, M. Birlan, S. Eggl, S. Fornasier, M. Fulchignoni, D. Hestroffer, W. Thuillot, A. W. Harris, L. Drube: Requirements For Mitigation Precursor Reconnaissance, A Study From The Neoshield Project, Planetary Defense Conference 2013, 14-19 April 2013, Flagstaff, USA, 2013.