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The Asteroid Impact Mission (AIM)

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Abstract

The Asteroid Impact Mission (AIM) is ESA's contribution to an international cooperation targeting the demonstration of deflection of a hazardous near-earth asteroid as well as the first in-depth investigation of a binary asteroid. After launch in 2020, AIM will rendezvous the binary near-Earth asteroid (65803) Didymos in 2022 and observe the system before, during, and after the impact of NASA's Double Asteroid Redirection Test (DART) spacecraft. The AIM mission will test new technologies like optical telecommunications by laser and Cubesats with nano-payloads and will perform scientific measurements at the asteroid system.

1. Introduction

Binary asteroids and their formation mechanisms are of particular interest for understanding the evolution of the small bodies in the solar system (e.g. [1]). Also, hazards to Earth from impact of near-Earth asteroids and their mitigation have drawn considerable interest over the last decades [2].

Those subjects are both addressed by ESA´s Asteroid Impact mission, which is part of the Asteroid Impact & Deflection Assessment (AIDA) collaboration between NASA and ESA. NASA's contribution to this cooperation, the DART mission will impact a projectile into the minor component of the binary near-Earth asteroid (65803) Didymos in 2022. The basic idea is to demonstrate the effect of the impact on the orbital period of the secondary around the primary. ESA's AIM will monitor the Didymos system for several months around the DART impact time. In what follows, we describe the ESA AIM component of the AIDA mission.

2. The Target

The near-Earth asteroid Didymos was detected in 1996 and its binary nature was derived from light-curve measurements in 2003. From data taken over several years, the diameters of the primary and the secondary are estimated to be 800 m and 170 m, respectively, and the separation between the centres of the two bodies is approximately 1.1 km [3]. Those parameters make the Didymos system the most suitable target for an impact deflection demonstration mission.

3. Mission Profile

AIM will be launched in October or November 2020 with a Soyuz rocket from Kourou, French Guyana. It is foreseen to arrive at Didymos in April 2022. The mission takes advantage of a close approach of Didymos to Earth. The next opportunity would arise in 2040 only.

AIM will stay near Didymos for approximately 6 months. Most of the time it will be placed on station-keeping trajectories on the illuminated side of the system, at distances of approximately 35 km and 10 km. AIM is expected to move away from Didymos for some time around the DART impact.

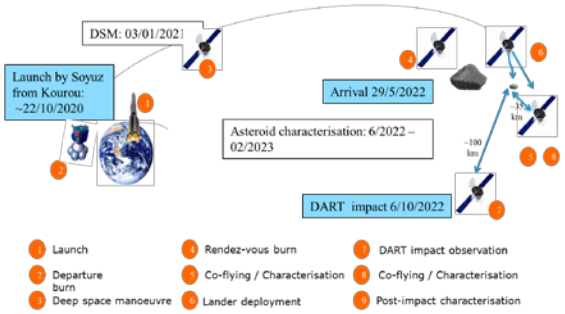

Figure 1: Overview of the AIM mission

4. Payload

The payload elements foreseen for AIM are listed below. In addition, the spacecraft will carry a camera to be used for navigation, characterisation of global parameters and the geomorphology of the asteroids, measurement of the orbital parameters of the system, and observation of the impact cloud created by DART.

Payload Instruments:

- A small, Hayabusa-2 MASCOT-type lander that will provide ground truth for the physical properties of the surface of Didymoon.
- A thermal infrared imager to determine the thermal and physical properties of the surface of the asteroids.
- A High Frequency Radar (HFR) to measure the subsurface structure of both the primary and the secondary component. It may also be used to investigate the impact cloud from DART. A Low Frequency Radar to measure the internal structure of the target body. The radar will send radio waves between the AIM spacecraft and the MASCOT-type lander, through the asteroid.
- An Optical laser terminal is onboard to enhance science in two ways: firstly, it will be used as a range finder to accurately position the spacecraft and determine the surface topography and 3D shape of the asteroids. Furthermore the laser altimeter can perform ranging for mass determination and provide measurements of the impact cloud. Secondly, the laser terminal will be used as a demonstration of optical telecommunications with interplanetary space.
- AIM will carry 2-6 Cubesats that will transport nano-sensors to the Didymos system. Studies for possible Cubesat payloads are ongoing. It is foreseen to use the Cubesats, together with the MASCOT-type lander, to test inter-spacecraft communication in interplanetary space.

5. Conclusions

AIM is a small and innovative mission that is expected to accomplish several goals for the first time:

- The first rendezvous with a binary asteroid and its characterization, including its surface, subsurface and internal structures as well as its thermal properties
- The first demonstration of optical telecommunications in interplanetary space, between spacecraft and Earth and possibly also between different satellites
- In the framework of AIDA, the first demonstration of asteroid deflection and documented impact experiment at asteroid scales

References

[1] Steinberg, E. and Sari, R.: Binary YORP Effect and Evolution of Binary Asteroids, Astron. J., Vol. 141, article 55, 2011.

[2] Gehrels, T. (ed.), Hazards Due to Comets and Asteroids, Univ. of Arizona Press, Tucon, 1995.

[3] Pravec, P., et al.: Photometric survey of binary near-Earth asteroids, Icarus, Vol. 181, pp. 63-93, 2006.