Asteroid Impact Mission (AIM): the European component of the AIDA space project

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AIM-D2: a revised version

AIMA is a joint cooperation between ESA & NASA. It consists of two separate spacecraft: the European orbiter AIM [1] and the US kinetic impactor DART [2]. AIM & DART are both planned to launch in late 2020. AIM will arrive at the target a few months before DART to perform the target’s characterization. The DART impact is planned in October, 2022 when the target will be within 0.072 AU of the Earth and observable with ground-based telescopes.

Reduced from the original AIM mission design [1], a minimum payload suited to address AIM objectives, resulting in the AIM-D2 (AIM-Deflection Demonstration) mission, was assessed in January-March 2017. This addressed all primary objectives of AIM (demonstration of an asteroid deflection, close-proximity operations and interplanetary Cubesat) and secondary objectives indirectly (e.g., internal structure through bulk density determination and system dynamics) [3].

AIM-D2 is robust programmatically and cost wise due to its simplicity, and has several technology objectives.

It will demonstrate European capabilities to:
- Perform close proximity operations in the environment of a binary asteroid system and the smallest asteroid ever visited (163 meters in diameter).
- Carry, deploy and operate a Cubesat in interplanetary space, contributing for the first time to spectral characterization of a small body.
- Determine the mass of the target body and dynamical changes after the DART impact; measure crater size, ejecta, and momentum transfer [2].

AIM target: the binary asteroid 65803 Didymos

Table 1 gives basic data on AIM target, Didymos, based on observations to date. The secondary, which is the main target of the mission, is assumed to orbit in the equatorial plane of the primary. Figure 1 shows the current shape model from radar and lightcurve observations. From [1].

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Diameter</td>
<td>0.780 ± 0.105 km</td>
</tr>
<tr>
<td>Secondary Diameter</td>
<td>0.163 ± 0.018 km</td>
</tr>
<tr>
<td>Total System Mass</td>
<td>(5.27 ± 0.04) × 1031 kg</td>
</tr>
<tr>
<td>Component Bulk Density</td>
<td>2.105 km m³ ± 0.035</td>
</tr>
<tr>
<td>Primary Rotation Period</td>
<td>3.060 ± 0.0013 h</td>
</tr>
<tr>
<td>Secondary Orbital Period</td>
<td>11.92 ± 0.04 ± 0.08 h</td>
</tr>
</tbody>
</table>

AIM-D2 payload

AIM-D2 carries two payloads (Fig. 2): AIM Framing Camera ASC (flight spares of the NASA Dawn mission camera provided by the MPS, Germany [6], Fig. 3), and the Cubesat ASPECT supported by Finland and Czech Republic.

AIM-D2: Deflection Demonstration

- First images of a binary asteroid in orbit
- First images and in-situ compositional analysis of the smallest asteroid ever visited
- Understanding of binary formation (15% of small asteroids are binaries).
- Understanding of physical/compositional properties and geophysical processes in low gravity, with implications on our understanding of small body surface properties and their evolution.

AIM-D2 with DART

- First documented impact experiment at asteroid scale, orders of magnitude beyond the scale accessible in laboratory
- Validation of numerical simulations of hyper-velocity impacts that are used in planetary science (planet and satellite formation, impact cratering and surface ages, asteroid belt evolution ...)
- Provide constraints for collisional evolution models of small body populations and planetary formation.

AIM-D2 science return and firsts

AIM-D2 stand-alone

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References