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Asteroid Prospection Explorer (APEX) Cubesat For the ESA Hera Mission

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Abstract

APEX is a proposed addition to the ESA HERA mission to the binary asteroid Didymos, scheduled to arrive following the NASA's Double Asteroid Redirection Test (DART). Slated for arrival to the system some years following DART's impact with the smaller body in the system, "Didymoon", Hera will study the after effects of the collision. Hera will carry with it two 6U CubeSats – APEX and Juventus, in part as technology demonstrations of new systems for the operation of small satellites in challenging environments. APEX will carry three scientific instruments: ASPECT (Visible to Mid-infrared hyperspectral imager), ACA (low energy ion and neutral particle analyzer) and MAG (boom-mounted fluxgate magnetometers), which will complement measurements made by Hera and Juventus.

1. Introduction

The target of both DART and Hera is the near-Earth binary asteroid, Didymos. The primary, "Didymain has a diameter of ~800m vs. "Didymoon's" ~160m. They are separated by ~1.2 km and orbit each other every ~12h. This presents a challenging environment for the operation of a small satellite, for example in navigating in close proximity in quasi-stable orbits, with a high degree of autonomy required due to the use of Hera as a relay.

Scientific goals of the APEX mission include mapping the surface composition, surface properties, and internal structure of both asteroids, and quantifying the effects of the DART impact on Didymoon by studying the impact crater produced.

2. The APEX Cubesat

The platform is a 6U cubesat of ~12 kg mass, sufficient to accommodate the scientific payload and all subsystems necessary for autonomous operation at Didymos. The nominal mission duration of 6 months includes orbits at the L4 and L5 Lagrange points in the binary system, with possibilities for close in (~100s of m) operations at Didymoon, and a final low-velocity "crash" at the end of mission.

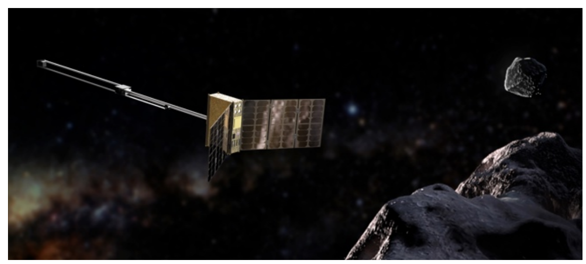

Figure 1: APEX Cubesat rendering, with deployed arrays and magnetometer boom. Image credit: Tomi Kärkkäinen / Reaktor Space Lab

In addition to the scientific payload APEX will carry an Attitude and Orbital Control System designed for operations in close proximity and semi-autonomous operations, LIDAR for asteroid ranging and navigation cameras.

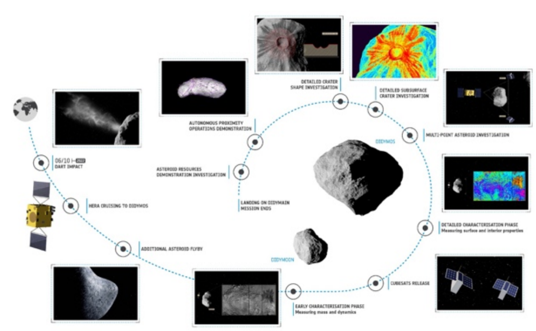

Figure 2: DART, Hera and APEX Mission Scenario

3. Instrumentation

3.1 ASPECT

The Asteroid Spectral Imager, ASPECT is a visible and near infrared (500-2500nm) hyperspectral imager designed by VTT of Finland. Primary aims are the mapping of surface mineralogy on both asteroids.

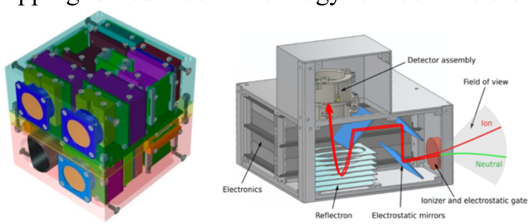

Figure 3: ASPECT and ACA Designs

3.2 ACA

The Asteroid Composition Analyzer (ACA) is a low mass, low-power ion and neutral time of flight mass spectrometer. Primary science goals include the determination of the properties of ions and neutrals sputtered from the asteroid surfaces.

3.3 MAG

The magnetometer provided by KTH comprises dual fluxgate sensors, mounted on a 2 m boom deployed following release of APEX from Hera. Primary science goals include the measurements of the magnetization or lack-thereof of the two asteroids, and characterization of the solar wind interaction with the binary system.

4. Conclusions

APEX and Juventus are intended to be at the forefront of deep-space scientific and technology demonstration cubesats. APEX is currently studied by the within the GSTP programme of ESA. Further development rests of the adoption of the parent Hera mission in November 2019.

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