Asteroid Prospection Explorer (APEX) CubeSat for Hera mission

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Asteroid Prospection Explorer (APEX) is a 6U CubeSat for Hera spacecraft (ESA) with a unique set of instruments designed to provide a global characterization (Fig. 1) of the Didymos system – target of the joint ESA-NASA Asteroid Impact and Deflection Assessment (AIDA) mission. The instrument set includes ASPECT (Asteroid Spectral Imager), ACA (Asteroid Composition Analyzer), and MAG (Magnetometer).

Both ASPECT and ACA provide crucial information of the Didymos surface composition. While ASPECT can provide the mineral composition information at high resolution (2 m/px or better) from mineral absorption bands, ACA complements this by the elemental composition of sputtered ions from asteroid surface ejected by solar wind. Combining the information from these two instruments we can obtain a complex picture of the Didymos system composition and detect the compositional variations between Didymos I and II as well as along the bodies itself. MAG complements this information by searching for an intrinsic magnetization of the building blocks of the asteroids, thus being potentially able to distinguish between monolithic and various levels of rubble pile structure.

APEX scientific observations are planned in two stages. First, a global mapping phase is scheduled on 4.2 km, slightly inclined orbit around barycenter of the Didymos system. From this orbit, global composition and magnetic field mapping will be achieved at uniform resolution utilizing all three payload instruments. In the second phase, APEX will gradually transfer to locations nearby L4 and L5 points of the Didymos binary system. From here, APEX will engage in a high resolution compositional and magnetic mapping of both Didymos I and II. At the end of the mission, a landing of APEX on one of the Didymos asteroids will be tried.

APEX concept with its unique instrument set and capabilities can be applied in any future asteroid characterization projects from purely science and planetary defense driven missions to characterization of the asteroid ISRU potential.

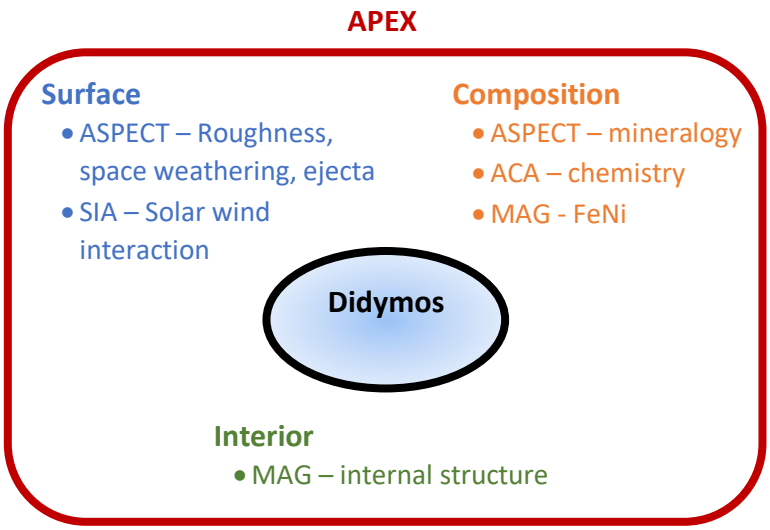

Fig. 1. APEX Science objectives and key payload.

	APEX scientific objectives and results	Payload Element
AS1	Map the global composition of the Didymos asteroids	
Result	**Mineral composition and homogeneity of the Didymos asteroid surface**	ASPECT
Result	**Elemental composition of the Didymos asteroid surface**	SIA
Result	**Constrain FeNi amount from induced component of the magnetic field**	MAG
AS2	Determine the internal structure and evolution of the Didymos system	
Result	**Mineral and elemental composition differences between Didymos I and II**	ASPECT, SIA
Result	**Detection and origin of the magnetization of the Didymos asteroid material**	MAG
Result	**Size of building blocks of the Didymos asteroids inferred from their remanent magnetic signature**	MAG
AS3	Determine surface roughness or regolith grain size of the Didymos asteroids	
Result	**Surface particle size distribution and composition for Didymos I and II**	ASPECT
AS4	Evaluate space weathering effects on Didymos II by comparing mature and freshly exposed material	
Result	**Optical and possible elemental differences between mature and freshly exposed material**	ASPECT, SIA
AS5	Identify local shock effects on Didymos II caused by DART impact based on spectral properties of crater interior	ASPECT, SIA, MAG
Result	**Determine optical properties of the material within crater**	ASPECT
Result	**Determine elemental composition on surface, differences inside and outside the crater**	SIA
Result	**Determine magnetic signature of the crater**	MAG
AS6	Map global fallback ejecta on Didymos I and II	
Result	**Detailed global mapping of fallback ejecta on both Didymain and Didymoon**	ASPECT, SIA
AS7	Characterize interaction of Didymos system with interplanetary environment	
Result	**Magnitude of interaction of the Didymos system with interplanetary magnetic fields, detection of temporary megnetoshpere**	MAG
Result	**Determine the magnitude of solar wind ion disturbances/interaction with the binary asteroid (Didymos system)**	SIA
AS8	Determine mass of Didymos I and II from APEX orbit perturbations	
Result	**Mass of Didymos I and II**	APEX, Hera
AS9	Determine strength of the near-surface material from APEX landing	
Result	**Surface material strength**	APEX, Hera