Flyby Observation of Asteroid (3200) Phaethon to Be Conducted by Cameras onboard DESTINY⁺ Spacecraft

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DESTINY⁺ (Demonstration and Experiment of Space Technology for INterplanetary voYage, Phaethon fLy-by and dUst Science) is a mission proposed for JAXA/ISAS Epsilon class small program, currently in the pre-project phase (Phase-A). DESTINY⁺ is a joint mission of technology demonstration and scientific observation. The near-Earth asteroid (3200) Phaethon, the flyby target, is known as a parent body of the Geminid meteor shower, the size of which is approximately 5 to 6 km in diameter.

In this mission, spatially resolved images of Phaethon will be taken by two onboard cameras, the Telescopic CAmera for Phaethon (TCAP) and the Multiband CAmera for Phaethon (MCAP) during the flyby, in order to understand the nature of a meteor shower's parent body, which is one of the sources of interplanetary dust particles that are thought to be an important transport medium of organic matter to the Earth. The spacecraft flybys Phaethon with relative speeds of 30 to 40 km/s. Despite such a high flyby speed, the cameras are required to take unblurred images of Phaethon.

The main purposes of the DESTINY⁺ flyby observation of Phaethon is to understand the geology of a parent body of a meteor shower, and in particular constrain the dust ejection mechanisms from active (i.e., dust-ejecting) asteroids. The specific objectives of the camera observation are taking images for (1) obtaining the global shape of Phaethon, (2) obtaining the semi-global features of Phaethon such as large impact craters and an evidence of surface disruption, (3) observing the local features of Phaethon such as topography related to dust ejection, and (4) observing the material distribution on Phaethon. The observations (1) to (3) will be conducted by TCAP, and (4) by MCAP.

TCAP is a telescopic panchromatic camera for high spatial resolution imaging of the surface of Phaethon and have a rotational mirror for automatic asteroid tracking during flyby. The rotational mirror can change the direction of the boresight from 0 to 180 deg. This enables to observe Phaethon throughout the flyby with wide solar phase angles, which is extremely important to image and understand the surfaces of planetary bodies because the solar phase angle affects significantly the appearance of geological features in taken images.

MCAP is a multiband camera, the wavelengths of which are 400, 480, 550, 700, 850, and 950 nm (700 and 950 nm are optional bands) and has multiple optical systems and sensors in order to take all band images simultaneously. This is because there is not enough time to take each band image in turn with changing bandpass filters using such as a filter wheel in this high-speed flyby mission. MCAP does not have a tracking mirror due to the weight limitation. Instead, the boresight of MCAP is fixed to the spacecraft with 40 deg off the relative velocity vector of the spacecraft and, Phaethon will be imaged while it is in the relatively wide field of view of MCAP.

We will explain the flyby imaging sequence of DESTINY⁺, and show the conceptual designs of TCAP and MCAP.

Keywords: Phaethon, DESTINY+, Flyby, Camera