Development of DESTINY$^+$ Dust Analyzer and its expected science return

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Demonstration and Experiment of Space Technology for INterplanetary voYage, Phaethon fLyby and dUst Science (DESTINY$^+$) led by Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science (JAXA/ISAS) will be launched in 2023. In addition to its two main engineering missions such as advancement of the electrical propulsion in space and acquisition of the fast flyby technique to the solar system small body, DESTINY$^+$ set two scientific missions to perform fast flyby observation of an active asteroid, 3200 Phaethon, and dust observation during interplanetary cruising and Phaethon flyby phases. In this presentation, we will introduce the dust analyzer for DESTINY$^+$ (DDA) and its expected science return.

DDA is an dust impact detector equipped with time-of-flight mass spectrometer (TOF-MS) which is the technologically advanced model of the dust analyzer (CDA) onboard the NASA's Saturn explorer, Cassini. DDA has been under development by a dust group at University of Stuttgart who developed CDA. Planetary Exploration Research Center at Chiba Institute of Technology (CIT/PERC) plays a role in interface adjustment between the spacecraft and DDA, operation planning, leading the DDA’s dust science, and so on.

Hypervelocity impact, >~1 km/s, of micrometeoroid on the target plate of the DDA sensor generates a plasma cloud composed of positive and negative ions and electrons. The applied electric field inside the sensor separates positive or negative particles from the other according to its polarity, and directs the separated ions into an ion collector. Then one can obtain TOF mass spectra and estimate the chemical composition of detected dust particles. The past dust analyzers had historically employed the positive ion detection mode in which the impact target is positively biased, however, DDA will have two sensor heads tuned for analyzing positive and negative ions respectively in order to reveal the chemical composition of dust particles with a wide variety of atomic and molecular species at the same observation condition. Another upgrade of DDA is a two-axes gimbal for aiming the sensor head towards the direction from which more incident of dust particles is expected.

During the interplanetary cruising phase between Earth and Venus orbit for about 2 years, DDA will observe the interplanetary dust originated from asteroids and comets and the interstellar dust incoming from outside the Solar System. At the Phaethon flyby, DDA will try to detect and analyze the ejected dust particles from Phaethon itself due to bombardment of the interplanetary dust.

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