

Mission Concept Study for Japan's Next Venus Exploration

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Japan's Venus Climate Orbiter, AKATSUKI has been observing Venus since its orbital injection in 2015, and has made significant achievements in elucidating phenomena in the Venusian atmosphere, such as super-rotation and gravity wave. Recently, a mysterious flash has been detected which could be a promising sign of lightning strike. On the other hand, AKATSUKI is already in the late operation phase and the end of its operation is in sight. We are considering the next generation of Venus missions to continue to investigate this interesting and enigmatic neighboring planet and to understand its unknown phenomena.

As one such mission, we are considering a project to put small probes into orbit around the Lagrange points L1 and L2 of Venus, respectively, to observe both the day and night sides of Venus continuously and simultaneously. This project was named PLANET-D after PLANET-C, the name of AKATSUKI when it was planned, and the two probes were named PLANET-D1 and PLANET-D2 respectively. Under the plan, the two spacecraft will initially be carried as a single unit on the launcher, launched, and once in LEO, will be injected into the Earth-Venus transiting orbit on a kick stage located between the launcher and the spacecraft. The spacecraft will then be controlled by the propulsion system in the vicinity of Venus and will first enter the L1 Lissajous orbit of Venus. After that, PLANET-D1 and PLANET-D2 will separate on the Venus L1 Lissajous orbit, PLANET-D1 will keep the same orbit, and PLANET-D2 will transfer to the Venus L2 Lissajous orbit. Each spacecraft will control its own orbit to maintain its orbit, and continue observations of Venus from two directions via X-band using different stations or in the manner to halve a visibility for each spacecraft.

The Epsilon rocket, Japan's small solid rocket, was tentatively set as the launch vehicle, and the system design of the spacecraft was carried out using the technical results of AKATSUKI and HAYABUSA2, and the results of the subsystem study of the future mission, DESTINY+. The Orbital Maneuver Engine (OME) for planetary transit is mounted only on PLANET-D1, while PLANET-D2 has only a small propulsion system, the Reaction Control System (RCS), for transfer between Venus L1 and L2 and for maintaining and controlling its own orbit, Venus L2 Lissajous. Due to the difference of the propulsion system, the mass of PLANET-D1 and PLANET-D2 are different, 145 kg and 55 kg respectively. The timing of the launch is better in 2031 than in the Earth-Venus meeting cycle.

Currently, the science community is discussing what should be observed on Venus from the viewpoint of planetary science. In addition to the Venusian meteorology targeted by AKATSUKI, many new themes are proposed, such as atmospheric chemistry, atmospheric escape, and geologic processes. The detail design of PLANET-D will be revised and updated in response to a demand from the science community.

Keywords: Venus, Exploration, Lagrange point