Next generation Japan's Venus Exploration in 2020s

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Akatsuki is the first Japanese Venus orbiter, which was launched in 2010. After the Venus orbit insertion (VOI) in 2015, a lot of images have been taken by the cameras onboard Akatsuki. Lower and middle clouds in the nightside are imaged by 2-μm infrared camera (IR2). Cloud top in the dayside is imaged by the ultra violet imager (UVI). Temperature at the cloud top level is measured by a longwave infrared camera (LIR). UVI and LIR have been working for 4 years after the VOI, but IR2 has ceased its observation about one year after the VOI due to its malfunction of the electronics. Total numbers of the UVI, LIR and IR2 images are different among them; 17,306, 31,444 and 3,201, respectively. Akatsuki observes the Venus atmosphere at different altitudes, local times, and latitudes, then we come close to understanding the Venusian atmospheric dynamics. However, we have to say that the knowledges in the cloud layer are not enough. We need to plan a follow up Venus mission to get more information from the Venusian atmosphere. Now Russia is planning Venera-D mission, and the European scientists are proposing EnVision mission to ESA. Japan should also follow up Akatsuki with a new mission which has the same designed cameras onboard Akatsuki. This leads to the creation of an international Venus observation network.

We are considering that two small probes put at the Lagrange 1 and 2 points of Venus, which is located almost 10^6 km from its dayside and nightside. This idea is inspired by Limaye and Kovalenko [2019][1]. From Lagrange 1(2) point, the dayside (nightside) hemisphere can be always observed. The radius of the Lissajous orbits depends on the delta-V which is required in the insertion. We assumed that the observation phase angle is 25 degrees and estimated total delta-V (for the orbit maneuver to Venus and L1(2) Lissajous orbit insertion) as 720 m s^{-1}.

One idea is to use JAXA’s Epsilon launcher. Epsilon launch vehicle of JAXA is expected to launch 200-250 kg mass to Venus. Then the weight of each probe is about 100 kg, and the required fuel (monopropellant) for the delta-V is estimated to be 36 kg. Assuming 10 kg for the science payload, remaining mass of 54 kg can be used for the bus system including the propulsion, telecommunication, etc. Other possibilities inserting two probes to Lagrange points of Venus, e.g. using H3 launch vehicle or others, should be investigated.

We will discuss follow up Venus science as well as more detail of our future mission plan (launcher, orbit insertion, probe system, etc.) to Venus in the presentation.

Reference

1. Monitoring Venus and communications relay from Lagrange Points, Limaye and Kovalenko, Planetary and Space Science 2019, https://doi.org/10.1016/j.pss.2019.104710

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