

Synergetic mission of simultaneous observations toward bow-shaped structures induced by atmospheric gravity wave on Venus with ALMA and Venus Climate Orbiter “Akatsuki”

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For understanding of the origin of short-term changes of the CO mixing ratio in the Venusian middle atmosphere observed by our ground based millimeter wave band 10m Telescope, SPART, it is essential to study the link between the atmospheric chemistry and dynamics in Venus. In December 9, 2015, the longwave infrared (LIR; 10 μm) band camera on board Venus Climate Orbiter “Akatsuki”, which traces the temperature of the cloud tops, discovered the mysterious steady bow-shaped structures induced by atmospheric gravity waves on Venus. It is expected that the observations of the distributions of atmospheric minor constituents driven by the gravity waves/bow-shaped structures provide us important information about the link.

In November 20 and December 1, 2016 we carried out the synergetic observations with Atacama Large Millimeter/submillimeter Array (ALMA) and Akatsuki toward the western highland of Aphrodite terra where the next events of large stationary atmospheric gravity waves would be expected. The LIR camera of Akatsuki succeeded to shoot the images continuously at the perihelion. ALMA executed the observations of CO and ¹³CO at 200 GHz band (Band 6) and CO, ¹³CO, HDO, SO, and SO₂ at 300 GHz band (Band 7). ALMA in Cycle 4 consists of fifty 12m antenna arrays and Atacama compact arrays (twelve 7m antenna arrays and four 12m single dish antennas) to obtain a good coverage of the uv plane. The spatial resolutions for the Band 7 and Band 6 under the C40-4 antenna configuration during the observing period are 0.43 and 0.63 arcsec, respectively.

The Voigt line shapes of the spectral lines obtained by ALMA give us the information about vertical distributions of the minor constituents in the middle atmosphere of Venus. The wind velocity at the lower thermosphere of Venus is also derived from the Doppler shift of the spectral lines. On the other hand, by using the infrared and ultra-violet band cameras of Akatsuki the information about the dynamics and chemistry in the cloud region and troposphere are obtained. The highly resolved time-dependent 3D data obtained simultaneously by ALMA and Akatsuki give us a unique opportunity to standardize and connect our understandings of atmospheric dynamics and chemical reaction networks in the middle and lower atmospheres via H₂SO₄-H₂O clouds. In this conference, we will present the current status of the synergetic mission with ALMA and Akatsuki.

Keywords: Atacama Large Millimeter/submillimeter Array (ALMA), Venus Climate Orbiter "AKATSUKI", Venus, Atmospheric Gravity Wave, SPART Telescope, Planetary Atmosphere