Investigation of Venusian upper troposphere using millimeter-wave continuum emission

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Venus has dense 90-bar CO_2 atmosphere with a thick cloud layer covering entire the planet at altitudes of ~50 - 70 km. This optically thick cloud layer hampers us to observe any information below the cloud. Only a few specific spectral regions at near infrared (e.g., 2.3 micron) play as the atmospheric “window” at which wavelengths the thermal emission from the hot lower atmosphere (~35 km for 2.3 micron window) leaks to the space. The emission at such near infrared wavelengths is attenuated by cloud particles, and can be used to retrieve cloud opacities.

A new approach to the upper troposphere of Venus is proposed by using millimeter-wave (microwave) observations. At the microwave region, the main opacity source in the Venusian atmosphere is the collision induced absorption (CIA) of CO_2, whereas the cloud opacity becomes almost negligible due to relatively long wavelength of observations compared to the sizes of cloud particles (~order of several microns). The CO_2 CIA reduces its absorption intensity with increasing the wavelength at millimeter-wave domain (and becomes almost transparent at radio frequencies). The radiative transfer calculation of the CO_2 CIA opacity indicates that the thermal emission originated from the altitudes of ~40–60 km can be observed at millimeter-wave of $\lambda = 3$ - 4 mm (frequency of ~60 –100 GHz) —which is the operation wavelength of the currently under development ALMA Band-2 receiver.

This study reviews potential scientific topics that can be investigated with the millimeter-wave continuum emission from Venus atmosphere, and presents feasibility study of the application of ALMA –Band 2 receiver in future Venus observations.

Keywords: Venus, atmosphere, ALMA

