

Observation of the Venusian Lower Atmosphere in the 1.7 μm Band by Near-infrared Echelle Spectrometer onboard PIRKA Telescope in Nayoro Observatory

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Over the past 20 years, various exoplanets have been discovered, and observations of habitable Earth-like planets have been actively promoted. Venus, which is surrounded by the CO₂ atmosphere, is one of the important observation targets for understanding the fundamental atmospheric properties of planets. The surface of Venus has the higher atmospheric temperature and pressure than those of the Earth. However, the temperature and pressure in the cloud region of Venus are similar to those at the Earth's troposphere. Recently based on the ultraviolet band absorption features toward the cloud region of Venus, the possibility that microbes such as bacteria may remain in this region has been discussed. Therefore, a more detailed understanding of how the lower and upper layers of the atmosphere circulate through these cloud regions, and how the physical and chemical environments of the atmosphere are balanced between them is expected.

The 10 m radio telescope at the Nobeyama Radio Observatory (Nagano Prefecture) of the National Astronomical Observatory of Japan has been monitoring of the millimeter-wave band spectral lines of carbon monoxide in the Venusian middle atmosphere since 2011. CO at an altitude of around 80 km shows long-term changes in the time-scale of the solar activity cycle and shorter-term ones. For a detailed understanding of these changes, it is important to promote systematic simultaneous observations of trace molecular species toward the upper and lower atmospheres by the milli/submillimeter-wave band and the near-infrared band spectroscopies, respectively.

In August 2018, a test observation of the Venusian lower atmosphere was performed at Nayoro Observatory using a near-infrared echelle spectrometer (NICE) (University of Tokyo) mounted on the PIRKA telescope (Hokkaido University). Although there were many days when the atmospheric condition was unstable due to the influence of typhoons, on 8/22, we succeeded in detecting the spectrum from the night side lower atmosphere of Venus in the 1.7 μm band. The resolution of the spectrometer was $\lambda / \delta \lambda = 5600$, the slit size was 1"×6.7", and HIP 69701 was observed as the standard star for the intensity calibration. The seeing (1 sigma) was 2.5". The profile of the obtained spectrum was well consistent with the atmospheric radiative transfer model (Y.-J. Lee et al.) of Venus using the HITEMP database.

The University of Tokyo Atacama Observatory (TAO) Project is promoted by Institute of Astronomy (IoA), the University of Tokyo with many collaborators. In 2021, NICE is scheduled to be installed on the infrared band TAO telescope with a 6.5m diameter aperture on the summit of Cerro Chajnantor at Atacama in Chile (alt. 5640 m). Near the TAO site, Atacama large millimeter-wave submillimeter-wave interferometers are operated. Therefore, it is expected that simultaneous observations toward the Venusian upper and lower atmospheres on the same day will be possible. We will report the results of the

observation with NICE and the installation plan of NICE onto TAO.

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