A circumpolar stratospheric telescope FUJIN-2 aiming at identification of a UV absorber in the Venus atmosphere

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FUJIN-2 is a project to study phenomena in the planetary atmospheres and plasmas by an optical telescope suspended by a balloon up to the polar stratosphere at an altitude around 32 km. FUJIN-2 can observe planets for a long continuous period in a wide wavelength range. Seeing is expected to be 0.1" or less at that altitude, smaller than the diffraction limited spatial resolution of a visible telescope with an aperture of 1 m. Since FUJIN-2 floats above the peak density of the ozone layer, it is possible to observe wavelengths of 280 nm by FUJIN-2. On the other hands the balloon-borne telescope has a disadvantage that its launch depends on the weather condition. We regard that the above merits of the balloon-borne telescope surpass those of the other observation platforms even the disadvantage of balloon observation is admitted.

Venus is covered with thick sulfuric acid (H_2SO_4) clouds throughout the altitude range of 45-70 km. The cloud layer, not the ground surface, absorbs solar radiation and heats the atmosphere. At an altitude of 64 km, 50% of the solar radiation is scattered and absorbed [Tomasko et al., 1980]. The Venus atmosphere also has a special general circulation called as a super rotation, which circulates the entire planet to the west. The wind speed of the super rotation reaches 100 m/s at an altitude of 70 km, 60 times faster than the rotation speed of the solid body.

Attempts to reproduce the high velocity wind by a numerical model are an indispensable approach to theoretically explain the super rotation, and so far a large number of studies have been carried out. However, insufficient understanding about the solar heating makes it difficult to build a sophisticated model which reflects the realistic solar heating and distributions of chemical species. The main reason for this is that an absorber of a broad absorption band in the wavelength range of 320 - 500 nm is still unidentified. The ultraviolet absorption band for the wavelength region shorter than 320 nm is well explained by absorption due to SO_2 centered at 283 nm. However, the absorption in the wavelength region longer than 320 nm cannot be explained by SO_2. Absorbing materials containing S (sulfur) have been proposed to explain the absorption in these several decades. Recently, it is shown that S_2O or OSSO are the most promising candidates for reproducing the edge of the absorption band at 400 - 500 nm. Some researchers propose that microorganisms are also a candidate of the unknown absorber.

The first target of FUJIN-2 is to identify the unknown absorber in the Venus atmosphere. Since the absorption ranges from NUV to the visible region which can be observed from the ground, we have to examine how precisely we can resolve the absorption structure by a ground-based observation. A test spectroscopic observation of Venus was performed with the Pirka telescope in Nayoro City, Hokkaido. As a result, an absorption spectrum at wavelengths shorter than 310 nm could not be acquired, because the signal intensity was weak in the spectral region. In addition, we could not detect the characteristic absorption spectrum of S_2O in the atmospheric absorption spectrum of Venus, though the spectrum clearly showed absorption in the wavelength range shorter than 550 nm.

A Cassegrain telescope with a cler aperture diameter of 400 mm has been under development for FUJIN-2. FUJIN-2 is equipped with the same spectroscopic and imaging observation system used for the observation at Nayoro. Attitude of the gondola is 3-axis stabilized by two pairs of control moment gyros, while only azimuth of the gondola was controlled for FUJIN-1. In order to confirm the performance of the attitude control and guiding system a ground-based test experiment is planned to be carried out in Taiki-cho, Hokkaido in November 2019.