Spectral imaging of Saturn's atmosphere using liquid crystal variable filters in near-infrared and visible spectral ranges

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Previous studies demonstrated that haze consisting of sub-micron particles exists in the Saturn's stratosphere and upper troposphere. However, there are still open questions about the structure and constituent particles of the haze, and what kinds of physical processes produce the haze. Knowledge of the physical properties of the haze particles and their location in the atmosphere is essential for our understanding of the dynamics of the atmosphere and the influence of seasonal changes whose cycle is about 29 earth years (equal to the orbital period of Saturn). Spectral information is necessary in order to examine the haze structure. Since methane existing in the Saturn's atmosphere absorbs some specific wavelengths, it enables us to derive the vertical haze structure from differences in the intensity of methane absorption. In the past, imaging observations of Saturn were carried out only at several wavelengths and spectroscopic observations carried out in particular regions of Saturn. Consequently, we need higher spectral resolution imaging to investigate 3-dimensional haze structures. Although the Cassini spacecraft is in an orbit around Saturn and is providing a great deal of new data, long-term ground-based observations are still indispensable for examining the seasonal changes in Saturn's atmosphere.

Considering these backgrounds, we used liquid crystal variable filters (LCVF) and high-speed CCD camera (PixelVision, 652 x 494 pixels), which can take Saturn's images with high spectral and spatial resolution. There are two LCVFs covering visible region (425-750 nm) and near infrared region (650-1100 nm). Using them we can obtain Saturn's images over a wide wavelength range of 425-1100 nm. The center wavelength of these LCVFs can be selected at 1 nm intervals. The FWHM is 5 nm in the visible region and 10 nm in the near infrared region.

The LCVF and CCD camera were attached to a 60 cm reflecting telescope located at the Iitate observatory, Fukushima. The center wavelength of the filter was shifted at 5 nm intervals, ranging 650-1000 nm and the exposure time of the camera was set as 500 msec. We could acquire several dozen of Saturn's images at each wavelength. These images include degraded images due to the atmospheric sintilation. We therefore selected images with sharp outlines and superposed these selected images to improve S/N values. Then, we extracted absorption spectra of sunlight and earth's atmosphere using the spectra of Saturn rings or standard stars.

The obtained spectra of Saturn's atmosphere near the center of the disk are found to be consistent with past results. We will discuss a possibility to derive the 3-dimensional haze structure of Saturn from our spectral imaging observations at the methane band.