The imaging system for Jupiter observation using liquid crystal variable filters in near-infrared and visible spectral ranges

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It is known that the major cause producing the zonal structure of clouds in Jupiter is counter flowing eastward and westward winds called zonal jets and the difference in the altitude of clouds. We do not know, however, what kinds of physical processes produce such a wind system and clouds structures. The optically thickness of clouds obstruct us to observe the movement of the atmosphere under clouds directly. But the dynamics can be comprehended by investigating the structure of altitude of cloud tops. Although the horizontal motions of the clouds have been investigated since the 1960s, studies on the vertical motions of cloud started in the 1990s. Spectrum observation is effective in order to know the structure of clouds because the methane absorbs some specific wavelengths, consequently, it enable us to derive the vertical cloud structure from differences in the intensity of methane absorption. In the past observations of clouds, however, images were obtained at only several wavelengths since one filter with fixed wavelengths was used per each absorption band. Recently the Galileo space craft took images of Jupiter at about 30 wavelengths, ranging from 410 to 5200 nm, but we need the observations taking images at more many wavelengths to comprehend a smooth and three-dimensional structures of clouds.

Considering these circumstances, we have developed a new imaging system which can take cloud images of Jupiter over a wide wavelength range with high wavelength resolution. The most important component of this system is two liquid crystal variable filters covering the wavelength ranges of 425-750 and 650-1100 nm. Using these two filters and a cooled high-speed CCD camera (PixelVision, 652x494 pixels), we can obtain the cloud images of Jupiter over the wavelength range of 425-1100 nm continuously. The center wavelength of these liquid crystal variable filters can be selected at 1nm intervals. The full widths at half maximum are 5 and 10 nm respectively. We can obtain the detail spatial information of spectrum by the observation of Jupiter at 676 wavelengths maximum. This imaging system is attached in a 20 cm reflecting telescope located in the Tohoku University campus, Sendai. We carried out test observations of Jupiter to check the performance of the developed system. The center wavelength of filter was shifted by 5 nm, ranging 425-750 nm. We acquired images of Jupiter at 66 wavelengths. To avoid the influence of seeing the exposure times were 0.5-1.0 s and less distorted images were selected and composed. We obtained a spectrum of atmosphere of Jupiter and confirm a possibility to derive the vertical cloud top structure of Jupiter from obtained data. The observation system and the result of these test observations will be reported and discussed. We will also present an applications of the developed system to balloon and satellite telescopes for observations of planetary atmospheres.