Development of 1-5 micron infrared camera for planetary atmospheric observations

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Recent progresses of infrared imaging technique bring us a breakthrough in measurements of Venusian middle and lower atmospheres revealing the cloud pattern and CO distribution at an altitude range of 50 - 70 km. It is essential to make continuous measurements for understanding Venusian atmospheric phenomena such as super rotation and meridional circulation. However, such continuous measurements are prevented due to limited machine time on large telescopes.

Owing to these circumstances, we have developed an infrared camera dedicated to planetary observations. This camera has a collimator optical system with combination of a 256x256-pixel InSb focal plane array with which sensitive wavelength of 1 - 5 microns and spatial resolution of 0.43 arcsec/pixel can be attained. The camera will be installed at the Cassegrainian focus of the Iitate Telescope (F12, D=525 mm) of Tohoku University.

Double filter turrets are located in the collimator section, and each turret has eight filter positions. Three filters with center wavelengths of 2.294, 2.329 (for Venusian clouds), and 3.414 microns (for Jovian aurora) are already mounted on the turret. The outer shell of the instrument is a vacuum chamber, and vacuum level of 3.5 x 10ˆ-6 torr was attained. On the other hand, the inner part is a radiation shield for shielding the radiation from the outer chamber and for thermal insulation, and the radiation shield is mounted on the chamber with stress relief to avoid misalignment of optical axis due to thermal contraction. The helium refrigerator whose power of 10 W at the first stage and 3 W at the second stage is used, and it was confirmed that the radiation shield could be cooled to 92 K, and that the sensor was cooled to 35 K in thermal vacuum tests. The total camera weight is totally 67 kg, and the camera and electronics could be mounted on the Iitate Telescope using additional balance weight.

From the electrical and functional tests for driving a sensor and image data processing, we finally succeeded to obtain an infrared image of filament of a halogen lamp. The estimated sensitivity is 28.9 kilo-Rayleighs/sec/count, and the read-out time is 72.1 ms/frame, and minimum exposure time is 55 ms. By taking a flat image data of cold plate with a temperature of 77 K, it is found that the random noise amounts to 7 counts, which corresponds to 202 kilo-Rayleighs.

Using this camera, we will be able to obtain the disk of Venus (60 arcsec), Mars (25 arcsec), and Jupiter (45 arcsec) mapped onto 130, 58, and 100 pixels, respectively. Particularly, from 2.295 and 2.330-micron observation with 1 sec exposure, the Venusian clouds and CO distribution pattern is expected to be obtained with signal-to-noise ratios of 77 and 20 respectively. On the other hand, 3.4-micron Jovian auroral emission is expected to be observed with signal-to-noise ratios of 33 (1 min. exposure time) and 100 (5 min. exposure time), respectively.