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The Circumpolar Stratospheric Telescope FUJIN for Observations of Planets

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The planets have been optically observed by spacecraft and ground-based and space telescopes, which have provided many information on their atmospheres and plasmaspheres. It is important to conduct long-term continuous observations for studies on time-dependent events therein. Observations by spacecraft have an advantage that it is able to observe planets intensively with high spatial resolution during a rather short period (several years), however the observation geometry is not constant as the spacecraft orbits around the planet. Moreover, it is difficult to detect a fluctuation with time scales close to an orbiting period or a decade using an orbiter. On the other hand, remote sensing from the Earth can monitor a planet from a fixed direction for a long time in succession. A ground-based observation may accomplish high spatial resolution by using a telescope with a large diameter, though it is usually limited by seeing. A period of planetary observation from an observatory in the middle and low latitudes is not as long as 10 hours. Three observatories are required at least to continuously monitor a planet. Thus, observations of planets by spacecraft and ground-based telescopes are complimentary.

Then, we have been promoting the FUJIN-project, which aims at continuous observations of planets using a telescope lifted by a balloon in the polar stratosphere. FUJIN-2 will be launched at ESRANGE in Kiruna, Sweden in the window from May to July in 2016. The gondola will be recovered in Scandinavia after a circumpolar flight for two or three weeks. Although the primary study subject of the FUJIN-2 was Venus, we changed Venus to Jupiter. Because the diameter and aspect ratio of Venusian disk changes as its phases, a study subject of Venusian atmosphere depends on its phase. However, a chance of observation is quite limited. A launch window of a balloon cannot be freely selected. A circumpolar flight can be performed only during the summer season from May to July. So we concluded that Venus is not a suitable target of FUJIN. But, Jupiter can be observed under an almost same condition throughout the year except for the period of superior conjunction. We will observe Jupiter at the deepest absorbing band, methane (˜890nm), in the visible to near-infrared region, and obtain a phase velocity and a wave number of planetary-scale waves and background wind velocity at a bright haze area near the polar region. Using these data, we will deduce parameters which are essential to identify the wave structure as the Rossby wave. Also, we will detect the cumulonimbus cloud in Jupiter and compare the positions of the clouds and the zones and the belts in the Jovian atmosphere, and study dynamics in the cumulonimbus cloud in Jupiter.

A simulation of the electric power in the polar orbit was performed. During daytime SCPs (Solar Cell Panels) of which the nominal maximum power is 540 W generates electric power for FUJIN-2, and during nighttime Li-ion batteries supply electric power. Under the condition of a circumpolar flight of FUJIN-2 from July 1 to 14 in 2016, we estimate that the SCPs can supply power larger than 330 W in average. Considering power required for charging the Li-ion battery the electric power which the system can consume is about 330 W and 191 W during daytime and nighttime, respectively.

Apart from that the control system of gondola (CMGs and DCP), a drive circuit of motors, an interface of CCD, a hood and its rotation system, and an extension of an airtight chamber of electric system are under development. Optical alignment of the telescope will be adjusted, and the image quality will be tested. After all of the sub-systems are integrated, a thermal vacuum test under the stratospheric environment will be conducted in fall in 2015. According to the test result the electric power required for the heaters will be determined. The functional tests will be completed by the end of 2015, and the FUJIN-2 gondola will be shipped to ESRANGE.

Keywords: FUJIN project, Jupiter, the polar stratosphere, continuous observations, balloon, FUJIN-2