R009-13
Zoom meeting D ：11/1　PM1　(13:45-15:30)
14:00-14:15

地上望遠鏡と光電子倍増管を利用した惑星雷発光の観測

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Planetary lightning flashes observation using ground based telescope with Photomultiplier tube

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Lightning in planetary atmospheres is generated by the convections. The detection of lightning can be used to understand the atmospheric dynamics and the large-scale structures on other planets. In the case of Jupiter, the lightning flashes have been observed. Previous studies (e.g. Gierasch et al., 2000; Ingersoll et al., 2000) suggested that zonal jet is driven by the merging of small-scale eddies that receive their energy from moist vertical convection which similar to thunderstorm on the Earth. Although it is difficult to observe the vertical convections within the dense clouds, lightning is correlated with the cumulonimbus, and thus lightning observations can be used to investigate the formation of Jupiter's zonal jet. In Venus, the existence of Venusian lightning is controversial for 40 years. The possible generation mechanisms are convection, volcanic, or aeolian triboelectric activity. In the previous study, there are radio wave observations and optical observations with CCD. Although some of the observations have detected lightning, no unambiguous lightning flash events have been detected by LAC (Lightning and Airglow Camera) onboard AKATSUKI Venus Climate orbiter (Lorenz et al., 2019). There is no robust evidence of existence the lightning because it is difficult to distinguish between the lightning signal and the electrical noise or other plasma waves, the observation area is limited, and the CCD's sensitivity is not enough to detect the lightning. If we can confirm the existence of Venusian lightning like the Jovian, it could also be useful as an indicator of Venusian atmospheric dynamics.
To reveal the relationship between lightning and atmospheric dynamics of Jupiter and Venus, we have developed the Planetary Lightning Detector (PLD), which is the high-speed and high-sensitive lightning detector mounted on a 1.6-m ground-based telescope by using a photomultiplier tube to observe the planetary lightning flashes. Using this telescope we can get an observation period at least one hour per day for several months, longer than the previous studies. We can obtain the light-curve of flash events with a sampling rate of >20 s^{-1} to distinguish the other flashes and decrease the contamination of dayside light and sky background to improve the Signal-to-Noise ratio. We will reveal the distribution of lightning and its frequency, and then we derive the distribution of a few tens km scale vertical convections. We compare the results and the variation of wind velocity and cloud distribution to reveal the atmosphere dynamics.
777.4 nm is the strongest emission line in the Venus lightning spectra (Borucki et al. 1996). PLD equips narrowband filter (FWHM = 1 nm) of 777 nm. PLD observes the light curve by using a photomultiplier tube. The minimum exposure time is 50 microseconds. The maximum time resolution is about $2x10^4$ points/s. The FOV of PLD can be changed to 5", 10", 30", 60" pinhole, and 2"x11" slit by using field stops. The slit or pinhole is used for Venus's night-side observation. To obtain the lightning's light curve, we operate the bandpass filter or other signal process to remove the shot noise and large time scale variation by Earth's atmosphere. We have observed Venus and Jupiter by using PLD from May 2020. In our Venus observation, we could find several possible lightning events having large count values above 4-sigma of the background level from the May data. The number of the detected event is 3 events per 2000 s observation period. The estimated peak energy of light-curve is about 10^8 J. The calculated rate of flash event is about 10^{-11} [$s^{-1}km^{-2}$]. It is ten times larger than the rate of previous study $2.7x10^{-12}$ [$s^{-1}km^{-2}$] (Hansell et al., 1995). Although, our observation duration is not enough to compare with the previous study. we will increase the total observation time more than 3 hours.
In this time, we will introduce the developed lightning observation instrument PLD and present our observation results obtained from May 2020. We will also show our future coordinated observation with LAC.