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Zoom meeting D ：11/2 PM1 (13:45-15:30)
14:45〜15:00

Observation and analysis of optical emission by lightning in Jupiter and Venus with high-speed photometer

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The investigating the lightning can be used to understand the atmospheric dynamics on the other planets. Sometimes the lighting is generated by the moist convection in the planetary atmosphere. Jovian lightning has been detected by some spacecraft by night-side optical imaging and radio wave observation. Previous studies (Gierasch et al., 2000; Ingersoll et al., 2000) suggested that zonal jet is driven by the many small-scale eddies which are received their energy from the moist convection. Moist convection is expected to be correlated with the Jovian lightning distribution, like as on Earth. The monitoring of lightning is useful to investigate the local and general circulation, energy transport, and composition of Jupiter and other planets. In the case of Venusian lightning, its existence 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. It is difficult to distinguish between the lightning signal and the electrical noise or cosmic ray, the spacecraft and ground-based observation area are limited, and the CCD's sensitivity is not enough to observe the lightning on disk of Venus. If we can reveal the existence of Venusian lightning, it could be used to promote an understanding of the Venusian atmospheric dynamics.

We have developed the Planetary lightning Detector (PLD) to observe the optical planetary lightning flashes. We use the PLD observed data to understanding the relationship between lightning and atmospheric dynamics by comparing it with other observation data. The PLD is mounted on the 1.6-m Pirka telescope. Using this ground-based telescope, we can obtain an observation period of at least one hour per day for several months, longer than the previous studies. The PLD is the high-speed and high-sensitive photon-counting sensor by using the photomultiplier tube to obtain the light curve of lightning optical flashes. We can obtain it with a sampling rate of over 20 s^{-1} to distinguish the other flashes and decrease the contamination of sky and dayside light variation and improve the Signal-to-Noise ratio. The observed data be used to obtain the distribution of lightning and its frequency. The PLD equips narrowband filters of 777 nm (FWHM = 1nm) and 656 nm (FWHM = 1nm) for Jovian and Venusian lightning. These wavelengths are the strongest emission light of the experienced lightning spectrum (Borucki et al., 1996). We can select the FOV of PLD from some pinholes and a slit to observe appropriate Jovian dayside and Venusian night-side disk. PLD observes the background variation simultaneously by using a second photomultiplier tube with a broadband filter to estimate the variation of background (e.g., sky, dayside light) after finishing our improvement work. We have observed Venus and Jupiter since 2020 while improving. We analyze the data with denoising to remove the shot noise and CR with moving average or wavelet denoising. In our Venus observation, we obtain a few hour observation period. We could find several possible lightning events having large count values above the background level.The estimated peak energy of light-curve is about from 10^6 to 10^8 J. However, we have not yet been able to estimate the frequency of occurrence due to insufficient analytical processing such as noise removal.The estimated event rate is about 10^{-11} [$s^{-1}km^{-2}$], which is larger than result of previous study 2.7x10^{-12} [$s^{-1}km^{-2}$] (Hansell et al., 1995). The LAC onboard AKATSUKI Venus Climate orbiter should record the lightning more frequently if the estimated results are correct. Although, our observation duration is not enough to compare with previous study. It is necessary to increase the observation time up to 3 hr in total.

In this time, we will introduce the developed lightning observation instrument PLD, the analysis method, and present our observation results.