Contribution ID: **718** Type: **Talk**

Investigation of the connection between gamma-ray glow and cosmic-ray in the next generation “thundercloud project”

Wednesday 16 July 2025 14:05 (15 minutes)

The connection between cosmic ray air showers and thunderclouds has become a major research topic in recent years in high-energy atmospheric physics.
One of the open questions is whether cosmic rays are involved in triggering a “gamma-ray glow”. A “gamma-ray glow”is a phenomenon in which gamma-ray increases for tens of seconds to several minutes during the passage of thunderclouds. A strong electric field is generated by charge separation in the developed thundercloud. When high-energy seed electrons pass through this region, electrons are accelerated and amplified to relativistic speed. Relativistic electrons interact with the atmosphere, producing gamma rays by bremsstrahlung, which reach the ground. The origin of these seed electrons is still unknown, but one candidate is thought to be electrons from cosmic ray air showers.
To track moving thunderclouds, Citizen Science “Thundercloud Project”has installed about 70 gamma-ray detectors “Cogamo”along the Japan Sea coast area in winter since 2018. The Cogamo detectors are equipped with 5×5×15 cm CsI (Tl) scintillators and store radiation event data with a time resolution of 100 μs and housekeeping data every 10 seconds. This multi-point observation has revealed temporal changes in gamma-ray glow such as the growth, disappearance, as well as spatial distribution of the height and size of the electron acceleration region in thunderclouds.
In the FY2024 observations, in addition to the previous mapping observations of the Cogamo detectors, a new detector was installed at Kanazawa University to investigate the relationship between cosmic ray air showers and gamma-ray glow. This detector can discriminate between charged particles and gamma rays using the MoMoTarO board, which is being developed for lunar water resources exploration and can acquire 4-channels event data with a time resolution of 100 ns. A plastic scintillator EJ200 (5×15×1 cm) is mounted under the CsI (5×5×15 cm) scintillator so that charged particles and gamma rays from the vertical direction can be discriminated by 2-channel coincidence. To detect photonuclear reactions (Enoto et al.,2017), a plastic scintillator EJ270 (5×5×1 cm) doped with Li, which can detect neutrons, is mounted. GAGG (2×2×1 cm) is also installed to detect TGF(terrestrial gamma-ray flash), which has a large count rate within several ms.
Around 21:30 on February 19, 2025, a gamma-ray glow with a duration of about 2 minutes was detected with the new detector, mainly by the CsI(Tl) scintillator. A similar gamma-ray glow was also observed at the nearby Cogamo detector, which was located about 1 m away from the new detector. The maximum count rate was about 2-2.5 times the background, which was weak among the glows observed in Kanazawa. At this time, EJ200 showed an intensification of about 1.1 times from the background level.There was no noticeable intensification in the count rate of the EJ270 scintillator. A slight brightening was observed by the small effective area GAGG.
In this talk, I will report the results of the gamma-ray glow observations with the new detector and summarize improvements for next year’s observation plan.

Collaboration(s)

Author: TSURUMI, Miwa (Kyoto University)

Co-authors: Dr WANG, Daohong (Gifu University); Dr DINIZ, Gabriel (National Institute of Space Research); Dr TSUCHIYA, Harufumi (JAEA); Dr KATAOKA, Jun (Waseda University); Dr NAKAZAWA, Kazuhiro (Nagoya University); Mr NAKAYAMA, Kazuya (Kyoto University); Dr KAMOGAWA, Masashi (University of Shizuoka); Dr MIYAKE, Shoko (Gifu National College of Technology); Dr MORIMOTO, Takeshi (Kindai University); Dr SHINODA, Taro (Nagoya University); Dr ENOTO, Teruaki (Kyoto University); Dr WU, Ting (Gifu University); Mr TAKAGAKI, Toru (TAC); Dr NAKAMURA, Yoshitaka (Kobe City College of Technology); Dr IKKATAI, Yuko (Kanazawa University); Mr OMATA, Yuya (Kyoto University)

Presenter: TSURUMI, Miwa (Kyoto University)

Session Classification: CRI

Track Classification: Cosmic-Ray Indirect