



Contribution ID: 89

Type: Poster

Lightning-related cosmic ray air shower flashes detected by LHAASO-KM2A

Lightning is a common electrical discharge phenomenon in the atmosphere, which involves processes of lightning leader and return stroke. The strength of the atmospheric electric field (AEF) in the lightning leader can be up to 3000-4000 V/cm. In such a strong field, the relativistic runaway electron avalanche (RREA) mechanism could be initiated by the secondary electrons in extensive air shower (EAS). A large number of electrons and bremsstrahlung photons are produced in RREA process. These particles associated with downward lightning activity can be detected by ground-based experiments. As a sub-array of LHAASO, KM2A contains 5216 electromagnetic particle detectors (EDs) and 1188 muon detectors (MDs). The high altitude of LHAASO (~4410 m a.s.l.) and the large area of KM2A (~1.3 km²), made LHAASO-KM2A suitable to study the lightning-related cosmic ray air shower flashes (referred as TGF-like, similar to the TGF detected by satellite-based experiment). In this work, by analyzing the KM2A data and the information about thunderstorm/lightning at LHAASO site, the characteristics of candidate TGF-like events, such as intensity variations and spatiotemporal distributions are analyzed. It can be found that the flux increases abruptly. The temporal distribution becomes notably broader, with several hundred microseconds in duration. The spatial distribution becomes diffuse, even covering the entire KM2A array. These results offer valuable insights into the variation of KM2A data, and provide the important information to study the lightning flashes in atmosphere.

Collaboration(s)

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Session Classification: PO-1

Track Classification: Cosmic-Ray Indirect