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Development simulation of relativistic runaway electron avalanche in atmosphere with CORSIKA

Terrestrial Gamma-ray Flash (TGF), accompanied by lightning leader in atmosphere, is one of the hot topics in the high-energy atmospheric physics. To understand the downward TGFs detected by ground-based experiments, Monte Carlo simulations are performed with CORSIKA. The processes of relativistic runaway electron avalanche (RREA) induced by cosmic ray secondary electrons (referred as seed electrons) in atmosphere with strong electric field are studied. The energies of seed electrons are chosen as a series of values in the range of 1–200 MeV. Our results indicate that the number of electrons, positrons, and photons in RREA process increases exponentially. The amplitudes of enhancement are strongly dependent on the field strength and the layer thickness, and also on the energy of seed electron. For a seed electron with 100 MeV, after pass through the atmosphere with an electric field of -3000 V/cm and a thickness of 1000 m, the number of secondary electrons, positrons, and photons can reach up to 1.15×10∧5, 36, and 1.4×10∧5, respectively. The ratios of bremsstrahlung photons to electrons (Nph/Ne) in RREA process are discussed in this work. We find the ratio values are the function of the electric field strength, and also are related to the thickness of the electric field layer. These simulation results are beneficial for studying the characteristics of TGF source regions.

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