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High energy atmospheric physics and Terrestrial Gamma-ray Flashes

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Thunderstorms have been recently established as the most energetic natural particle accelerators on Earth. Starting from the early work by Wilson in 1925 suggesting the acceleration of electrons up to relativistic energies in thunderstorm electric fields, it took about 75 years to build up a sufficiently large observational frame and reach a general consensus on the existence of this phenomenon. The most violent manifestations of this process are Terrestrial Gamma-ray Flashes, sub-millisecond bursts of gamma-rays with energy up to several tens of MeV produced in thunderstorms and typically detected from space by detectors designed for high-energy astrophysics. First discovered in 1994 by the BATSE instrument onboard the NASA CGRO spacecraft, TGFs are now entering a golden age thanks to the wealth of observations delivered by the AGILE, RHESSI and Fermi satellites. Despite a general consensus on the underlying physical mechanism, several questions are still open, namely on the TGF-lightning relation, the maximal energy, and the pervasiveness of the phenomenon. In addition to TGFs observed from space, impulsive bursts of radiation as well as long-lasting emissions have been observed by detectors onboard research airplanes and deployed on ground, suggesting that the production of energetic radiation within thunderstorms is a much more pervasive phenomenon than previously thought. In this presentation I will review the state of this rapidly-growing field, focusing on the most recent results and the forthcoming observational programs.

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