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Space-borne Observations of Intense Gamma-ray Flashes (TGFs) above Thunderstorms

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Abstract

Intense millisecond flashes of MeV photons are being observed with space-borne detectors. These terrestrial gamma-ray flashes (TGFs) were discovered with the Burst and Transient Source Experiment (BATSE) aboard the Compton Gamma-Ray Observatory (CGRO) in the early 1990s. They are now being observed with several other instruments, including the Gamma-ray Burst Monitor (GBM) detectors on the Fermi Gamma-ray Space Telescope. Although Fermi-GBM was designed and optimized for the observation of cosmic gamma-ray bursts (GRBs), it has unprecedented capabilities for TGF observations. The TGFs usually have extremely hard continuous spectra, typical of highly-Comptonized bremsstrahlung radiation. These spectra are harder than those of GRBs, with photons extending to over 40 MeV. The most likely origin of these high-energy photons is bremsstrahlung radiation produced by a relativistic “runaway avalanche” electron beam. Such a beam is expected to be produced in an extended, intense electric field in or above thunderstorm regions. The altitude of origin and beaming characteristics of the radiation are quite uncertain. These TGFs may produce an appreciable radiation dose to passengers and crew in nearby aircraft. They have generated considerable observational and theoretical interest in recent years. Instruments are being designed specifically for TGF observations from new spacecraft as well as from airborne platforms.