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Characteristics of the Relativistic Feedback Discharge and the Energetic Radiation Produced

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Terrestrial gamma-ray flashes (TGFs) are brief bursts (typically <1 ms) of multi-MeV radiation originating from thunderclouds in the earth's atmosphere. They were first detected by BATSE/CGRO and have since been measured by several spacecraft, including RHESSI, AGILE, and Fermi. It has been established that TGFs are produced inside the thunderclouds by bremsstrahlung interactions of energetic electrons, known as runaway electrons, with air atoms.

The relativistic feedback discharge model developed by Dwyer [JGR, 117, A02308, 2012] has successfully explained many properties of TGFs. In this talk, we report a new modeling study on the relativistic feedback discharge and energetic radiation produced following Dwyer's work. A new numerical code has been independently developed, which implements the same energetic particle transport model as the work of Dwyer [2012] and, in addition, includes components for modeling transport of low-energy electrons and ions [e.g., Liu and Pasko, JGR, 109, A04301, 2004]. The modeling results confirm all the aspects of the work by Dwyer [2012]. Most importantly and generally, intense gamma ray flashes can be produced naturally by the relativistic feedback discharge developing in large-scale thundercloud and lightning fields. Our study also indicates that the durations of the TGF pulses produced by the relativistic feedback discharges vary from tens of microseconds to several milliseconds, depending on the thundercloud field configuration. In particular, millisecond-long TGF pulses can be produced by a self-propagating relativistic feedback streamer. We investigate the characteristics of the relativistic feedback discharge and discuss our results in the context of the observed properties of TGFs.