Relativistic Feedback Discharge Theory

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The relativistic feedback mechanism generates large numbers of relativistic runaway electrons avalanches (RREAs) through a positive feedback effect produced by backward propagating positrons and Compton backscattered x-rays. This mechanism allows the production of runaway electrons to become self-sustaining, creating very large fluences of runaway electrons and bremsstrahlung gamma-rays, making relativistic feedback a good candidate for explaining terrestrial gamma-ray flashes (TGFs). The energetic electrons created by the relativistic feedback mechanism ionize the air, creating electron-ion pairs. These electrons and ions then produce large electrical currents that discharges the electric field. The resulting change in the electric field influences the feedback rates, which in turn influences the discharge rate. Because of the close connection between the relativistic feedback mechanism and its resulting electrical discharge, the relativistic feedback discharge must be considered as a whole. For instance, it has been found that as the high field region discharges inside a thundercloud, intense pulses of relativistic feedback generated runaway electrons and hence gamma-rays are sometimes produced, illustrating that the relativistic feedback discharges are complicated and have interesting and varied behaviors. It has been found that the electrical currents produced by this mechanism may sometimes rival those produced by lightning, and so relativistic feedback discharges are an alternative path for thunderclouds to discharge themselves. In this talk, the theory of relativistic feedback discharges is discussed and new results are presented. In particular, the relativistic feedback discharges in the high field, x-ray feedback regime and the RF emissions produced by relativistic feedback discharges will be presented.