1 Lightning Generated Gamma Ray Bursts

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Brief Summary

The prime focus of this research effort is to advance the state of understanding of correlation between lightning strokes and γ—ray flashes. Key issue addressed was the revision of the existing models of runaway breakdown in the stratosphere due to low altitude lightning, which are related to the source of γ—ray flashes. The revision includes the assessment of the effect due to geomagnetic field on the development of runaway discharge.

Runaway electron discharge in the presence of geomagnetic field. A new type of the electric breakdown, called runaway breakdown or runaway discharge was discussed recently by Gurevich, Milikh and Roussel-Dupre [Phys. Lett. A, 165, 463, 1992]. In this process high energy electrons are accelerated by the electric field of a thunderstorm to relativistic energies and cause the ionization of the air. This effect has implications for runaway discharges in the atmosphere caused by low-altitude lightning. The runaway discharges manifest themselves as fluxes of γ−rays as previously observed by the detector aboard Compton Gamma Ray Observatory. The observed spectra of the γ−ray flashes are in a good agreement with the predictions of the theory of runaway breakdown. However, the geomagnetic field plays a significant role in the runaway discharge due to thunderstorms for heights above 20 km, where the cyclotron frequency of relativistic electrons exceeds their collision frequency [Papadopoulos et al., 1996].

In this project we generalized the theory of the electron runaway and runaway discharge to the case of a laminar electric field at an arbitrary angle to the magnetic field

and derived the relevant threshold conditions [Gurevich et al., 1996]. It was shown that the conditions of runaway process depend on the angle between the electric and magnetic field. Since the static electric fields from thunderclouds are directed almost vertically, one can expect a significant difference in the properties of high-altitude runaway discharges occurring at equatorial and high-latitude regions. This effect could be important for the interpretation of γ—ray flashes observed by the GRO, since the GRO views the equatorial region, where the electric and geomagnetic fields are almost perpendicular to each other, so the influence of geomagnetic field on runaway process is the strongest.

Publications

1. K. Papadopoulos, G. M. Milikh and J. A. Valdivia, Comment on "Can gamma radiation be produced in the electrical environment above thunderstorms?" by B. Chang and C. Price, *Geophys. Res. Lett.*, **23**, 2283–2284, 1996.
2. A. V. Gurevich, J. A. Valdivia, G. M. Milikh and K. Papadopoulos, Runaway electrons in the atmosphere in the presence of a magnetic field, *Radio Science*, **31**, 1541–1554, 1996.

Invited talk

1. G.M. Milikh, K. Papadopoulos, J.A. Valdivia, and A.V. Gurevich, Runaway breakdown in the presence of a magnetic field, Workshop on Sprites and Blue Jets, Phillips Laboratory at Hanscom AFB, Boston, November 1995.

Contributed conference paper

1. Runaway breakdown in the presence of a magnetic field, A.V. Gurevich, J.A. Valdivia, G. M. Milikh and K. Papadopoulos, EOS, Trans. AGU, Fall Mtg. Supple., **76**, F106, 1995.