

WHISTLER WAVE INSTABILITY AND GAMMA RAY
FLASHES IN THE ATMOSPHERE

Surja Sharma, Parvez Guzdar, Gennady Milikh
University of Maryland, College Park, Maryland

Whistler waves generated during a lightning play an important role in the generation of energetic electrons and their propagation to higher altitudes. The relativistic electrons produced by cosmic ray showers during a thunderstorm can form the seed population that leads to a runaway discharge at an altitude of about 5 km. In such a discharge the energetic electrons ionize the neutral gas, thus producing thermal electrons which are accelerated to runaway energies by the thunderstorm electric field, and thus generating further ionization. These relativistic electrons drive the whistler waves unstable and lead to the formation of ducts by self-focusing. These ducts in turn facilitate the propagation of the energetic electrons to heights of about 30 km. At these altitudes the gamma rays produced by bremsstrahlung of the relativistic electrons can escape the atmosphere, and are well correlated with the gamma ray flashes detected by spacecraft, e.g., Compton Gamma Ray Observatory. The focus of this paper is on the instability when a beam of hot magnetized electrons interacts with whistler waves in the atmosphere. The drift of the energetic electrons relative to the bulk electrons leads to a negative energy instability of the whistlers. The growth rate of the instability depends on the number density of the energetic electrons and their collision rate, and peaks at about 25 km. The runaway breakdown, which is essential for the whistler instability, develops under conditions similar to those leading to the generation of strong narrow bipolar radio pulses, which have been observed recently. The correlation between these two phenomena is under study.

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1. (a) Surja Sharma
University of Maryland
Department of Astronomy
College Park, MD
20742 USA
ssh@umd.edu
- (b) 301 405 1528
- (c) 301 405 2929
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3. (a)
4. I - Invited Paper, Program
chair: Yakov Dimant
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