Kinetic theory of gas discharge under condition of longitudinal pressure and electric field gradient

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Investigation of phenomena caused by thunderstorm activity in the atmosphere is a strategic and applied value. Papers [1, 2] demonstrate a unique relationship between the occurrence of powerful X-ray flashes in the atmosphere and the formation of "blue jets". Proposed model is the beginning of a way to describe this phenomenon. The task conditions of our numerical experiment are similar to those observed in nature (no uniform distributions for field and pressure take place). We use a circuit with a series-connected discharge gap and a charged capacitance. The gap is the spherical sector filled with nitrogen with a pressure gradient from 1.0 to 0.1 of atmospheric value (from cathode to anode coordinates).

We assume a generation of runaway electrons plays an important role in the breakdown phenomenon. Therefore, for an adequate simulation we use the fundamental principles of electron physical kinetics. Namely, the system of equations includes the Boltzmann kinetic equation for the electron distribution function with the modeling collision integral, the continuity equation for the discharge current, and the Kirchhoff equation for the electric circuit. The numerical solution is carried out by grid difference schemes. The proposed method makes it possible to simulate an electrical breakdown with sufficient accuracy and to obtain such important characteristics as the discharge current, the distribution of the electric field in the gap, the energy spectrum of the electron component at any time. The proposed method for describing the discharge was successfully tested earlier for high-pressure discharges and showed good agreement with experiment [3].

References

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