the energy- flux change-over effect in the pinch dynamics

A.V. Gordeev

NRC “Kurchatov Institute”, Moscow, Russia, [gordeev@dap.kiae.ru](mailto:gordeev@dap.kiae.ru)

The pinch compression of the plasma structures usually ends in the stagnation phase, where the near-axis current structure with the electrons, drifting in the crossed electric and magnetic fields, is formed in the framework of the following equations [1]

. (1)

Such current filament represents by the account of the vorticity  some sort of the electron magnetic self-insulation in the absence of the inner conducting electrode. In the pinching process, the change-over from the radial energy flux  to the longitudinal energy flux  happens, what gives rise to the filament birth due to the condition , where  is the voltage drop across the pinch gap [2]. Moreover, the cathode is placed on the axis, where the relativistic electrons move, and the periphery plasma plays the role of an anode. As a result the changing of the current structure gives the increased effective resistance in the pinch gap

, (2)

where  is the Ohmic resistance. Such increase of the resistance provides the very high radiation power up to  terawatt [3]. Also the similar processes may be responsible for the lightning leader forming, when the once created plasma medium in the lightning channel can be restarted due to the photoionization, so that the relativistic current filament generated in the previous leader step produces the radiation pulse, which appears by the electron scattering in the separation region between the subsequent leader steps. It is the longitudinal electric field that is responsible for the electron acceleration inside the current filament in the framework of the following equation

    (3)

where  is the longitudinal electric field,  is the atmosphere density,  is the summary cross-section of the electron scattering. In the process, the periodic destruction of the filament magnetic “frame” results in the separated lightning leader steps with the step size on the order of  cm, what is in reasonable agreement with [4].

References

1. Rudakov L.I., Babykin M.V., Gordeev A.V. et al.// In: The Generation and Focusing of The High-Current Relativistic Electron Beams, ed. L.I. Rudakov. Energoatomizdat, Moscow, 1990.
2. Gordeev A.V. and Losseva T.V.// Plasma Physics Reports, 2009, v. 35, N 2, p. 118.
3. Cuneo M.E., Waisman E.M., Lebedev S.V. et al.// Phys. Rev. E, 2005, v. 71. p. 046406.
4. Rakov V.A., Mallick S., and Dwyer J.R.// In: Thunderstorms and Elementary Particle Acceleration, Moscow, 9-11 July, 2012. Book of Abstracts, p.37.