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FORMATION OF SUPRATHERMAL ION DISTRIBUTION IN A PINCH DISCHARGE *)

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In gas Z-pinches, at the moment of waist compression, conditions can be formed under which the relaxation of the ion component of the plasma occurs more slowly than the energy gain by high-energy ions. This effect arises as a result of the compression of MHD instability. A strongly increasing magnetic field, together with plasma leakage through the ends of the waist, leads to an increase in temperature and plasma density.

The time of ion-ion interactions is proportional to the plasma temperature to the power of 3/2 and inversely proportional to the density [1]. At the moment of maximum plasma compression, a decrease in the flight time of high-energy ions through the Z-pinch waist is observed in comparison with the characteristic time of interaction with plasma ions. This circumstance indicates the presence of a mechanism for the formation of the suprathermal distribution of ions in a pinch discharge. Available experimental data also indicate the possibility of forming an ion distribution that differs from the Maxwell distribution [2].

Considering the dynamics of Z-pinch plasma based on the kinetic approach is fraught with difficulties. The fundamental possibility of forming a suprathermal distribution was demonstrated in [3]. A more detailed calculation of such a problem is associated, among other things, with numerical difficulties. Therefore, it is necessary to use statistical methods, for example, the Monte Carlo method.

This work is devoted to the study of the formation of suprathermal ion distribution in a pinch discharge. The study is based on modeling the movement of individual ions in the pinch waist. A probabilistic approach to the issue of interaction of an ion with plasma is considered. The change in time of the magnitude of the magnetic and electric fields, the size of the waist, the temperature and density of the ion component of the plasma is taken into account. We consider ions moving with different initial velocities and in different directions. The simulation results are summarized to obtain the final distributions.

The results of the work demonstrate the presence in Z-pinches of two complementary mechanisms responsible for the formation of the suprathermal distribution of ions. The first mechanism is instability. It ensures a delay in plasma relaxation relative to the energy gain by ions. The second mechanism is responsible for the accumulation of energy by ions. High-energy ions, interacting with a changing magnetic field, increase their energy in the same way as described in [4]. The presence of suprathermal ion distribution is probably due to the presence of neutron anisotropy, high-energy ion jets and other features of pinch discharges.

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