FEATURES OF THE FINAL STAGE OF Z-PINCH COMPRESSION [[1]](#footnote-1)\*)

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As is known, Z-pinches are characterized by pronounced instability, which leads to a sharp increase in plasma density and particle energy [1]. Plasma flows out through the ends of the Z-pinch, and the action of the magnetic field is ultimately not balanced by any other forces. A decrease in the radius of the plasma column is accompanied by an increase in the pressure of the magnetic field on its side surface and at the same time an increase in the rate of plasma flow through the ends.

The experimentally observed properties of Z-pinches cannot be exhaustively described within a single approach. If plasma dynamics has been successfully modeled by magnetic hydrodynamics for a long time [2], then, for example, the generation of high-energy ions is traditionally considered through the interaction of a single ion with plasma and the Z-pinch electromagnetic field [3]. The application of various approaches to modeling or analyzing the physical features of Z-pinches should be accompanied by a clear identification of the boundaries of the approximations used. Otherwise, difficulties are inevitable when trying to obtain a correct description of the processes in the Z-pinch under conditions of the development of strong instability.

This work is devoted to the modeling of a gas cylindrical Z-pinch. Several approaches to the description of the Z-pinch were considered in order to clarify the limits of their applicability. Modeling of the initial stage of plasma dynamics is based on the framework of the gas-dynamic approach. The limits of applicability of the model are determined based on the calculation of the characteristic relaxation time of the ion component. It is shown that the gas-dynamic model may not be applicable at the stage of strong compression of the Z-pinch constriction. Next, a kinetic model is considered that allows taking into account the energy distribution of ions. It is shown that during compression, the ion distribution forms an energy spectrum at the output of the pinch that differs from the spectrum corresponding to the Maxwell distribution, especially in the high-energy region. The use of the kinetic equation approach is limited by numerical effects. Due to the fact that nonrelaxing high-energy ions interact with a magnetic field with increasing frequency over time, numerical simulation of plasma kinetics at the final compression stage is limited by the time step of integration. Also, within the framework of the kinetic approach, there is a difficulty in explaining the anisotropy of neutron radiation. The anisotropy of ion motion is considered based on the dynamics of individual high-energy particles.

The results obtained indicate the importance of understanding the limitations of physical approaches to describe an unstable system. The interest in Z-pinches is due to the fact that they implement a mechanism of direct energy transfer from the electromagnetic field to ions during the development of instability, which requires further theoretical and experimental research.

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/It/ru/DG-Frolov.docx) [↑](#footnote-ref-1)