MECHANISM OF FORMATION OF THE ENERGY SPECTRUM OF IONS IN Z-PINCH BASED ON MHD INSTABILITY [[1]](#footnote-1)\*)

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1Frolov A.Yu., 2Vikhrev V.V.

1Bauman MSTU, Moscow, Russia, alexeyfrolov92@yandex.ru
2NRC Kurchatov Institute, Moscow, Russia, vikhrev@mail.ru

The ion jets generated by Z-pinches are characterized by an energy spectrum that is significantly different from the Maxwellian one. The available experimental data indicate that in the plasma escaping from the Z-pinch waist, the spectrum of dN/dEd ions has an inverse power-law dependence with an exponent of 2–4 [1]. Moreover, with an increase in energy, this indicator decreases.

Neutrons generated in deuterium and deuterium-tritium Z-pinches also have their own peculiarities. The energy anisotropy, determined by the energy difference of the order of fractions of a MeV, cannot be a consequence of hydrodynamic processes in the Z-pinch plasma. The width of the neutron energy spectra for a DT plasma is hundreds of keV [2], which is much larger than the width corresponding to the Maxwellian distribution of ions in the plasma — tens of keV [3]. Thus, the experimental data indicate that there is a mechanism for increasing the ion energy in the Z-pinches.

It is believed that the main property that determines the features of the Z-pinch is the presence of MHD instability in it. Due to the strongly developing compression, in the Z-pinch, the characteristic times of hydrodynamic processes decrease to the time that determines the process of plasma thermalization. Based on this, the Z-pinch distinguishes between the hydrodynamic and non-hydrodynamic stages of development. It is shown that in the non-hydrodynamic stage, conditions are created for non-uniform acceleration of ions, depending on their energy [4]. Simulation of elastically interacting particles in a rapidly contracting cylindrical wall also showed that there are prerequisites for the formation of a distribution that significantly differs from Maxwell's in the high-energy region [5]. In [6], a gyro-relaxation effect is described, from which it follows that conditions can be created in a plasma under which the energy of the predominantly ionic component will increase, bypassing electrons.

This work is devoted to the study of the mechanisms of ion acceleration in Z-pinches. The study was carried out on the basis of the numerical solution of the Fokker-Planck equation for a deuterium plasma compressed by a magnetic field. The conditions of the problem are close to experiments. It follows from the results that an increase in the path length of high-energy ions in plasma leads to the fact that they begin to interact, predominantly, with the magnetic field of the Z-pinch. Through this, a single ion is accelerated without losing energy due to ion-ion interactions. As a result, it is true that in the Z-pinch there is a mechanism for the transfer of energy from the magnetic field directly to the ionic component, and to its high-energy component. This mechanism is based on the presence of MHD instability in the Z pinch.

References

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