DOI: 10.34854/ICPAF.51.2024.1.1.089

ANOMALOUS SCATTERING OF IONS BY ELECTROMAGNETIC OSCILLATION IN THE HELICAL OPEN TRAP SMOLA *)

[2]Tolkachev M.S., [2]Inzhevatkina A.A., [2]Sudnikov A.V., [2]Chernoshtanov I.S., [1]Ustyuzhanin V.O.

[1]*Novosibirsk State University, Novosibirsk, Russia*
[2]*Budker Institute of Nuclear Physics, Novosibirsk, Russia, M.S.Tolkachev@inp.nsk.su*

To increase the parameters of plasma confinement in open traps, it is necessary to reduce the losses associated with the flow of particles along the magnetic field. One of the approaches is the locking of particles with the help of multiple mirror sections, in which there is an exchange of momentum between the plasma and the magnetic field, due to which the plasma flow rate decreases. It is theoretically predicted that the efficiency of multiple mirror confinement increases with the movement of the magnetic field maxima [1]. Such a system can be created by placing a rotating plasma in a helical magnetic field [2]. The proposed method is currently undergoing experimental testing at the SMOLA device [3] in the INP SB RAS.

For effective confinement in multiple mirror systems, it is necessary for the free path length of the ions to be equal to the length of one cell of the multiple mirror section. Since the free path relative to Coulomb collisions in hot thermonuclear plasma is much longer than the period of the multiple mirror magnetic field, the emergence of alternative scattering mechanisms is necessary for the effective operation of multiple mirror sections. Thus, the development of bounce instability in experiments on the GOL-3 installation led to the appearance of anomalous scattering and an increase in the energy lifetime of the plasma [4]. The flows of trapped and traveling particles in a multiple mirror trap with moving plugs are oppositely directed and have a relative velocity proportional to the plasma rotation speed, which should lead to inhomogeneity of the distribution function and, as a consequence, the occurrence of instabilities. Recent experiments at the SMOLA device have shown no sharp deterioration in confinement [5], which may be due to the development of vibrations that additionally scatter ions.

The report demonstrates the parameters of the oscillations observed in the plasma and discusses their relationship with anomalous scattering. It is shown that the oscillations of the plasma potential satisfy the conditions for resonance with trapped ions. The measured oscillation amplitude is on order of the estimated one required for effective scattering.

This work was supported by Russian Science Foundation (project No. 22-12-00133).

References

[1]. Budker G.I., Mirnov V.V., Ryutov D.D. Influence on corrugation of the magnetic field on the expansion and cooling of a dense plasma //ZhETF Pisma Redaktsiiu. – 1971. – I. 14. – P. 320.
[2]. Beklemishev A.D. Helicoidal system for axial plasma pumping in linear traps //Fusion Science and Technology. – 2013. – I. 63. – №. 1T. – P. 355-357.
[3]. Sudnikov A.V. et al. Plasma flow suppression by the linear helical mirror system //Journal of Plasma Physics. – 2022. – I. 88. – №. 1. – P. 905880102.
[4]. Koidan V.S. et al. Progress on the multimirror trap GOL-3 //Fusion science and technology. – 2005. – I. 47. – №. 1T. – P. 35-42.
[5]. Sudnikov A.V. et al. Helical magnetic mirror performance at up-and downstream directions of the axial force //Journal of Plasma Physics. – 2022. – I. 88. – №. 6. – P. 905880609.

*) abstracts of this report in Russian