study of plasma electron thermal conductivity in the magnetic mirror

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Most part of open magnetic systems has the device for the expansion of the plasma stream flowing out of the trap. Using of such a magnetic nozzle (expander) allows solving a series of physical and technical challenges: to reduce the thermal load on the end wall, to carry out direct recuperation of plasma energy into electricity, and so on. In addition, as shown in a number of theoretical studies, expanding magnetic field can also suppress the electron heat flow between the central part of the trap and plasma absorber. Unfortunately, the current models of plasma in the expander seem to be oversimplified and cannot be applied to a modes corresponding to large devices such as the neutron source or fusion reactor. In particular, it requires further development of the electron kinetic theory, as well as the account of balance and the dynamics of neutral gas. GDT expander physics studied experimentally earlier, but at much lower plasma parameters than today’s [1]. Thus, more precise investigations of electron longitudinal confinement physics in an open trap is important in terms of future applications.

In recent experiments on the GDT well-studied method of vortex confinement had been used to suppress the transverse plasma losses arising by the MHD instabilities development [2]. This method allowed to reach the relative pressure of plasma *β* = 0.6 which is record value for axisymmetric mirrors as well as an electron temperature exceeding of 0.6 keV. Such temperature has been achieved in recent experiments with additional plasma heating by microwave radiation on the electron cyclotron resonance (ECR) [3]. These advances bring the neutron sources projects based on axisymmetric mirrors to the competitive level. Thus, there is a possibility of direct experimental verification of such projects in order to extrapolate the results for future fusion reactors.

For realization of mentioned tasks a series of experiments were carried out on the GDT device. Measurements of potential, the average energy of the electrons and its density in the expander as a function of position along the magnetic field line at high electron temperature in the center of the trap was carried out. The minimum degree of expansion which is necessary for the electron heat conductivity suppression from the open trap was defined. The expansion ratio was varied using a movable central section of the end wall. It should be noted that the physics of the expander for the different types of open traps is quite similar, so the studies carried out on GDT can be useful for a wide range of other projects.

References

1. A.V. Anikeev, et al. Plasma Phys. Rep. 25, 10, 775-782, 1999;
2. A.D. Beklemishev, et al. Fusion Science and Technology, v.57, p 351 (2009);
3. P.A. Bagryansky et al., Phys. Rev. Lett. 114, 205001 (2015).