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ROLE OF RADIATION LOSS IN TRANSPORT PROCESSES IN SELF-ORGANIZED PLASMA IN TOROIDAL MAGNETIC TRAPS *)

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At many tokamaks, in the regimes with additional heating, the effect of improving plasma confinement is observed under conditions of injecting impurities (helium, neon, argon) [1, 2]. In this case, despite the obvious increase in radiation loss, there occurs an increase in the plasma energy content and energy lifetime. In particular, the phenomenon of improving plasma confinement when injecting impurities was studied at the T-10 tokamak in the regimes with additional electron cyclotron resonance (ECR) heating [2]. The authors of [2] explain this phenomenon using the concept of plasma self-organization. At the same time, it would seem that an increase in radiation loss after injecting impurities should lead to deterioration of plasma confinement. This contradiction can be resolved by finding out what is the role radiation loss in the mechanism of plasma self-organization and transport processes in plasmas of toroidal magnetic traps.

In this work, we analyzed the plasma energy confinement in the L-2M stellarator in the regime of electron cyclotron resonance (ECR) heating. Energy confinement was studied both in the quasi-stationary stage and relaxation stage after switching off the ECR heating. Experimental dependences of the plasma energy confinement time on the radiation loss power were obtained. In these experiments, no additional impurities were injected, but an increase in radiation loss occurred due to the inflow of impurities from the vacuum chamber wall. For the L-2M stellarator, these impurities were boron and carbon (light impurities, radiation of which is emitted at the periphery of the plasma column). The obtained dependences indicate that an increase in radiation loss from the edge plasma of the L-2M stellarator does not lead to deterioration of plasma confinement.

The explanation for this effect may be such that plasma confinement in the L-2M stellarator and the total heat fluxes in it through different loss channels (thermal losses, diffusion losses, turbulent losses, radiation losses, etc.) are determined by the phenomenon of plasma self-organization. An increase in radiation loss only leads to a redistribution of heat fluxes: heat fluxes in other loss channels decrease. This fact has been established experimentally.

Based on the experiments performed, an explanation has been proposed for the effect of increasing the plasma energy content observed after additional impurity injection into tokamak plasmas.

References

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