Progress of plasma confinement studies in the Gas Dynamic Trap

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Worldwide activity of studies of plasma confinement in magnetic mirror traps decreased dramatically in the late 80's of the last century. The reason is that the mirror concept is thought to have three unattractive characteristics. The magnets are complex, the plasma is plagued with micro-instabilities and the electron temperature would never approach required keV levels. Researches on the Gas Dynamic Trap (GDT) device at the Budker Institute of Nuclear Physics demonstrated the possibility to overcome these three deficiencies. Stable high energy density plasma can be confined with simple circular magnets [1, 2], micro-instabilities can be tamed [3], and electron temperatures reaching a keV have been measured [4, 5]. These three accomplishments provide a basis to reconsider the mirror concept as a neutron source for materials development, nuclear fuel production, and fusion energy production. Furthermore, these three achievements allowed to go to the next level of tasks, aimed at support of the next generation of research facilities, as well as fusion reactors based on mirror traps. List of the most important next-level problems includes the following: optimization of heating modes using neutral beam injection and auxiliary ECR heating and a detailed study of physical processes in the expanders (regions with an expanding magnetic field behind the magnetic mirrors), limiting longitudinal energy losses.

The paper includes a brief overview of researches on the stabilization of MHD instabilities, study of micro-instabilities, and demonstration a tangible increase of the electron temperature with application of auxiliary ECR heating. According to Thomson scattering data, the electron temperature exceeds 0.9 keV thus demonstrating more than threefold increase as compared with modes, where only neutral beams were applied [4, 5].

The paper focuses mainly on recent results obtained in studies related to application of microwave radiation for plasma generation and plasma heating in the GDT. An overview of the recent studies of the physical processes in the expanders, which determine the longitudinal energy transport, is also presented in this paper.

References

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