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Progress of Plasma Confinement Studies in the Gas Dynamic Trap

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Active and successful studies of plasma confinement in magnetic mirror traps stopped practically in the late 80's of the last century, despite a number of potential benefits of such systems as the basis for development a nuclear fusion reactor. 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, micro-instabilities can be tamed, and electron temperatures reaching a keV have been measured. 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 on the basis of mirror traps. List of the most important next-level problems includes: optimization of heating modes using neutral beam injection and auxiliary ECR heating and a detailed study of physical processes in the divertors (regions with an expanding magnetic field behind the magnetic mirrors), limiting longitudinal energy losses. The proposed report 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 reaches 0.9 keV thus demonstrating threefold increase as compared with modes, where only neutral beams were applied. The main focus in the report made on the study a number of physical processes in the divertor, which define the longitudinal energy transport.

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