Spontaneous formation of peaked density profile in a dipole plasma

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Cross-field particle transport and self-organization of various structures are widely observed phenomena in space and laboratory plasmas. In the study of high-temperature plasmas, control and optimization of density profiles are essential issues for the efficiency of future fusion reactors. Understanding of the self-organization mechanism of plasmas is therefore a very important research subject in plasma physics and nuclear fusion studies. In this paper, we report the spontaneous formation of strongly peaked density profiles in the Ring trap 1 (RT-1) [1], a magnetospheric configuration generated by a levitating dipole field magnet [2]. Primary research goal of RT-1 is formation of a very high-beta plasma that enables advanced fusion using D-D and D-^{3}He fuels [3]. In the first series of experiments in RT-1 started in 2006, a plasma is generated and heated by electron cyclotron resonance heating (ECH) with 8.2 and 2.45GHz microwaves. Hot electron plasma with the maximum local beta value of ~70% has been successfully realized [4]. In the strongly inhomogeneous dipole field, formation of self-organized plasma structures is governed by the process of inward particle diffusion. Slow fluctuating fields in the plasma can destroy the conservation of canonical angular momentum of a charged particle, which allows the cross-field diffusion of magnetized particles toward flat distributions in the phase space [3]. In the dipole field, it gives strongly peaked density profiles in the strong field regions, which agree with experimental observations with three-chord interferometers [4]. Although the present experiment was conducted in the magnetospheric dipole field configuration, the inward diffusion mechanism may play important roles in other fusion plasma configurations.

References

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