§13. Magnetic Island Effect on Radial Particle Flux in TU-Heliac

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The influence of the island width on the ion viscosity was studied in the Tohoku University Heliac (TU-Heliac). It is important to study the effect of magnetic islands for the understanding of the transport mechanism and the research on the active control knob for helical reactors. Recently the healing of magnetic islands was observed experimentally, which provides good prospects in the design for helical reactors, and many ideas, in which magnetic islands are actively applied to control/improve confinement modes, are proposed. In LHD it is also important to study the m = 1 island effect on the transport mechanism for the advanced control method of a plasma periphery. In TU-Heliac, a helical axis stellarator, the profile of a rotational angle can be changeable by selecting ratios of coil currents. TU-Heliac has local vertical field coils (auxiliary coils) which produce external perturbation fields to resonate the magnetic Fourier components of (n, m) = (3, 2), (5, 3) and to grow m = 2 and 3 magnetic islands. The maximum island width was ~ 8 mm in m =3 islands. Furthermore the improved mode transition has been triggered by the electrode biasing using a hot cathode made of LaB_6. The driving force $\boldsymbol{J} \times \boldsymbol{B}$ for a plasma poloidal rotation was externally controlled and the poloidal viscosity was successfully estimated from the driving force[1-4]. The purposes of our island experiments in TU-Heliac are, (1) to estimate the ion viscosity from the driving force in configurations containing magnetic islands, and (2) to study the magnetic island effect on the radial electric field and the radial particle flux.

The experimental set-up for the biasing experiments in configurations with magnetic islands is shown in Fig. 1. The LaB_6 hot cathode (diameter, 10 mm; length, 17 mm) was inserted horizontally into the plasma inside the m = 3 magnetic islands located along the plasma periphery. The hot cathode was heated by a floating power supply and negative current source was applied against the vacuum vessel (Fig. 1). The electrode current required for the improved mode transition increased with increasing width of magnetic islands located along the plasma periphery[5]. This suggested that the ion viscosity increased with increases in the magnetic island width. The increase in the electrode current was equivalent to that in the driving force for poloidal rotation, suggesting the possibility of an active viscosity control assisted by externally controlled island width and magnetic island rotation. The ratio of the radial electric field with islands to that without islands is shown in Fig. 2. Radial electric fields increased by ~20% on the bulk plasma side of the magnetic islands. Thus, it seemed that the radial particle flux was enhanced by the magnetic islands in this region.

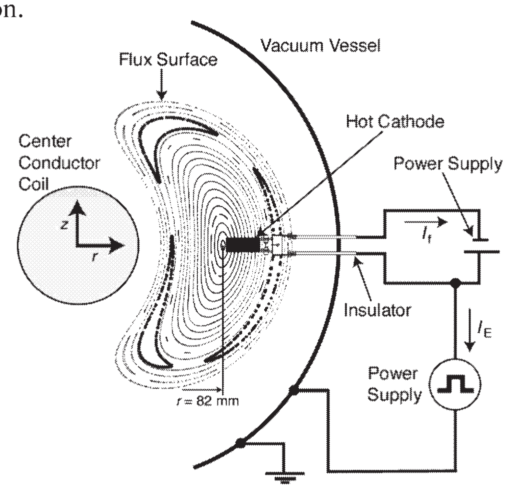

Fig. 1. The experimental set up of the hot cathode inserted horizontally into the plasma inside the m = 3 magnetic islands.

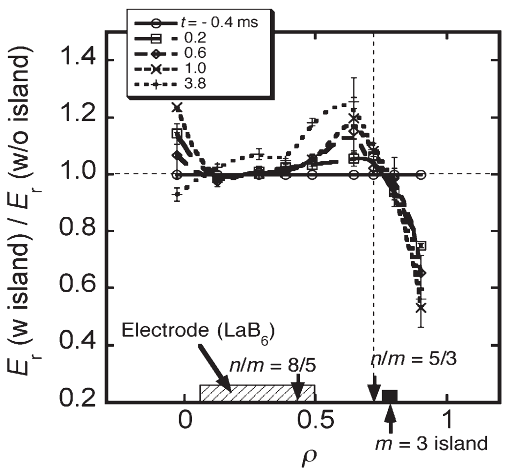

Fig. 2. Ratios of the radial electric field with islands to that without islands. The magnetic island was located at ρ = 0.7 and t is the elapsed time after the supply of the perturbation fields.

References

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