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

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It is important to study the effect of magnetic islands for the designing 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 the Tohoku University Heliac (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. These islands were obserbed experimentally by the fluorescent mesh method. Furthermore the improved mode transition has been triggered by electrode biasing experiments using a hot cathode made of LaB_6. The driving force $\boldsymbol{J}$ x $\boldsymbol{B}$ for a plasma poloidal rotation was externally controlled and the poloidal viscosity was successfully estimated from the driving force[1-2]. The purposes of our island experiments in TU-Heliac are, (1) to estimate the ion viscosity from the driving force for the poloidal rotation by the electrode biasing in configurations containing magnetic islands, and (2) to study the magnetic island effect on radial particle flux.

Preliminary biasing experiments in configurations containing magnetic islands were carried out in TU-Heliac. 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 as shown in Fig. 1. The hot cathode was heated by a floating power supply and negative current source was applied against the vacuum vessel by a *current-control* power supply (Fig. 1). In Fig. 2 increasing the magnetic island width which was proportional to the root of the auxiliary coil current I_{aux}, the electrode current I_E^* required for the improved mode transition was increasing. It suggested that the ion viscosity increased according to the increase of the magnetic island width. The experiment will be extended to biasing experiments in limiter configurations in order to clarify the effect of the target plasma volume on the transition. In order to estimate precisely poloidal Mach numbers in the biased plasmas ion temperature measurements were tried out by a high-resolution spectrometer.

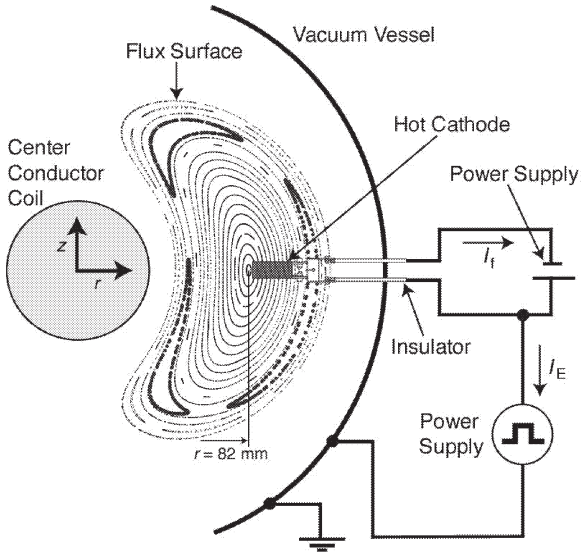

Fig. 1. The experimental set up of the hot cathode inserted horizontally into the plasma inside the m = 3 magnetic islands.

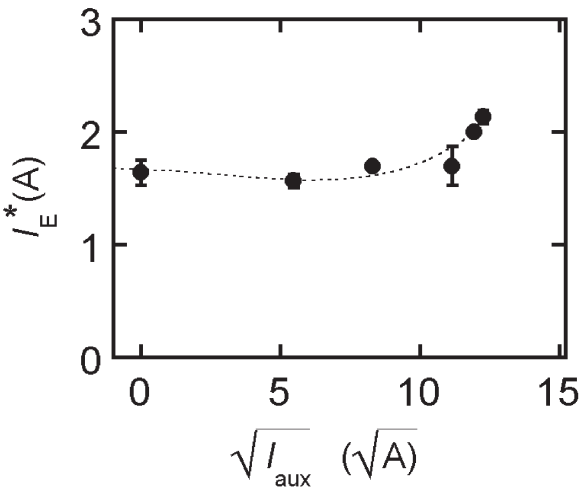

Fig. 2. Dependence of the electrode current I_E^* required for the improved mode transition on the root of the auxiliary coil current I_{aux} which is proportional to the magnetic island width.

Reference

1) Takahashi, H. *et al.*,: Comparison of Bifurcation Phenomena During LH/HL Transition Observed in Biasing Experiment in Tohoku University Heliac, presented at ICPP2004 [Nice, Oct., 2004] D1-5.
2) S. Kitajima, *et al.*: LH Transition by a Biased Hot Cathode in the Tohoku University Heliac, presented at 20th IAEA FEC [Vilamoura, November 2004] IAEA-CN-116/EX/9-3.