§27. Radial Electric Field Control by Electron Injection in CHS

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The radial electric field control experiments were carried out by an electrode biasing in the Compact Helical System (CHS). In L–H transition theories, the local maximum in ion viscosity versus poloidal Mach number M_p around $-M_p \sim 1$–3 is considered to play a key role. This maximum is considered to be related to the toroidicity. In stellarators each machine has its own Fourier components of the magnetic field configuration, causing complexity in radial particle fluxes and in the ion viscous force. In the Tohoku University Heliac (TU-Heliac), the effects of the viscosity maxima on the L-H transition have been experimentally investigated. The poloidal viscosity was estimated from the $\boldsymbol{J} \times \boldsymbol{B}$ driving force for a plasma poloidal rotation, where $\boldsymbol{J}$ was a radial current controlled externally by the LaB_6 hot cathode biasing. It was experimentally confirmed that the local maxima in the viscosity play the important role in the L-H transition[1-4]. However, in the operation condition on TU-Heliac the collisionality is comparatively high (plateau regime) and the friction of neutral particles affects the poloidal damping force. Therefore it is important to perform this biasing experiments mentioned above in the confinement system that has sophisticated diagnostic systems, abilities to produce low collisional plasmas and changeability of the Fourier components of the magnetic configurations. The purposes of our electrode biasing experiments in CHS were, (1) to estimate the ion viscous damping force from the driving force for the poloidal rotation, and (2) to study the dependence of the ion viscosity on helical ripples.

In the biasing experiments in CHS, the target plasma was produced by the ECH of 2.45 GHz. We observed some experimental results implying the improvement in the plasma confinement, i.e. the increase in line-averaged electron density by three times, the formation of the steep gradient of the electron pressure and the formation of the negative radial electric field[5]. We evaluated the poloidal ion viscosity and the poloidal Mach number from the result of the electrode biasing experiment in CHS and compared with the theoretical calculations based on the Shaing model[6], which includes the effect of the helical ripple. The dependence of the experimental ion viscosity on the poloidal Mach number shows qualitative agreement with the calculations (Fig. 1a). In the Tohoku University Heliac, the experimental poloidal viscosity and the calculations were also compared and they showed good agreement (Fig. 1b). These results indicate that the Shaing model is appropriate for evaluation of the ion viscosity in helical devices, and show the possibility that the mechanism of the LH transition can be explained as the bifurcation phenomena originated from the ion viscosity.

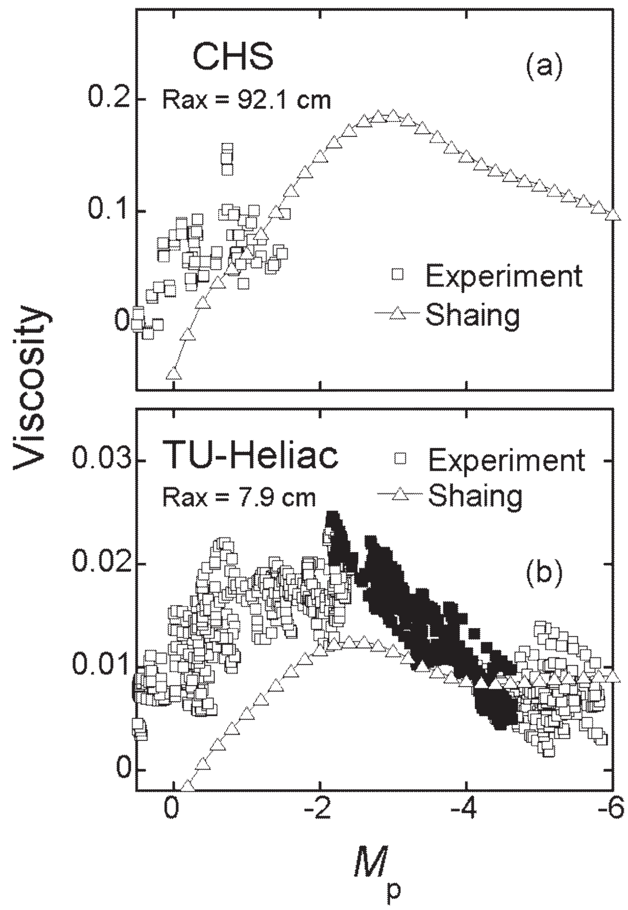

Fig. 1. The dependence of the poloidal ion viscosity on the poloidal Mach number in (a) the Compact Helical System and (b) the Tohoku University Heliac.

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