§10. Configuration Effect on the Transition Criterion

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In TU-Heliac and Compact Helical System, we carried out the electrode biasing experiments in order to clarify the role of the poloidal ion viscosity for the transition to high confinement mode. An ion viscosity is a momentum damping force originated from a ripple structure of a toroidal system, thus the investigation of the configuration dependence of the transition condition leads to the clarification of the role of the ion viscosity for the transition.

The dependence of the critical driving force F_{C_EXP} and the critical viscosity F_{LM_CAL} on the magnetic axis position are shown in Fig. 1. F_{C_EXP} is the poloidal driving force of $\boldsymbol{J}_r \times \boldsymbol{B}_t$ when the transition due to electrode biasing is attained and F_{LM_CA} is the value of the local maximum of the calculated ion viscosity based on Shaing model, respectively. Thus those parameters correspond to the experimental/ theoretical criterion for the transition. As can be seen in Fig. 1, the dependence of the experimental transition criterion on the magnetic configuration shows good agreement with theoretical one. Slight differences between experiment and theory in the data in the inward configuration for CHS are caused by the ambiguity in the ion temperature.

Figure 2 shows the dependence of the poloidal Mach number at the local maximum of the ion viscosity and the radial electric field formed after transition on the magnetic axis position. A radial electric field compose a poloidal flow rotation as $\boldsymbol{E}_r \times \boldsymbol{B}_t$, thus the dependence of the radial electric field on the magnetic configuration corresponds to that of the poloidal flow velocity. In the configurations in TU-Heliac, the poloidal Mach number at the transition was almost constant (~ -2.2) and configuration dependence was not observed, therefore we show only CHS data here. As can be seen in Fig. 2, the radial electric field formed after transition tends to be large in inward configuration and this is consistent with the dependence of M_{p_LM} predicted from the neoclassical theory.

These results indicate that the transition mechanism is the bifurcation phenomena of a poloidal flow originated from the local maximum of the ion viscosity and is explained by neoclassical theories.

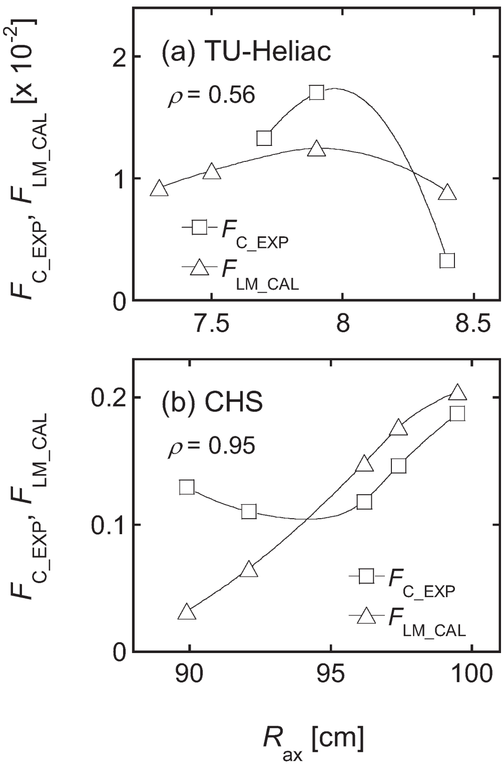

Fig. 1. The dependence of the critical driving force and the critical viscosity on the magnetic axis position in (a) TU-Heliac and (b) CHS.

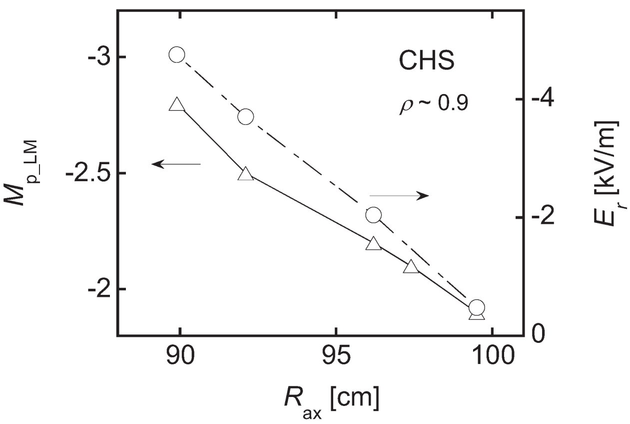

Fig. 2. The dependence of the poloidal Mach number at the transition and the radial electric field formed after the transition on the magnetic axis position in CHS.

1) Shaing, K. C., Phys Rev. Lett. **76**, (1996) 4364
2) Takahashi, H. *et al.*, J. Plasma Fusion Res. Ser, **6**, (2004) 366