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ヘリオトロンJ三次元磁場配位における平行フロー速度計測

Parallel flow velocity measurements in three-dimensional magnetic configuration of Heliotron J

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In order to clarify the effect of the magnetic field component on the parallel flow in three-dimensional magnetic field configurations, we have investigated the role of the toroidal mirror ripple on the parallel flow in the neutral-beam-injection (NBI) heated plasmas of Heliotron J [1,2]. In this study, we try to understand the mechanism of the parallel flow within the framework of the neoclassical transport.

Two magnetic configurations with different toroidal mirror ripple components, high and standard ripple configurations, are used to examine the effect on the parallel flow velocity under the condition that the external torque is applied by NBI. The parallel flow velocity at the core region, which is measured by the technique of the charge exchange recombination spectroscopy (CXRS), depends on the ripple strength. The closed symbols in Figs 1(a) and (b) show the parallel flow velocity with CXRS as a function of minor radius for the standard and high ripple configurations. In the case of the co-directed NBI at the injection power of 0.5MW, the flow velocity at standard ripple case is measured to be around 10km/s in the co-direction and it is 2-3 times higher than that for the high mirror ripple configuration. In the peripheral region (r/a~0.6), on the contrary, the parallel flow velocity (2-3km/s) in the co-directed NBI is not sensitive to the ripple strength. Since the Fokker-Planck analysis shows the external torque at the peripheral region is small, this indicates existence of spontaneous rotation in the peripheral region of Heliotron J. In the standard ripple configuration with the counter-directed NBI case, a reversal of the flow velocity to the co-direction is observed in the peripheral (r/a>0.6) region.

The neoclassical transport analysis using moment method is carried out to evaluate the parallel flow velocity by taking the effect of the external torque input into account [3]. The solid lines in Figs 1(a) and 1(b) show the calculated parallel flow velocity with the neoclassical transport analysis. For both the ripple configurations, the parallel flow velocities by the measurement results are consistent with the neoclassical transport analysis. Even in the counter-directed NBI case, the reversal of the flow velocity to the co-direction can be reproduced by the analysis. From the analysis the radial thermodynamic force is a candidate to explain the spontaneous rotation.

References

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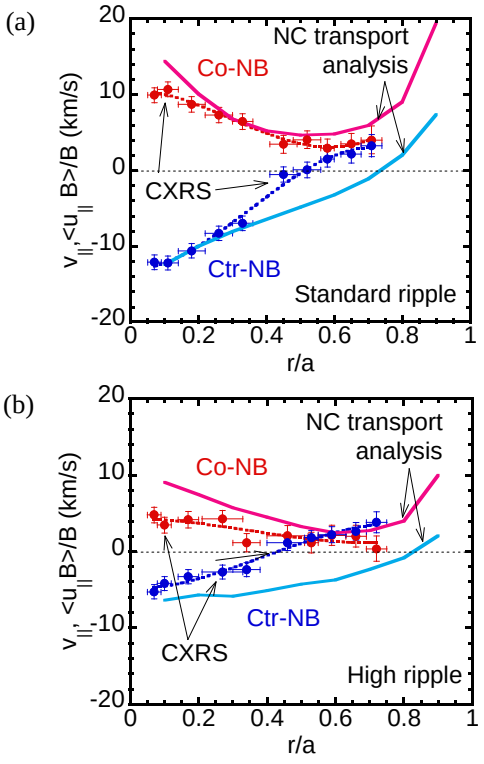

Fig. 1. Radial profile of parallel flow velocity measured by CXRS (closed symbols) and calculated with neoclassical transport analysis (solid-lines) in the (a) standard and (b) high ripple configurations of Heliotron J.