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ヘリオトロンJにおける新古典フロー・粘性の制御可能性に関する数値解析
Numerical analysis of controllability of neoclassical flow and viscosity in Heliotron J

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Investigation of plasma flow and viscosity is important to understand transport and stability of magnetically confined plasmas. In Heliotron J, experiments to change the parallel magnetic ripple strength have been made under almost the same energy content plasma for the control of plasma flow and viscosity [1]. In order to measure the parallel ion flow directly, a charge exchange recombination spectroscopy (CXRS) method was adopted in Heliotron J. The CXRS is a powerful method, but it is difficult to measure the bulk (deuterium) ion velocity directly. Therefore, numerical methods have important roles for the estimation of bulk ion flow.

The moment method [2] is a powerful tool to analyze neoclassical (NC) flows and viscosity numerically. This moment method with the DKES result was applied to HSX plasmas for the first time in order to analyze radial transport and parallel flow. However, the present study in Heliotron J needs to consider the effects of external momentum input from NBI. Numerical estimation of NC transport matrix of the plasma with the effects of external momentum input has been already reported in Ref. [3]. We have applied this method to estimate the relationship between parallel flow and NC viscosity in NBI plasmas in Heliotron J.

Numerical estimations of C^{6+} flow by the moment method and the CXRS measurement of C^{6+} flow are shown in Fig.1. The numerical results is found to be consistent with the CXRS measurement results in the standard (STD) and high ripple strength (HG) configurations of Heliotron J. In addition, they also indicated that parallel C^{6+} flow velocity in the HG configuration is about a half of the flow velocity in the STD configuration. The parallel viscosity coefficients of C^{6+} are shown in Fig.2. In the HG configuration, NC C^{6+} viscosity coefficient is much larger than the coefficient in STD configuration. This larger viscosity causes the suppression the parallel ion flow in the HG configuration. The detailed estimation of controllability of parallel plasma flow, and poloidal and toroidal viscosity of ions are now under investigation.

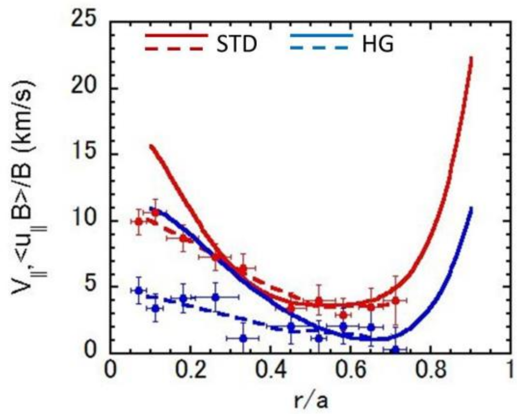

Fig. 1. Radial profiles of parallel C^{6+} flow velocity measured by CXRS (dotted-lines) and of calculated NC flow velocity (solid-lines) in STD and HG configurations.

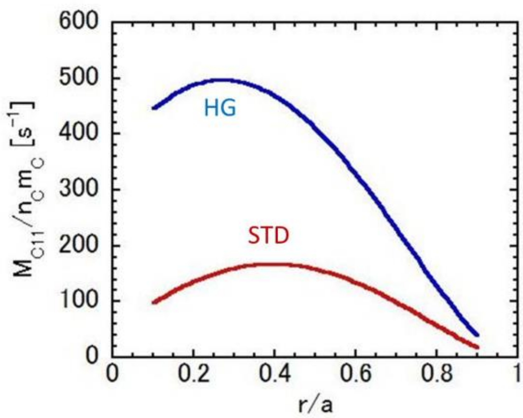

Fig. 2. Radial profiles of parallel C^{6+} viscosity coefficients in STD and HG configurations

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