26pB10

ITER プラズマにおける燃料イオン・ヘリウム灰の ITG-TEM 駆動乱流輸送
ITG-TEM driven turbulent transport of D-T fuels and He-ash in ITER-like plasma

仲田 資季 [1], 本多 充 [2], 沼波 政倫 [1]
Motoki NAKATA[1], Mitsuru HONDA[2], Masanori NUNAMI[1]

核融合科学研究所 [1], 日本原子力研究開発機構 [2]
NIFS[1], JAEA[2]

Understanding of turbulent transport processes and accurate predictions of the resultant transport levels are crucially important issues towards future burning plasma experiments in ITER and DEMO. Since the burning plasmas are always composed of multiple particle species such as fuel ions(D and T), He-Ash, and the other impurities, the systematic studies on the particle and heat transport are indispensable to realize the sustained burning state with optimized impurity exhausts and D/T fueling. In this study, the ITG-TEM driven turbulent heat and particle transport in the ITER-like D-T-He plasma is investigated with a gyrokinetic Vlasov simulation GKV[1], where multiple ions and fully kinetic electrons including their inter-species collisions are incorporated[2,3]. In particular, we explore an plasma-profile condition which satisfies the steady burning plasma condition[4] with He-ash exhaust(outward) and fuel-pinch(inward), i.e., $\Gamma_{He} > 0$, $\Gamma_{D,T} < 0$, and $\eta_i T_i \Gamma_{He} > Q_i/\alpha^*$ (or equivalently $\tau_{He} < \alpha^* \tau_E$), where $\alpha^* \sim 5 - 10$ is a constant. The GKV simulations reveal the different nonlinear saturation levels and spatial structures in fuel ions and He-ash species [Fig. 1]. Furthermore, the density-gradient scans of turbulent particle and energy fluxes at $\rho = 0.5$ clarify that there exists a certain regime ($R_{ax}/L_n \leq 1.27$) in which the above steady burning condition is satisfied [Fig. 2]. These results contribute to deeper understanding of the multi-species transport processes in burning plasmas, and encourage the quantitative predictions for ITER and DEMO.

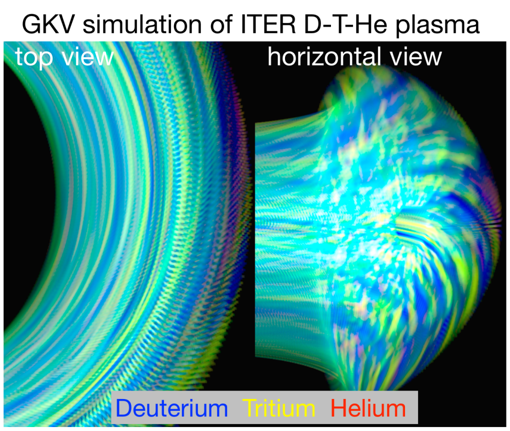

Figure 1: Fluctuations of D(in blue), T(in yellow), and He(in red) in multi-species ITG-TEM turbulence.

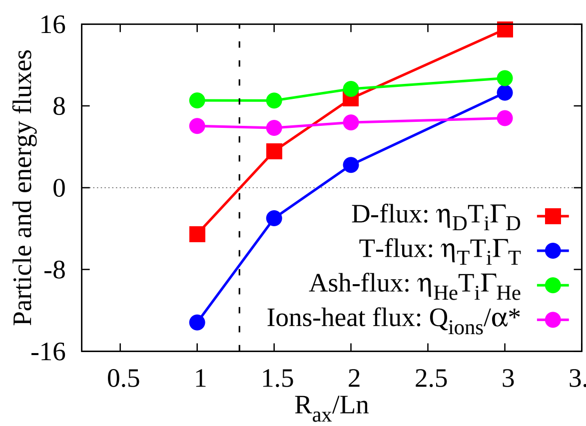

Figure 2: Density-gradient scan of turbulent particle and energy fluxes, where $\alpha^* = 7$. The steady burning condition is satisfied in $R_{ax}/L_n \leq 1.27$(dashed-line).

[1] T. -H. Watanabe and H. Sugama, Nucl. Fusion **46** 24 (2015)

[2] M. Nakata, M. Nunami *et al.*, Comput. Phys. Commun., in press (2015)

[3] M. Nunami, M. Nakata *et al.*, Plasma Fusion Res. **10** 1403058 (2015)

[4] D. Reiter, G. H. Wolf *et al.*, Nucl. Fusion **30** 2141 (1990)