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# Characteristics of particle transport due to TEM and ITG turbulence in tokamak plasmas

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In MCF plasmas, it is extensively recognized that the micro-turbulence resulting from the trapped electron mode (TEM) and ion temperature gradient (ITG) mode instabilities may govern the anomalous particle and heat transport. Simulations and experiments have shown the coexistence of these two instabilities and the phenomena of transition between ITG and TEM. In many tokamak experiments, the temperature and density gradients can drive both micro-instabilities simultaneously, so that transitional regime is important for a detailed understanding of turbulent transport. In this work, we have performed a comprehensive investigation on the characteristics of turbulent particle flux depending on dominated TEM or/and ITG instabilities using a newly developed and well benchmarked gyro-Landau-fluid code ExFC (Extended Fluid Code). The dynamic transition between ITG and TEM is simulated. Here, the global effects of turbulent fluctuation and transport are emphasized. The ITG and TEM dominant regimes are compared between global and local simulations, showing a notable difference for the growth rate. The parametric regime of the scale-length of density and temperature for different direction of turbulent particle flux is identified as well as the type of dominant instability (ITG or/and TEM). One of the main results is shown in Fig. 1.

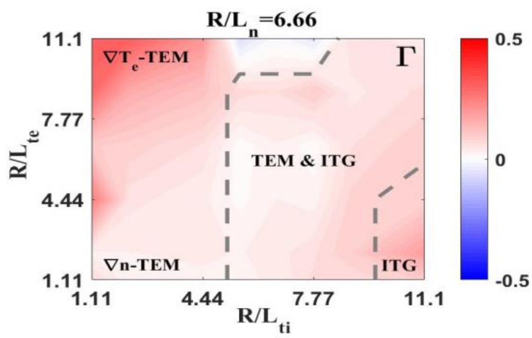


Fig. 1 Slice of the contour plot in the plane of ($R/L_{ti}$, $R/L_{te}$) for given $R/L_n$ =6.66. The turbulence type is partitioned by dashed curves.

With the aid of the machine learning with neural network (NN) algorithm, systematical parametric scans on ITG and TEM instabilities and turbulent transport including the heat and particle fluxes are performed over three key drive forces of instabilities: gradients of ion and electron temperature as well as density. The scans can be greatly accelerated by applying the NN based prediction approach. Based on the dataset, the radial profiles ($T_e(x), T_i(x), n(x), \chi_e(x), \chi_i(x), \Gamma(x)$) can be predicted according to any initial parameters ($T_{e0}(x), T_{i0}(x), n_0(x)$) within the training region. One of the training results about the distribution of particle flux is shown in Fig. 2.

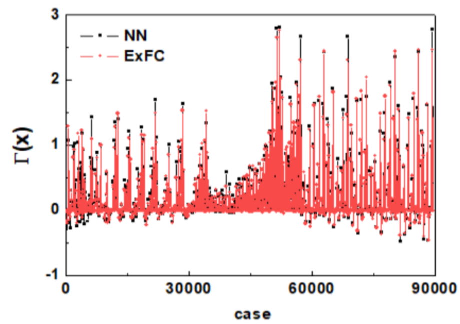


Fig. 2 The comparison of $\Gamma(x)$ between the NN approach with the ExFC simulations within NN training domain ($R/L_n$, $R/L_{te}$, $R/L_{ti}$).

Moreover, the ExFC is applied to simulate about the experimental observations on the QCM excitation on the HL-2A tokamak. The main simulation results are presented in detail.

## References

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