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TOPICS と OFMC を用いたトロイダル運動量と径電場の輸送シミュレーション

Transport simulations of toroidal momentum and radial electric field using TOPICS with OFMC

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A toroidal momentum solver has been derived for the 1.5D integrated transport code TOPICS (see e.g. [1]) from the equation of motion and it calculates the evolution of the toroidal angular momentum density summed over thermal species. A novel scheme that can uniquely determine the radial electric field E_r without iterative calculations has been modeled and is also used to compute the parallel and toroidal flows for each species based on the neoclassical transport theory. The combination of TOPICS and OFMC enables us to predict the evolution of not only the density, temperature and safety factor but also the toroidal momentum and E_r. The framework developed has been tested against experiments and showed the predictive capability of toroidal rotation.

Several time-dependent simulations in which toroidal rotation and E_r play a important role have been carried out, showing that the turbulence suppression due to the steep E_r gradient is of crucial importance in the formation of transport barriers. For example, we are now focusing on the effect of the direction of toroidal rotation on the confinement after the L-H transition, that is, the formation of an edge transport barrier (ETB), using the tuned CDBM model with the $E\times B$ flow shear suppression mechanism [2]. As shown in figure 1, the energy confinement significantly varies depending upon the direction of toroidal rotation: Co toroidal rotation gives the best performance of all in the formation of ETBs, while counter rotation the worst. The change in the E_r structure due to toroidal rotation is found to play a crucial role in the performance of the ETB. The results are consistent with experimental observations in JT-60U [3].

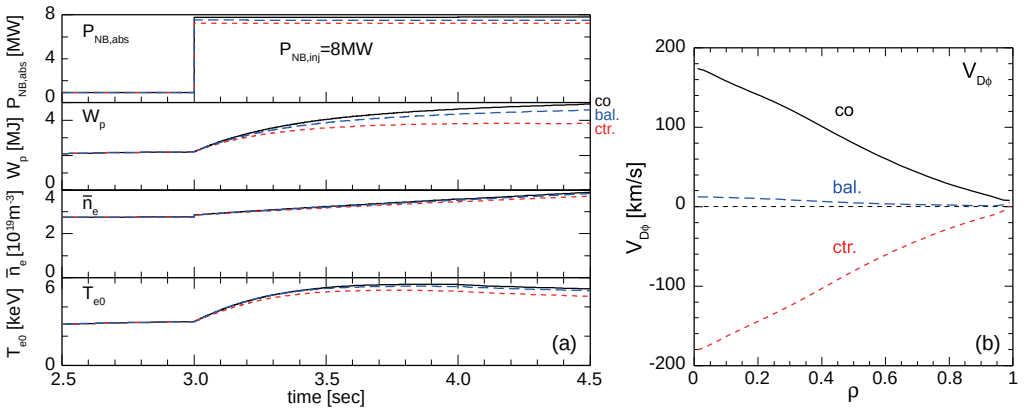

Figure 1: (a) Time histories of the neutral beam absorption power $P_{\rm abs}$, the plasma stored energy $W_{\rm p}$, the line-averaged electron density $\bar{n}_{\rm e}$ and the ion temperature on axis $T_{\rm i0}$. Black, red and blue lines correspond to the co, counter (ctr.) and balanced (bal.) NB injection cases, respectively. (b) The toroidal rotation profiles of deuterium for three cases at $t = 4.0\,$s.

[1] M. Honda, *Comp. Phys. Commun.* **181** (2010) 1490.
[2] M. Yagi *et al.*, *Contrib. Plasma Phys.* **52** (2012) 372.
[3] H. Urano *et al.*, *Nucl. Fusion* **48** (2008) 085007.