Prediction of Toroidal Rotation in ITER Based on the Torque due to Neoclassical Toroidal Viscosity and Auxiliary Heating

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Abstract

A theory-based model for predicting toroidal rotation in Tokamak plasmas is developed based on several mechanisms, including torques from Neoclassical Toroidal Viscosity (NTV) concept and auxiliary heating, in which the auxiliary heating includes Neutral Beam Injection (NBI), Ion Cyclotron Resonance Frequency (ICRF) heating, and Lower Hybrid (LH) heating. This toroidal rotation model is implemented in 1.5D BALDUR integrated predictive modeling code, which can be used to evolve plasma current, temperature, and density profiles in Tokamak plasma experiments. It is found that the predicted toroidal rotation is in a close range of the experimental data, with an average RMSE below 8% for four JET optimized shear discharges. In addition, the formation of ITB can be reproduced for both time and location. BALDUR code with a combination of semi-empirical Mixed Bohm/gyro-Bohm core transport model and NCLASS neoclassical transport model together with the toroidal velocity obtained from the toroidal rotation model developed will be used to predict the plasma profiles in ITER, which can lead to fusion performance. In addition, a variation of plasma parameters, such as plasma density and auxiliary heating power, will be explored. Finally, the ignition test will be conducted to observe the plasma response in each design after shutting down an auxiliary heating.