Improved Multi-Mode Anomalous Transport Model

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In this study, the new Multi-Mode transport model, version 7.1 (MMM7.1), is introduced. The theoretical foundation of the new MMM7.1 model is significantly advanced compared to the earlier MMM95 model. The new anomalous theory based transport model includes an improved Weiland model for the ITG, TEM, and MHD modes [1], the Horton model for short wavelength ETG modes [2], a model for paleoclassical electron heat and particle transport [3], and a new model for the drift resistive inertial ballooning modes (DRIBM) [4]. The ETG transport threshold in the Horton model is refined by using the Jenko model threshold obtained from toroidal gyrokinetic ETG turbulence. The Weiland and DRIBM models in MMM7.1 include the following effects: Collisions, parallel electron and ion dynamics, electron inertia, ion gyro-viscous stress and polarization, electron and ion temperature and density profiles, toroidal and poloidal rotation, temperature and density perturbations, and diamagnetic and finite beta. In addition, the Weiland model includes the effects associated with impurity perturbations, elongation, magnetic shear, and variation of mode width. In integrated predictive modeling of tokamak plasmas, the MMM7.1 model is combined with the neoclassical ion thermal transport model allowing computation of thermal, particle and momentum transport. Interaction between different channels of transport is found to be important. In particular in this study, it has been found that the paleoclassical electron thermal flux is often significantly reduced in the L-mode plasmas when it is computed in combination with the DRIBM model. The combination of models in MMM7.1 is necessary in order to include the variety of different physical phenomena that affect the plasma transport. These components of the MMM7.1 model provide contributions to transport in the different regions of plasma discharge. For example, the ITG and TEM modes contribute to transport mostly in the plasma core; whereas, paleoclassical and DRIBM transport contribute at the plasma edge. The MMM7.1 is documented and organized as a standalone module, which fully complies with the NTCC (National Transport Code Collaboration) standards [5]. The new transport model has been used both with a standalone driver as well as within the PTRANSP code. Results will be presented to illustrate the extent that the various component models contribute to transport both in L-mode and H-mode discharges.

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