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1-D Predictive and Analysis Transport Model for Particle and Energy Transport in Stellarators

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Development of the Stellarator Transport Code (ST-Code) has been established on the basis of international co-operation, aiming to provide a numerical tool for better understanding of the existing experimental observations in various stellarator plasmas, and ultimately to provide a predictive capability for stellarator reactor-type plasmas complementary to the scaling relations. The new code is currently based on the1-D ASTRA code, modified for stellarator conditions. These modifications consist first of all of the equilibrium and the neo-classical transport coefficients, which will be organised in such a way as to facilitate the calculations and to provide a simple interface for the transport code. Since the magnetic configurations of stellarator devices differ considerably, the different modular structure of neo-classical transport coefficients (including the bootstrap current and resistivity) and the equilibria will be developed. Anomalous transport models have been incorporated based on a modified IFSPPL model of ITG turbulence for the ions and a modified RLW and ETG models for the electrons. These models are currently used in tokamak core plasma simulations and can be applied with some caution to stellarator plasmas. The main issue for stellarator transport models remains the equation for the radial electric field. An attempt will be made to incorporate such a differential equation for numerical simulation of the ion and electron roots. This allows one to simulate transient processes in the plasma, including the L to H transition and MHD oscillations at the edge. Another important issue is the modelling of the particle source and sinks corresponding to the different schemes of gas and pellet injection. A1-D model of neutral particles and the impurity dynamics in the core plasma (justified with the help of 3-D MC codes) will be applied. The boundary conditions at the edge of the core plasma are a special problem, which requires the consideration of the stochastic/island regions. The effective boundary conditions can be derived by averaging over such regions. Pedestal physics at the edge, for the case of H-mode confinement, includes the stabilisation mechanisms due to the radial electric field shear effects.

One important development is the corporation of the data base from different experiments to the code. The ST-Code will be benchmarked with the TOTAL Code , operating in NIFS and with the other stellarator codes. In the paper, the ingredients of this model and its comparison to experiments as well as its implication for reactor-type plasmas will be discussed.

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