The First Transport Code Simulations Using the TGLF Model

J. E. Kinsey,[1] G. M. Staebler,[1] and R. E. Waltz,[1]

[1] *General Atomics, P.O. Box 85608, San Diego, California 92186*

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Abstract

The first transport code simulations using the newly developed trapped gyroLandau fluid (TGLF) theory-based transport model are presented. TGLF has comprehensive physics to approximate the turbulent transport due to drift-ballooning modes in tokamaks. The TGLF model is a next generation gyro-Landau-fluid model that improves the accuracy of the trapped particle response and the finite Larmor radius effects compared to its predecessor, GLF23. The model solves for the linear eigenmodes of trapped ion and electron modes (TIM, TEM), ion and electron temperature gradient (ITG, ETG) modes and electromagnetic kinetic ballooning (KB) modes in either shifted circle or shaped geometry. A database of over 400 nonlinear gyrokinetic simulations using the GYRO code has been created. A subset of 83 simulations with shaped geometry has been used to find a model for the saturation levels. Using a simple quasilinear (QL) saturation rule, remarkable agreement with the energy and particle fluxes from a wide variety of GYRO simulations is found for both shaped or circular geometry and also for low aspect ratio. Using this new QL saturation rule along with a new $E \times B$ shear quench rule for shaped geometry, the density and temperature profiles have been predicted in over 500 transport code runs and the results compared against experimental data from 96 tokamak discharges. Compared to GLF23, the TGLF model demonstrates better agreement between the predicted and experimental temperature profiles. Surprisingly, TGLF predicts that the high-k modes are found to play an important role in the central core region of low (L-mode) and high confinement (H-mode) plasmas lacking transport barriers.

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