A Theory-Based Transport Model With Comprehensive Physics*

G.M. Staebler, General Atomics, San Diego, CA

A new theory based transport model with comprehensive physics (trapping, general toroidal geometry, finite beta, collisions) has been developed. The core of the model is the new trapped-gyro-Landau-fluid (TGLF) equations [1] which provide a fast and accurate approximation to the linear eigenmodes of drift-wave instabilities (trapped ion and electron modes, ion and electron temperature gradient modes and kinetic ballooning modes). This new TGLF transport model employs several new technologies that remove the limitations of its predecessor GLF23. No fitting to experiment is done so applying the model to experiments is a true test of the theory it is approximating. A model for the averaging of the Landau resonance by the trapped particles makes the equations work seamlessly over the whole drift-wave wavenumber range. A fast eigenmode solution method enables unrestricted magnetic geometry. A new model for electron-ion collisions and both parallel and perpendicular electromagnetic fluctuations are included. The linear eigenmodes have been benchmarked against comprehensive physics gyrokinetic calculations over a large range of plasma parameters. Deviation between the gyrokinetic and TGLF linear growth rates averages 11.4% in shifted circle geometry[1]. The transport model uses the TGLF eigenmodes to compute quasilinear fluxes of energy and particles. A model for the saturated turbulence amplitude is fitted to a large set of non-linear GYRO simulations. The fluxes at each wavenumber are fit by the model. The TGLF model is valid for the low aspect ratio spherical torus which has both a high trapped fraction and strong shaping of magnetic flux surfaces. It is also valid close to the magnetic separatrix so the transport physics of the H-mode pedestal region can be explored.

[1] G.M. Staebler, et al., Phys. Plasmas **12**, 102508 (2005).

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