

# **Extending the Trapped Gyro-Landau Fluid Transport Model to Include Multiple Ion Species<sup>\*</sup>**

G.M. Staebler, J.E. Kinsey, and R.E. Waltz

General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA

The trapped gyro-Landau fluid (TGLF) transport model solves a system velocity moments of the gyrokinetic equation for the linear drift-wave eigenmodes [1]. These linear eigenmodes are then used to evaluate the quasilinear fluxes. A saturation rule for the intensity of the fluctuations that has been fit to nonlinear gyrokinetic simulations is used to complete the TGLF flux calculation [2]. The TGLF transport model is a much better fit to the exact nonlinear gyrokinetic turbulence than its predecessor GLF23. This improved fidelity to theory has resulted in a better agreement between the TGLF transport model predicted temperature and density profiles and experimental measurements [3]. The linear drift-wave eigenmodes can be extended to multiple ion species in a straightforward manner. However, the extension of the saturation rule to multiple ion species is not unique. A saturation rule can be determined by comparing to nonlinear gyrokinetic simulations with multiple ion species using the GYRO code [4]. It is found that the impurity charge density fraction is the best weight for the ion species flux contributions. The level of agreement between TGLF and GYRO with kinetic helium or carbon impurities is presented. The departure of the kinetic impurity calculation from the dilution model is also explored. It is found that simple dilution (i.e. ignoring the impurity response) is a reasonable approximation for low concentrations of carbon but not as good for helium. The dilution model does not reproduce the dependence of the transport on the impurity density gradient. This can be important for hollow impurity density profiles. In no case is the dilution model acceptable when the impurity charge density fraction exceeds 50%. The difference in the energy confinement between a lumped ion DT mixture and a two-species plasma will also be explored.

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