# Gyrokinetic Simulations of Plasma Transport and Isotope Effects*

C. Estrada-Mila,[1] J. Candy,[2] and R.E. Waltz[2]

[1]University of California, San Diego, California
[2]General Atomics, P.O. Box 85608, San Diego, California 92186-5608

Abstract

In this poster we present a systematic study of plasma transport, for both pure and impure plasmas, and isotope scaling using a computational approach. Historically, ion and more recently electron energy transport has been the focus of most simulations, while previous works on plasma flow emphasized impurity instability and flows with adiabatic electrons.[1]

Two codes were used for our studies: the reduced gyrofluid transport model GLF23,[2] and the Eulerian gyrokinetic code GYRO.[3,4] The latter includes trapped and passing electrons with pitch angle collisions, finite-$\beta$ fluctuations, real flux-surface shape, linear and nonlinear E×B rotation, parallel shear flow and was recently modified to include multiple ion species with fully kinetic dynamics. The methodology employed for this research was to initially find interesting qualitative characteristics of the transport using GLF23, and subsequently analyze them in more detail using the quantitative realism of GYRO.

For the impurity flow study we made parameter scans for a mixture of deuterium with fully stripped helium, using the *Waltz Standard case*[2] as a reference point. The issues addressed in this presentation are the effects that impurity density gradient and the temperature gradient have on the transport. In particular, we explore the regimes where anomalous pinches (flow against primary gradients) are created. These results were used to make comparisons against the so called D-V model[5] where the total particle flux is the sum of a diffusive and convective part. Also, the passing and trapped particle contributions to pinch formation, in both pure and impure plasmas showing a roughly equal contribution from both in all cases analyzed. Finally, the question of validity of the dilution model, in which it is assumed that impurity species do not have a dynamical response, is considered. It is found that for realistic studies the model is not good above 10% impurity concentration.

The isotope scaling problem has also been analyzed from linear and nonlinear perspectives. We analyzed how the scaling of the growth rates for different type of plasmas is affected when kinetic electrons are included, and how the energy transport $\chi$ scales with $\mu = \sqrt{m_i/m_e}$ . Also, investigate whether multi-isotope (e.g. 50%–50% D-T) plasmas have effects not previously considered.

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*This was work supported by the U.S. Department of Energy under Grants DE-FG03-95ER54294, DE-FG03-95ER54309, and the SciDAC Plasma Microturbulence Project.