

A flexible linear gyro-fluid eigensolver with Onsager symmetry

G. M. Staebler¹

¹ *General Atomics, San Diego, USA*

Gyro-fluid equations are velocity space moments of the gyrokinetic equation. Special gyro-Landau-fluid closures have been developed to include the damping due to kinetic resonances fit to the collisionless local response functions [1,2]. This damping allows for accurate linear eigenmodes to be computed, even in the collisionless limit, with a relatively low number of velocity space moments compared to gyrokinetic codes. An analysis of the gyro-Landau-fluid closure schemes finds that the Onsager symmetries [3] of the resulting quasilinear fluxes are not preserved. Onsager symmetry guarantees that the matrix of diffusivities is positive definite, an important property for a transport model. The constraints on the closure due to Onsager symmetry and other considerations are shown to be very restrictive. A new, simpler scheme for regularizing the gyro-fluid equations that preserves the Onsager symmetry and is scalable to higher velocity space moments without change of the damping model is presented. Linear eigenmodes from the new system of equations are compared with gyrokinetic results, with and without collisions, including parallel and perpendicular electromagnetic fluctuations at high beta. The new linear gyro-fluid equation eigensolver (GFS) will be used to extend the TGLF quasilinear transport model [4] so that it can compute the energy and momentum fluxes due to parallel magnetic fluctuations, completing the transport matrix. The GFS equations do not use a bounce average approximation to the magnetic mirror force. General flux surface magnetic geometry is included. Only pitch angle scattering for electron collisions are included and equilibrium rotation is restricted to be subsonic. The Onsager symmetries will enable faster transport solvers since the matrix of convection and diffusion coefficients will all be computed by a single call to the quasilinear transport model.

This work was supported by the U.S. Department of Energy under DE-FG02-95ER54309

[1] G. W. Hammett and F. W. Perkins, Phys. Rev. Lett. **64** (1990) 3019.

[2] M. W. Beer and G. W. Hammett, Phys. Plasmas, **3** (1996) 4046.

[3] H. Sugama and W. Horton, Phys. Plasmas, **8** (1995) 2989.

[4] G. M. Staebler, J. E. Kinsey and R. E. Waltz, Phys. Plasmas **12** (2005) 102508.

DISCLAIMER: This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof