Theory of Electron-ion Collisions in Trapped Gyro-Landau Fluid Models*

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Including electron-ion collisions in a system of trapped gyro-Landau fluid equations [1] is complicated by the need to resolve the boundary between trapped and passing particles. The interaction between the Landau damping of the circulating particles and the averaging away of this damping by the trapped particles plays a crucial role in determining the gradient of the electron distribution function at the trapped passing boundary. It is this boundary gradient that determines the collisional damping of the trapped electron density moment. A hierarchy of trapped gyro-Landau fluid models with increasing number of velocity moments are explored to understand the role of the Landau and curvature drift resonances in determining the trapped electron density damping. It is found that both resonance terms can damp the density moment through coupling to higher velocity moments but that the Landau resonance has by far the strongest coupling strength. The 4-moment Hammet-Perkins Landau resonance closure scheme [2] is extended to an arbitrary higher moment system. This allows a high accuracy solution of the electron distribution function covering the trapped and passing regions continuously. The least damped eigenmode is found to be localized to the trapped region by the Landau damping outside this region of velocity space. The density moment of the gradient of the distribution function at the trapped-passing boundary can be computed and shown to be the primary damping of the trapped particle density. A model for this boundary term can be fit to the high moment solution and used in a low moment trapped gyro-Landau fluid system to accurately reproduce the linear drift-wave growth rate reduction due to electron-ion collisions.

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

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

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