Simulation of FLR effects on RFP tearing modes.

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The Plasma Science and Innovation Center (PSI Center) extends and applies MHD codes to understand and eventually predict emerging concept (EC) experiments. Kinetic effects such as finite Larmour radius (FLR), Landau resonances and phase space anisotropies are known to significantly impact the dynamics of many EC experiments.

The PSI Center has extended the hybrid kinetic-MHD implementation in NIMROD[1] from the drift kinetic model to the full kinetic model to include sufficient physics to accurately account for many of these effects, in particular FLR effects. The full kinetic implementation uses the Boris push to advance the Lorentz equations of motion and the δf method to compute moments of the particle distribution function. These moments (in our applications, the kinetic pressure tensor) are coupled to the MHD equations evolved in NIMROD. With this technique, we simulate the effects of an energetic minority species on the plasma dynamics. However, satisfaction of the gyro-frequency Courant condition may place a severe restriction on the particle time step relative to MHD time scales. For computational efficiency, we orbit average the kinetic contribution (the δf PIC) over the MHD time step.

Our first application simulates FLR effects on RFP tearing modes. Linear analysis by Svidzinski[2] has shown that FLR effects significantly reduce tearing modes in RFPs. Comparisons of the simulation and the analytic results will be presented. We also present recent studies that extend the simulations beyond the regimes accessible by analytics.

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[1] C.C. Kim et.al. " Hybrid Kinetic-MHD Simulations in General Geometry", CPC **164**, 448 (2004)

[2] V. A. Svidzinski and S. C. Prager, "Effects of particles with large gyroradii on resistive magnetohydrodynamic stability", PoP **11**, 980 (2004)