Hybrid Simulations of Z-pinches

V. I. Sotnikov[1] B. S. Bauer[1], J. N. Leboeuf[2], P. Hellinger[3], P. Travnicek[3] and V. Fiala[3]
[1]*UNR, Reno, NV 89557*
[2]*UCLA, Los Angeles, CA 90095*
[3]*IAP, Prague 4, Czech Republic*

The development of z-pinch instabilities in the presence of the Hall term, finite Larmor radius effects (FLR), and axial magnetic field is being investigated via 3D hybrid (particle ions, fluid electrons) simulations. We use the 3D version of the hybrid code Dolphin-3D based on the CAM-CL algorithm[1,2]. The hybrid simulations serve the dual purpose of comparing with linear Hall MHD theory and of investigating the nonlinear stage of instability. Simulations have been carried out to study the z-pinch instability development for Bennett equilibrium profiles with and without axial magnetic field and non-equilibrium profiles generated in the latest stages of wire array implosions[3].

Simulations with Bennett equilibrium profiles have been carried out in two regimes with respect to the strength of the Hall parameter $\varepsilon = c/\omega_{pi}r_0$ (c – is the speed of light, ω_{pi} is the ion plasma frequency and r_0 is the pinch radius) and with and without the axial magnetic field.

For profiles generated in the process of wire array implosion, instability development of the sausage and kink modes has been investigated in order to determine what part of the total energy of the imploding wire array can be transferred to the energy of the excited wave modes. In contrast to simulations with Bennet equilibrium profiles, analysis of the time evolution of kinetic and magnetic energies shows that rapid exchange between the magnetic and kinetic components takes place due to their initial imbalance in this case.

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