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Two-Fluid Physics and Field Reversed Configurations

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Fluid models of plasmas are a common tool to study fusion devices. In this talk algorithms for the solution of Two-Fluid plasma equations are presented and applied to the study of Field Reversed Configurations (FRCs). The Two-Fluid model is more general than the often used magnetohydrodynamic (MHD) model. The model takes into account electron inertia, charge separation and the full electromagnetic field equations and allows for separate electron and ion motion. Finite Lamor Radii effects are taken into account by self consistently evolving the anisotropic pressure tensor. The algorithm presented is the high resolution wave propagation scheme. The wave propagation method is based on solutions to the Riemann problem at cell interfaces. Operator splitting is used to incorporate the Lorentz and electromagnetic source terms. To preserve the divergence constraints on the electric and magnetic fields the so called perfectly-hyperbolic form of Maxwell equations are used which explicitly incorporate the divergence equations into the time stepping scheme. A detailed study of Field-Reversed Configuration stability and formation is performed. The study is divided into two parts. In the first, FRC stability is studied. The simulation is initialized with various FRC equilibria and perturbed. The growth rates are calculated and compared with MHD results. It is shown that the FRCs are indeed more stable within the Two-Fluid model than the MHD model. In the second part formation of FRCs is studied. In this set of simulations a cylindrical column of plasma is initialized with a uniform axial magnetic field. The field is reversed at the walls. Via the process of magnetic reconnection FRC formation is observed. The effects of Rotating Magnetic Field (RMF) drive on the formation of FRC are also presented. Here, a set of current carrying coils apply a RMF at the plasma boundary, causing a electron flow in the R-Z plane leading to field reversal. The strong azimuthal electron flow causes Lower-Hybrid Drift Instabilities (LHDI), which can be captured if the ion-gyroradius is well resolved. The LHDI is known to be a possible source of anomalous resistivity in many plasma configurations.