Simulation of Pellet Injection in Tokamaks using 3D Adaptive Mesh Refinement

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Abstract

We present results of Adaptive Mesh Refinement (AMR) simulations of the pellet injection process, a proven method of refueling tokamaks. AMR is a computationally efficient way to provide the resolution required to simulate realistic pellet sizes relative to device dimensions. The mathematical model comprises of single-fluid resistive MHD equations with source terms in the continuity equation along with a pellet ablation rate model. The numerical method developed is an explicit unsplit upwinding treatment of the 8-wave formulation, coupled with a MAC projection method to enforce the solenoidal property of the magnetic field. The Chombo framework is used for AMR. While the dominant mass redistribution occurs along the field lines, this is accompanied by "anomalous" transport which displaces the pellet mass in the outward radial direction[1]. The role of the $E \times B$ drift in mass redistribution during high field side (HFS) and low field side (LFS) pellet launches in tokamaks is examined. Fig. 1 clearly shows the asymmetry in density distributions poloidal slices at the mean toroidal pellet location for both the HFS and LFS cases.

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[1] R. Samtaney, S. C. Jardin, P. Colella, D. F. Martin, "3D Adaptive Mesh Refinement Simulations of Pellet Injection in Tokamaks", to appear in Computer Physics Communications, 2004.

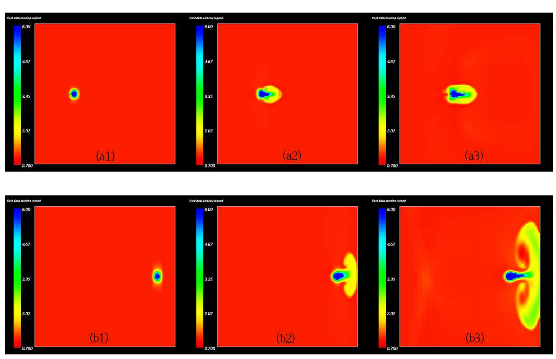

Figure 1: Density field in a poloidal cross-section. (a1) HFS $t = 2$, (a2) HFS $t = 20$, (a3) HFS $t = 60$, (b1) LFS $t = 2$, and (b2) LFS $t = 20$, and (b3) LFS $t = 60$.