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Nonlinear Plasma Simulation Studies using M3D*

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The multilevel physics, parallel processing plasma simulation code, M3D [1,2] has been used to study various toroidal plasmas. M3D currently has physics levels of MHD, two-fluids [3], and hybrid gyrokinetic-particle/fluid models.[4] It uses unstructured meshes [5], and the parallel processing structure utilizes MPI and the PETSc framework[6], with good parallel scaling up to 1000s of processors.

M3D has been extensively used for nonlinear simulation studies of tokamaks, ST's, stellarators, etc. A particular result included in this poster is an extension of our previous studies[7,8] of the current hole[9,10] phenomenon in tokamaks. In our previous results with very low β, it was found that *n=0* sawtoothing effectively prevented the current from becoming substantially negative in the current hole region. Finite β (with a peak β as low as a fractional percent) effects can change this picture and cause a saturation of the *n=0* sawtoothing mode, thereby allowing a substantial negative current in the 'hole' region. This effect remains in both two-fluid and particle/fluid hybrid models. The physical reason for this phenomenon is analogous to the *n=1* sawtooth saturation in tokamaks[11] and ST's[12] due to a pressure peak in the magnetic island (a 'snake'). Thus, it will be interesting to see whether such a correlation, i.e., more saturated cases with substantial negative current at higher plasma β, manifests in actual experiments.

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