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M3D Simulations of Stellarators, ITER Halo Currents, and Divertor Spheromaks

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The M3D code [1] has been applied to several magnetic configurations, which contain magnetic separatrices and open field lines. (1) M3D is being interfaced with the PIES [2] code, so that equilibria can be directly compared. PIES free boundary equilibrium will be also used as initial condition for M3D free boundary kink mode studies. These modes limit the attainable β in the NCSX design. It has already been shown [3] using M3D that ideal and resistive ballooning modes in NCSX are stabilized by two fluid diamagnetic drifts. Computations of two fluid stabilization of resistive modes in W7AS are in progress. It is conjectured that a low temperature high β mode observed in W7AS may be a resistive pressure driven mode, which is stabilized at higher temperature by diamagnetic drifts. (2) Simulations have been done of halo currents in ITER. The vacuum or halo region between the plasma core and outer wall is modelled as a cold, resistive plasma. A resistive wall boundary condition was applied, with the exterior vacuum solution obtained from Green's functions. A self consistent Spitzer resistivity was calculated from $T^{-3/2}$, where T is the temperature. A temperature contrast of 100 between the core and halo region is possible. In 2D, VDEs can occur, with growth rate confirmed to scale linearly in wall resistivity. In 3D, disruptions can occur as well. Toroidal peaking factors of halo current are found to be about 2. (3) Simulations have been done of the Dag[4], a spheromak like configuration with an inboard divertor. Calculations of a special case with finite β, show stability for $\beta < 12\%$. Above this value, modes with toroidal mode number $n = 3, 4, ...$ are unstable, producing a turbulent steady state like an RFP.

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