Nonlinear Resistive Wall Simulations

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Time dependent nonlinear 3D simulations are being carried out which depend on resistive wall effects. The studies include the deposition of halo current during disruptions, damping of toroidal flow by magnetic error fields, and nonlinear resistive wall modes. The M3D code includes resistive wall boundary conditions, which match the solution inside the resistive wall to the exterior vacuum solution. The exterior problem is solved with a Green's function method, using the GRIN code [2]. Source terms model a "virtual casing" to provide resistive equilibrium, and toroidally varying source terms are used to impose error fields. The M3D code has a time dependent self consistent resistivity model, and realistic geometry including the magnetic separatrix. Thermal conductivity in the presence of the separatrix provides an adequate temperature contrast between the core and the halo region, which is the open field line region outside the separatrix. Initial equilibria are initialized using EQDSK data. A parallel viscosity model has been introduced in M3D to provide dissipative coupling needed for resistive wall modes, as well as for toroidal flow damping. The model conserves toroidal angular momentum, and is consistent with equilibria with toroidal flow in which the equilibrium angular frequency is a flux function. When external magnetic perturbations are applied, the parallel viscosity causes a damping of the toroidal flow energy. Work is also in progress on the resonant amplification of error fields by stable resistive wall modes [3]. Studies are also continuing on the deposition of halo current on a resistive wall during disruptions. The aim to find the toroidal peaking factor and halo current fraction associated with different types of disruptions, including disruptions induced by magnetic error fields.

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