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Nonlinear Fluid Model Of 3-D Field Effects In Tokamak Plasmas[1]

J D CALLEN, C C HEGNA, M T BEIDLER, University of Wisconsin-Madison — Extended MHD codes (e.g., NIMROD, M3D-C1) are beginning to explore nonlinear effects of small 3-D magnetic fields on tokamak plasmas. To facilitate development of analogous physically understandable reduced models, a fluid-based dynamic nonlinear model of these added 3-D field effects in the base axisymmetric tokamak magnetic field geometry is being developed. The model incorporates kinetic-based closures within an extended MHD framework. Key 3-D field effects models that have been developed include: 1) a comprehensive modified Rutherford equation for the growth of a magnetic island that includes the classical tearing and NTM perturbed bootstrap current drives, externally applied magnetic field and current drives, and classical and neoclassical polarization current effects, and 2) dynamic nonlinear evolution of the plasma toroidal flow (radial electric field) in response to the 3-D fields. An application of this model to RMP ELM suppression precipitated by an ELM crash [1] will be discussed. [1] J D Callen, R Nazikian, C Paz-Soldan, N M Ferraro, M T Beidler, C C Hegna and R J La Haye, Model of $n = 2$ RMP ELM suppression in DIII-D, report UW-CPTC 16-4 (to be published).

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