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Calculation of Linear Two-Fluid Plasma Response to Applied Non-Axisymmetric Fields[1]

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The development of new numerical tools has allowed for the first time, the calculation of the response of a plasma to applied non-axisymmetric fields using a two-fluid model in diverted toroidal geometry. Reconstructed equilibria from several DIII-D discharges are considered. In addition to two-fluid effects, the model includes Spitzer resistivity using experimental electron temperature profiles, and realistic values of perpendicular viscosity and thermal conductivity. Toroidal rotation of the equilibrium is also included, with the axisymmetric equilibrium self-consistently modified as needed. The computational domain extends across the separatrix and the open field-line region is modeled as a low-temperature plasma. Both screening of applied fields and amplification of resonant modes are observed. Although rotation is found generally to inhibit the penetration of non-axisymmetric fields, it is found that the plasma response is not invariant under a reversal of the toroidal rotation, even within the context of single-fluid resistive magnetohydrodynamics. When two-fluid effects are included, it is found that error field penetration is greatest when the perpendicular flow velocity is small. Even in cases without rotation, time-independent parallel currents are found to exist in boundary layers at mode-rational surfaces. The time-independent response is calculated in two different ways: by evolving the dynamical system to steady-state and by directly solving the inhomogeneous time-independent equations. Calculations are performed using a parallel finite-element code, M3D-C1.

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