Penetration and amplification of resonant perturbations in 3D ideal-MHD equilibria

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abstract

The nature of ideal-MHD equilibria in three-dimensional geometry is profoundly affected by resonant surfaces, which beget a non-analytic dependence of the equilibrium on the boundary. Furthermore, non-physical currents arise in equilibria with continuously-nested magnetic surfaces and smooth pressure and rotational-transform profiles.

We demonstrate that three-dimensional, ideal-MHD equilibria with nested surfaces and δ-function current-densities that produce a *discontinuous* rotational-transform are well defined and can be computed both perturbatively and using fully-nonlinear equilibrium calculations.

The results are of direct practical importance: we predict that resonant magnetic perturbations penetrate past the rational surface (i.e. “shielding” is incomplete, even in purely ideal-MHD) and that the perturbation is amplified by plasma pressure, increasingly so as stability limits are approached.