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Computation of Resistive Instabilities in Tokamaks with Full Toroidal Geometry and Coupling Using DCON

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Precise determination of resistive instabilities is an outstanding issue in tokamaks, remaining unsatisfactory for a long time despite its importance for advanced plasma control. This paper presents the first successful computation of such resistive instabilities including full mode coupling and multiple singular surfaces, by upgrading DCON [1] with a resonant-Galerkin method [2] using improved basis functions such as Hermite cubics and high-order Frobenius power series. Incorporating the resistive layer model of Glasser-Greene-Johnson (GGJ) [3] and matching the inner-layer solutions into full outer-layer solutions in DCON, a complete picture of resistive instabilities in tokamaks can be obtained and studied. Excellent quantitative agreement with the MARS-F code [4], for both growth rate and outer-layer solutions, has been achieved. Convergence is also a distinguished property in DCON as tested with challenging NSTX equilibria with strong shaping, high-β, and multiple rational surfaces up to 10. Another important advantage in DCON is the separation of the inner-layer from the outer-layer regions, which will allow us to extend inner-layer model efficiently to more advanced fluid equations including drift kinetic effects and to perform more precise calculations of non-ideal stability and 3D perturbed equilibria in the future.

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