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Residual flow calculation with imposed magnetic perturbation
P.W. TERRY, M.J. PUESCHEL, D. CARMODY, University of Wisconsin-Madison, W.M. NEVINS, Lawrence Livermore National Laboratory — To test the hypothesis that a stochastic magnetic field disrupts zonal flows associated with ITG turbulence saturation, a finite-beta residual flow scenario was created. In this scenario a time-asymptotic Rosenbluth-Hinton (RH) residual flow is suddenly subjected to an externally imposed, fixed-$A_{||}$ perturbation. Simulations show that the potential decays from the residual level, crossing zero, with a time dependence that is roughly quadratic.[1] We investigate this behavior analytically, calculating the gyrokinetic response to an impulsive charge on a rational surface in the presence of a fixed $A_{||}$. For short times, the ion response remains unchanged from its RH value, while electrons are removed from their drift orbits by the radial displacements of magnetic-flutter losses. For $t \ll [v_e k_y k_x A_{||}/B_0]^{-1}$ the potential evolution has quadratic and linear components, with a zero crossing at finite time. The crossing time and its parametric dependencies are compared with the numerical results. The numerical and analytical results are in good agreement, and support the hypothesis that the high-beta runaway of numerical simulations is a result of the disabling of zonal flows by finite beta.

[1]M.J. Pueschel, et al., Phys. Rev. Lett. **110**, 155005 (2013).

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