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Long-time scale nonlinear simulation of RSAE/TAE instabilities[1]

DON SPONG, Oak Ridge National Laboratory — Both frequency sweeping and constant frequency fast ion driven Alfvén instabilities are often observed to persist for a few times 100,000 Alven times. Simulations for these time intervals are challenging both due to computational issues (numerical stability, error accumulation) and physics considerations (source/sink balancing, avoiding bursting/decay, resolution of nonlinear energy cascades, etc.). The usually invoked quasilinear saturation mechanisms do not allow maintenance of such long-lived turbulence; some form of self-organization due to effects such as zonal flows/currents is necessary to nonlinearly sustain Alfvén instabilities over these time intervals. The global mode structures of RSAE and TAE instabilities naturally drive such effects through the Reynold's and Maxwell stress terms. The TAEFL gyrofluid model is a useful tool for exploring such effects since it has the computational stability/efficiency and nonlinear Reynold's/Maxwell stress effects to follow long-time scale nonlinear Alfvénic turbulence. Since the evolving nonlinear mode structure can be quite different from linear mode structure, such effects can be of importance in evaluating fast ion losses and wall heating caused by the nonlocal wave-induced fast ion transport.

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