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TH/P3-04: Simulation of Sawteeth and other Global Macroscopic Dynamics of Tokamak Plasmas on the Transport Timescale

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Recent advances in implicit numerical algorithms for solving the 3D extended magneto-hydrodynamic equations in strongly magnetized plasmas have enabled massively parallel simulations of the internal global dynamics of tokamaks that can use very large time steps which allow one to span the timescales of ideal MHD stability, magnetic reconnection, and particle, energy, and momentum transport . It is now possible and feasible to run these high-resolution time-dependent initial value simulations for 10ˆ6 or more Alfvén times so as to span all relevant timescales in a single simulation. A transport model is specified by prescribing functions for the plasma resistivity, viscosity, particle diffusivity, and thermal conductivities. The calculations are then run long enough so that the system reaches either a stationary state or exhibits time-periodic behavior. We have identified different regimes that correspond to: periodic sawteeth events without precursors, stationary helical states with flow, or periodic behavior involving semi-stationary helical states (or precursors) together with sawteeth crashes. The parameter regimes for these different behaviors are mapped out and discussed for both single fluid and 2-fluid MHD.

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