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Free-boundary MHD simulations of time-dependent poloidal flow

LUCA GUAZZOTTO, RICCARDO BETTI, U. of Rochester — In the edge plasma region of tokamak experiments finite toroidal and poloidal flows are routinely observed. MHD theory predicts that when the poloidal velocity is transonic with respect to the poloidal sound speed ($c_{sp} \equiv c_s B_p / B$, where B_p is the poloidal field) transient shocks will develop in the transonic region. Such shocks will then move in the poloidal direction and disappear once they reach the location of the minimum transverse flow cross section. After the end of the transient, a steady-state pedestal in plasma density and pressure is left, with the height of the pedestal depending on the poloidal location. Numerical simulations of fixed-boundary plasmas performed by the authors have confirmed the predictions of theory. In the present work, we extend previous results to include a vacuum region around the plasma, thus studying a more realistic model of experiments. Close to the X-point the poloidal field and poloidal sound speed are vanishingly small. Therefore, the critical poloidal velocity necessary to create the transonic discontinuity in free-boundary simulations with an X-point is much smaller than in the fixed-boundary case. The main result of the free-boundary simulations is to confirm that in realistic conditions steady-state pedestal-like contact discontinuities will form even with small poloidal velocities if the poloidal rotation is transonic near the plasma edge. Work supported by US Department of Energy Contract No. DE-FG02-93ER54215.

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