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A self-sustaining mechanism that prevents tokamak plasmas from sawtoothing in non-linear 3D MHD simulations I. KREBS, Max-Planck/Princeton Center for Plasma Physics, S.C. JARDIN, Princeton Plasma Physics Laboratory, Princeton, NJ, USA, S. GÜNTER, K. LACKNER, M. HOELZL, Max Planck Institute for Plasma Physics, Garching, Germany, N. FERRARO, Princeton Plasma Physics Laboratory, Princeton, NJ, USA — We use the finite element 3D MHD code M3D-C^1 [Jardin et al., Comput. Sci. Discovery 5, 014002 (2012)] to study large-scale instabilities in the center of tokamak plasmas. It has been shown [Jardin et al., Phys. Rev. Lett. 115, 215001 (2015)] that in 3D MHD simulations of plasmas with a flat central $q \approx 1$, an ideal interchange instability can develop that keeps the current density from peaking despite central heating. The instability yields a ($m = 1$, $n = 1$) perturbation of the core plasma, i.a. a helical flow that flattens the central current density by (1) flattening the temperature profile and (2) combining with the perturbed magnetic field to generate a negative loop voltage through a dynamo effect. This might explain the "flux-pumping" effect observed in hybrid discharges [i.a. Petty et al., Phys. Rev. Lett. 102, 045005 (2009)]. We study in which parameter range the two effects are strong enough to prevent sawtoothing. We describe a new regime of quasi-stationary oscillating states and analyze cases in between the stationary and the cycling regime in which the sawtooth behaviour is modified by the current flattening mechanisms. To connect to experimental observations, we have set up simulations starting with a scenario comparable to the current ramp-up phase.

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