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Self-organized stationary states of inductively driven tokamaks[1]

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— We report on a mechanism for preventing the current and temperature profiles from peaking in a stationary state tokamak. For certain parameters, regardless of the initial state, the plasma profiles will evolve into a self-organized state with the safety factor q slightly above 1 and constant in a central volume. This large shear free region is unstable to interchange modes for any pressure gradient, and the instability drives a strong (1,1) helical flow. This flow has the property that **V x B** is the gradient of a potential, so it does not affect the magnetic field evolution. However, the driven flow appears in the temperature evolution equation and dominates over the thermal conductivity in the center of the discharge. The net effect is to keep the central temperature (and resistivity) profiles flat so that the resistive steady state preserves the self organized state with q slightly above 1 and constant in the central volume. This mechanism was discovered with the M3D-C1 toroidal 3D MHD code, and could possibly explain the mechanism at play in non-sawtoothing discharges with q_0 just above 1 such as hybrid modes in DIII-D and ASDEX-U and long-lived modes in NSTX and MAST.

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