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Fast sawtooth crash at $q \geq 1$ due to nonlinear interchange[1] LINDA SUGIYAMA, Massachusetts Institute of Technology MIT — Sawteeth at magnetic safety factor $q = 1$ often have a fast final stage that expels plasma and energy to well outside $q = 1$ and flattens the pressure and current density over the plasma center. It has a sudden onset and accelerates in time. It is nearly independent of resistivity. The final outflow is highly localized poloidally and at least somewhat toroidally. Similar fast crashes occur for double tearing modes (DTM) with two resonant $q = q_s$ surfaces. Analysis of the free energy δW identifies the instability as an interchange mode driven by the normal magnetic curvature κ_n at the outer q_s surface, triggered when the hotter magnetic island(s) narrows sufficiently that κ_n dominates the geodesic curvature and internal kink terms. Unlike the standard toroidal interchange instability, it can be independent of ∇p. In force-free or incompressible plasmas, it can be driven by the local $J_\perp$, consistent with its existence in 2-field reduced MHD simulations of the DTM. If ∇p exists, it can also contribute to the mode. Fully toroidal MHD simulations with the M3D code illustrate the interchange nature of the fast crash for internal kink and quasi-interchange $q = 1$ sawteeth.

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