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New picture of the 1/1 internal kink and sawtooth in compressible toroidal plasmas[1] LINDA SUGIYAMA, MIT — The $m = 1$, $n = 1$ internal kink mode and the sawtooth crash have been analyzed extensively in magnetically confined toroidal plasmas. Nevertheless, many questions remain. A new analysis, with the aid of numerical simulation, shows that small parameter expansions such as large aspect ratio break down in general for the MHD compressible toroidal 1/1 instability with realistically small growth rates. The perpendicular momentum rate of change $\rho\partial\mathbf{v}_\perp/\partial\mathbf{t}$ must be very small compared to the individual terms in $-\rho(\mathbf{v}\cdot\nabla)\mathbf{v}|_\perp + \mathbf{J}\times\mathbf{B}|_\perp - \nabla_\perp\mathbf{p}$. The lowest order mode still has the standard 1/1 internal kink form, but the $\mathbf{v}_\perp$ magnitude and growth rate are determined by the higher order terms. Terms containing $\tilde{B}_\phi$, nominally associated with the compressional Alfvén wave are important. One corollary is that reduced MHD (RMHD) fails completely and Sweet-Parker-type reconnection never develops. At a critical nonlinear amplitude, associated with the growth of the higher toroidal harmonics, a fast, explosive crash begins with rapidly accelerating velocity growth that matches observations. Other transverse MHD instabilities experience analogous effects.

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