

## TH/P1-13 Nonlinear and Toroidal Mode Coupling ... Sugiyama

- Studies of  $m=1/n=1$  modes in toroidal plasmas show that compressible, fully toroidal MHD provides a nonlinear picture different from reduced MHD that is much closer to experimental observations. (Based on simulations with M3D)
- New, nonlinear  $1/1$  ion density “snake” with embedded, slowly growing  $1/1$  internal kink-type mode when  $dn/dt$ ,  $dT/dt$  evolve with background plasma toroidal rotation. Resembles C-Mod.
- Small net perpendicular force in momentum equation is a characteristic property of  $1/1$  and other MHD instabilities
  - Cancellation of main  $\mathbf{J} \times \mathbf{B} - \nabla p$  terms  $\Rightarrow$  Higher order in aspect ratio contributes to  $1/1$  internal kink and sawtooth crash, even at  $r_{q=1}/R=1/10$
  - At low resistivity, sawtooth culminates in a fast crash lasting some  $100 \tau_A$  with rate nearly independent of resistivity (like experiments). Above a critical amplitude,  $d\mathbf{V}_\perp/dt$  accelerates steadily until  $\tilde{T}$ ,  $\tilde{\psi}$  are lost from  $q < 1$ .
- Plasma edge instabilities are dominated by nonlinear and toroidal mode coupling; related perpendicular momentum effects appear