Dylan Brennan
General Atomics/MIT

# Computing Nonlinear Magnetohydrodynamic Instabilities in Fusion Plasmas

One of the exciting new developments in fusion plasma physics has been an unprecedented agreement between theoretical predictions from the Magnetohydrodynamic (MHD) model and experimental data. Predictive understanding of instabilities in these plasmas is crucial to understanding the physics of present day experiments and the design of the next generation plasma experiments, which will be dominantly self heated (ignited) by fusion reactions. While many experimental observations remain unexplained, we present an overview of recent results using the NIMROD code (http://nimrodteam.org) which shed light on the important questions concerning this understanding, such as the effects of resistivity, viscosity, thermal transport and flow shear on the nonlinear dynamics of instabilities. Experimental equilibrium reconstructions are used to accurately model the nonlinear evolution of MHD instabilities observed in experiment, which is significantly challenging because of the requirements of high magnetic Reynolds number, anisotropy, and resolution combined with long time scales. Results are shown to reproduce some experimental phenomena in detail, such as the filamentary structure of edge localized modes (ELMs), and the scaling of growth rates of tearing modes with plasma heating. This work represents important steps towards detailed theoretical understanding of the physics of plasma evolution, and a model for onset and evolution of instabilities that can lead to accurate prediction, control and/or avoidance.

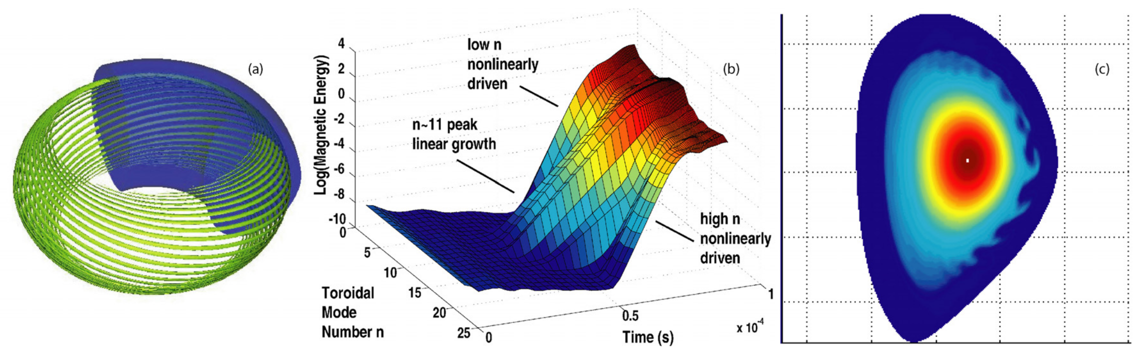


Fig.1 The linear structure of an edge localized mode (a) in a toroidally confined fusion plasma, the magnetic energy as a function of time (b) of the evolution of the mode, and a cross section of the electron temperature (c) during the late nonlinear phase of the mode.