NSTX

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Role of kinetic dissipation in modifying RWM eigenfunctions

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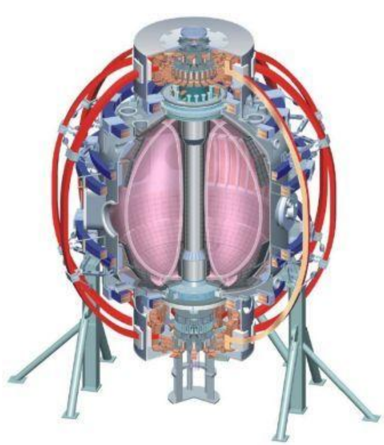

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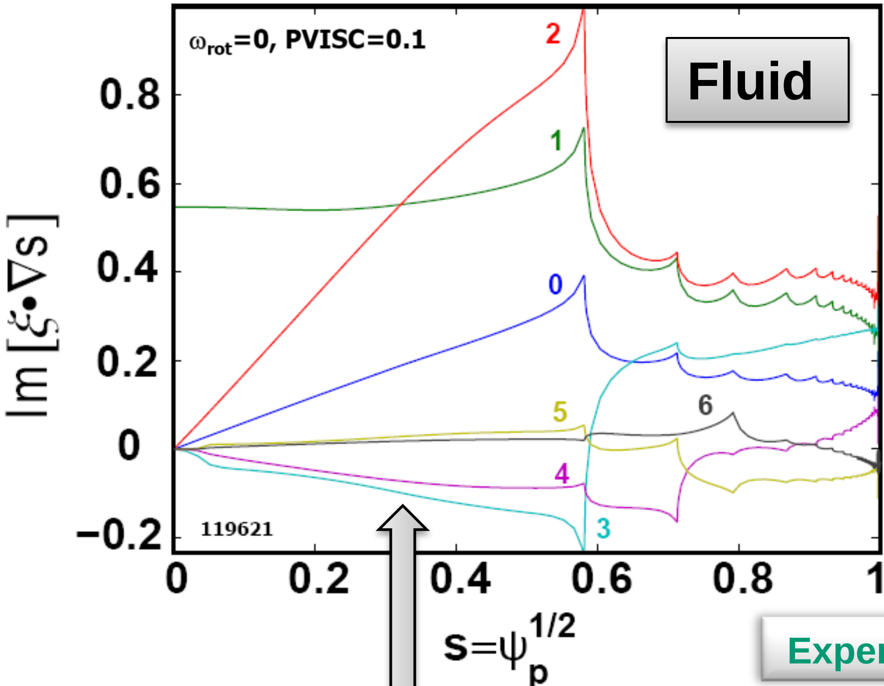
Remaining physics questions for RWM

- Questions (from 2010 MHD mode-control workshop):
  - NSTX MARS-K: substantial differences btw perturbative & SC
    - Unique to NSTX?
  - What determines range of validity of perturbative approach?
    - How large can δW_K and dissipation be?
    - What are effects of large ω_E on dispersion?

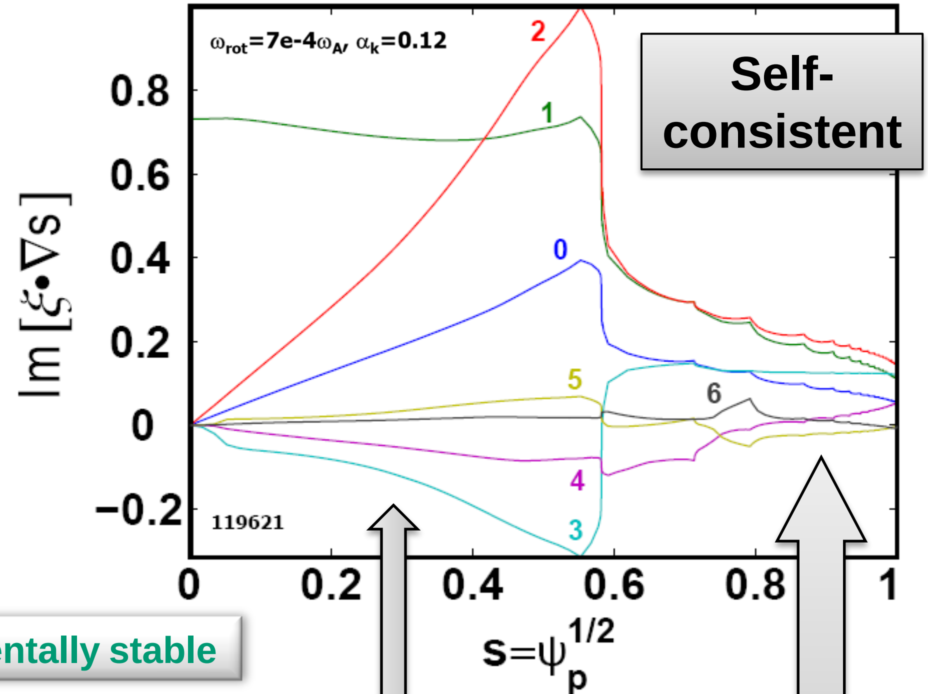
$$\gamma\tau_w^* \simeq -\frac{\delta W_\infty + \delta W_k}{\delta W_b + \delta W_k}$$

  - Is underlying single-fluid MHD treatment sufficient?
    - Eigenfunctions, dissipation can be highly localized near rationals
    - Is continuum damping computed accurately?
- Near-term/future work:
  - Collisions were not included in MARS-K analysis shown
    - YQ Liu adding this now - will modify e-contribution to δW_K, other?
  - Need more systematic benchmarking of fluid and kinetic δW
  - More complete comparisons to experiment: γ, ω, ξ

MARS-K self-consistent calculations for stable case indicate modifications to eigenfunction begin to occur at low rotation

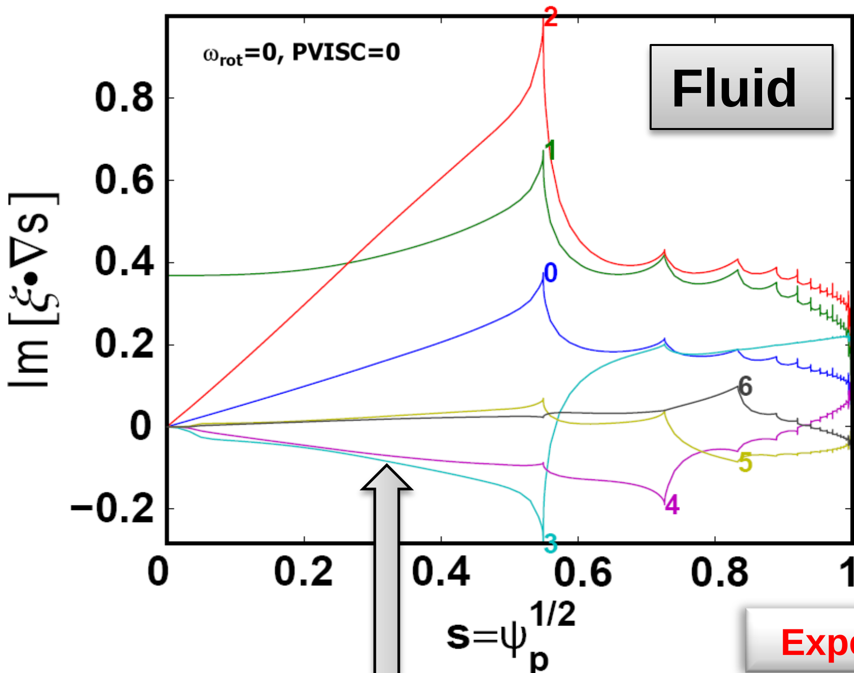


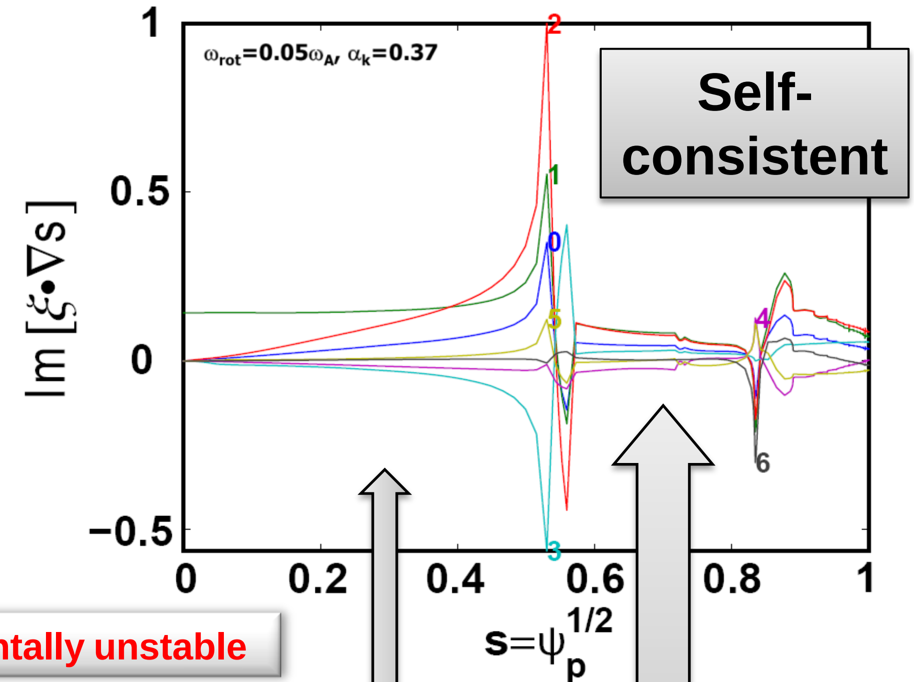
Experimentally stable



- Self-consistent (SC) eigenfunction qualitatively similar to fluid eigenfunction in plasma core
- SC RWM $\xi_\perp$ amplitude reduced at larger r/a
  - Low ω_E / ω_E (expt) = 0.3%, $\delta W_K/\delta W_K$ (expt) = 12%
  - Reduced amplitude could reduce dissipation, stability

MARS-K self-consistent calculations indicate rotation and dissipation can strongly modify RWM eigenfunction

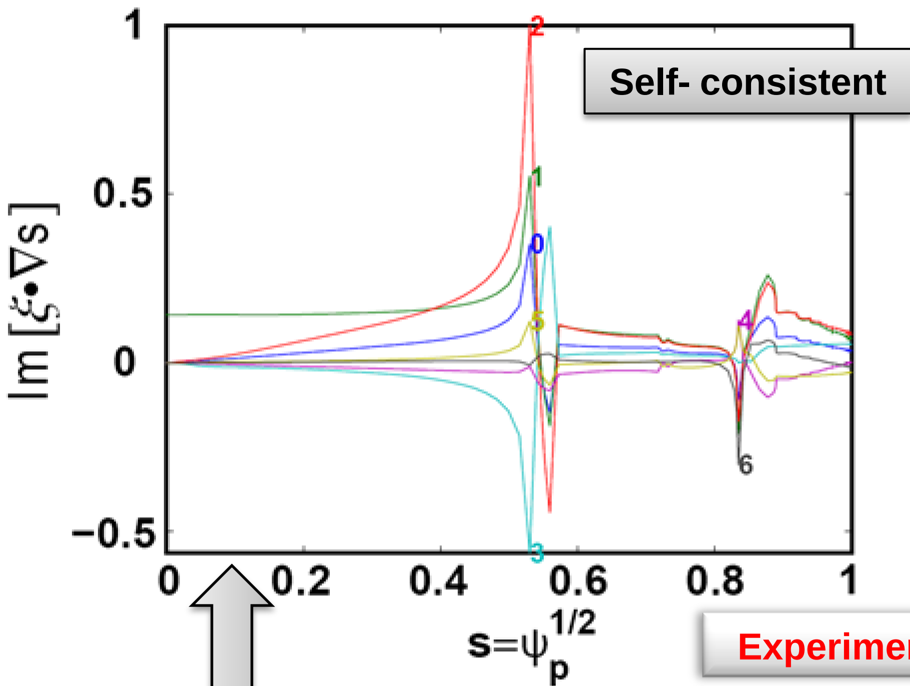




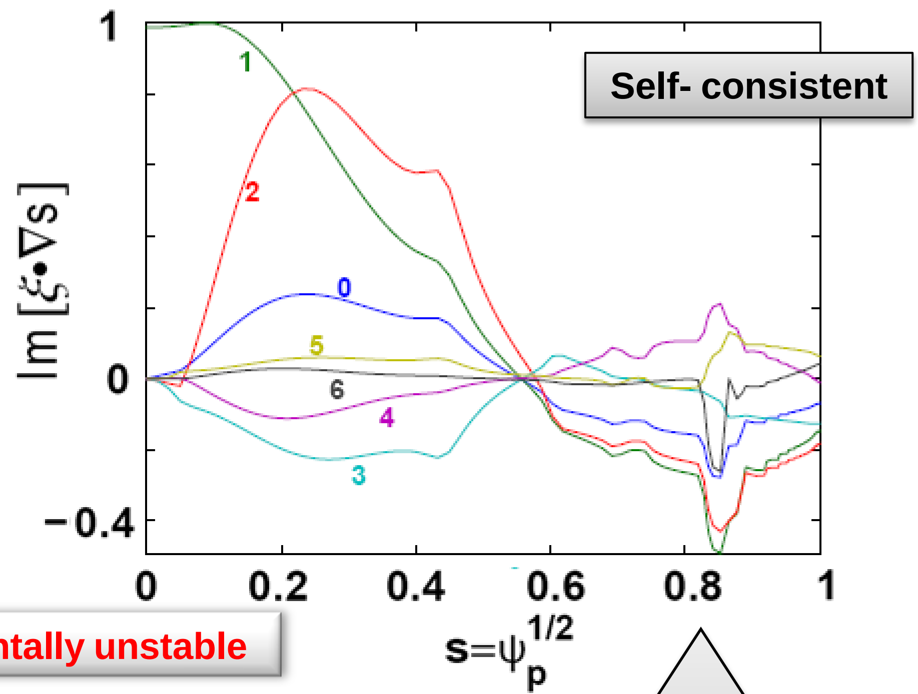
Experimentally unstable

- Self-consistent (SC) eigenfunction shape **differs** from fluid eigenfunction in plasma core
- SC RWM $\xi_\perp$ substantially different at larger r/a
  - Moderate ω_E / ω_E (expt) = 22%, $\delta W_K/\delta W_K$ (expt) = 37%
  - Differences could be even larger at full rotation and δW_K
  - **Does reduced edge $\xi_\perp$ amplitude explain reduced stability?**

At full rotation and kinetic effects in NSTX, MARS-K indicates likely transition to 2nd unstable eigenfunction



Experimentally unstable



- SC RWM $\xi_\perp$ at fraction of ω_E and δW_K
  - Moderate ω_E / ω_E (expt) = 22%, $\delta W_K/\delta W_K$ (expt) = 37%
- SC RWM $\xi_\perp$ at **full experimental ω_E and δW_K**
  - Eigenfunction shape substantially modified → transition to 2nd mode?

Experimental Plan

(1.5 day request, 0.5 day minimum useful)

- Predicted changes to eigenfunctions due to kinetic effects are substantial
- Suggests new edge SXR could likely distinguish eigenfunction changes
- Shot plan: Attempt to vary dissipation and look for any eigen-function changes:
  - Use n=1 travelling waves: co/counter propagation (30Hz? Faster?)
  - Measure ME-SXR perturbations, also reflectometer – also BES?
  - Measure RFA for all cases
  - Use n=3 (maybe n=2,3) to vary rotation profile and kinetic damping
    - Look for shot-by-shot changes in n=1 RFA and eigenfunction
  - Use Li and/or Ne puffing to decrease/increase collisionality
- Compare to MARS-F and MARS-K