Stability Modeling of DIII-D AT Scenarios

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GENERAL ATOMICS

MOTIVATION

- Strong local pressure gradients are often observed in discharges with ITB which can lead to instability at low beta
- Previous stability modeling studies have been mostly discussed in terms of P(0)/ <P>
- Goals
  - — Explore stable path to configurations with both internal transport barrier (ITB) and high normalized beta β_N
  - — Check sensitivity of stability limit to variations in q and ITB profiles

OUTLINE / KEY RESULTS

- Hyperbolic tangent function provides an useful representation to systematic study the effects of Internal transport barrier (ITB) width and radius on MHD stability
- Stability limit improves with transport barrier width and radius
- Wall stabilization is crucial for ITB with large radius
- Stability limit varies weakly with q(0)
- n=2 modes are more unstable in ITB with large radius and width

APPROACHES

- Ideal stability with a conducting wall
- Simulated equilibria with model q and pressure profiles
- Simulated equilibria with q and pressure profiles from self-consistent transport simulations

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ANALYSIS METHODS

- Equilibrium
  - ToQ, EFIT
  - Up-down symmetric DND based on long pulse high performance shot 95983
  - Pressure profiles modeled using hyperbolic tangent representation with various radii, widths, and amplitudes
  - q profiles modeled using spline representation with various q(0), q_{min}, and ρ_{qmin}
  - Fixed $q_{95} \sim 5.1$
  - Single transport barrier
- Stability
  - Low *n* modes evaluated using GATO with a conducting wall at 1.5a
  - High *n* ballooning evaluated using BALOO

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SCANS

- ITB radius ρ_P
  - Fixed shape
  - Fixed q(0), q_{min}, q_{95}, ρ_{qmin} - ρ_P
  - Hyperbolic tangent pressure with fixed half width W_P
- ITB half width W_P
  - Fixed shape
  - Fixed q(0), q_{min}, q_{95}, ρ_{qmin} - ρ_P
  - Fixed ρ_P
- ρ_P - ρ_{qmin}
  - Fixed shape
  - Fixed q(0), q_{min}, q_{95}
  - Hyperbolic tangent pressure with fixed half width W_P , ρ_P
- q(0), q_{min}

SUMMARY

- Hyperbolic tangent function provides an useful representation to systematic study the effects of Internal transport barrier (ITB) width and radius on MHD stability
- Stability limit improves with transport barrier width and radius
- Wall stabilization is crucial for ITB with large radius
- Stability limit varies weakly with q(0)
- n=2 modes are more unstable in ITB with large radius and width
- Future work
  - More sophisticated pressure models, hyperbolic tangent + linear
  - Higher n modes, edge stability
  - Shaping, squareness, outboard bump