DISCUSSION SUMMARY: BASIS AND APPLICABILITY OF β LIMITS TO COMPACT STELLARATORS

ARIES-CS Project Meeting

Discussion Summary

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Planned Procedure for ARIES-CS Design

- Ignore local stability criteria
- Check linear global stability as guide to approximate limit (TERPSICHORE)
- Monitor linear stability predictions against nonlinear predictions (NSTAB)
- Check flux surface quality (PIES)
- Check for and eliminate low order rationals with a pressure gradient near the edge
- ?
- Town Meeting Consensus: (order of importance)
  - Ignore local stability criteria (Do This)
  - Check flux surface quality (PIES) (Do this)
  - Check low order edge rationals (Do this)
  - Check linear global stability (Monitor for community buy in)
  - Nonlinear predictions (Research project)

What Outstanding Questions Remain?

- **Are nested surfaces a valid approximation for stability calculations:**
  - Does linear instability of a nested flux surface equilibrium simply result in benign nonlinear evolution to a 'nearby' non-nested state?
  - If nested surfaces are not valid, can the stability problem be formulated in terms of finding nonlinearly stable equilibria?
- **Nonlinear consequences crucial for interpreting stability calculations:**
  - Generally internal modes surrounded by a fairly robust and stable outer shell might be expected to be benign
  - Is there a way to quantify this without the full nonlinear calculation?
- **How rigorous is the link between approach to stability limits and equilibrium degradation:**
  - Presumably approach to a stability limit is a cause of equilibrium degradation
  - Is the converse true. Can all causes of equilibrium degradation be traced to the approach to some stability limit or not? Reiman says No! Turnbull is not so sure (yet)
  - Can it be made rigorous so that equilibrium tools can test nonlinear stability?
- ?

Input From Stellarator Community Required for Further Progress

- **Direct comparison of linear stability with experiments and nonlinear stability calculations**
- **Criteria to decide when linear instability of nested flux surface equilibria result in benign nonlinear evolution to 'nearby' states:**

  What is 'big enough'? What do we make of heightened sensitivity?

  - Local ideal ballooning and interchange modes (Probably ok)
  - Global ideal internal modes
  - Global ideal external modes
    - # Fast global β driven modes
    - # Current driven peeling modes
    - # Current driven external kinks
    - # ELMs
    - # Resistive interchange modes
- **Criteria to decide when free boundary equilibrium degradation yields an equivalent equilibrium limit to β**
- **?**

How Important Are the Distinctions Between Tokamaks and Stellarators

- **Do the distinctions only produce superficially different behavior or is there a more fundamental difference in the validity of MHD between Tokamaks and Stellarators:**
  - How much does the different current and pressure profiles between Tokamaks and Stellarators affect manifestation of the β limit?
  - Linear stability calculations generally assume nested flux surfaces: In Stellarators nested surfaces may not exist or may be stochastic !
  - Does relative roles of current and pressure in driving MHD instability mean different observed behavior
- **Are compact Stellarators more Tokamak-like than conventional Stellarators?**
- **?**