Configuration Development

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Elements of the Configuration Optimization Plan

- Test and evaluate new modules in optimizer. Apply to C82 to improve confinement. (Ku & Kessel)
- Explore higer ι, optimum κ, R/a, N. (Ku & Kessel)
- Develop free-boundary optimizer that works with sheet currents expanded in terms of "natural functions". Use it to incorporate coil desirability in plasma configuration design process. (Pomphrey & Boozer)
- Implement global search algorithm. (Mynick & Pomphrey)

An issue — Comparison of candidate configurations with respect to transport properties.

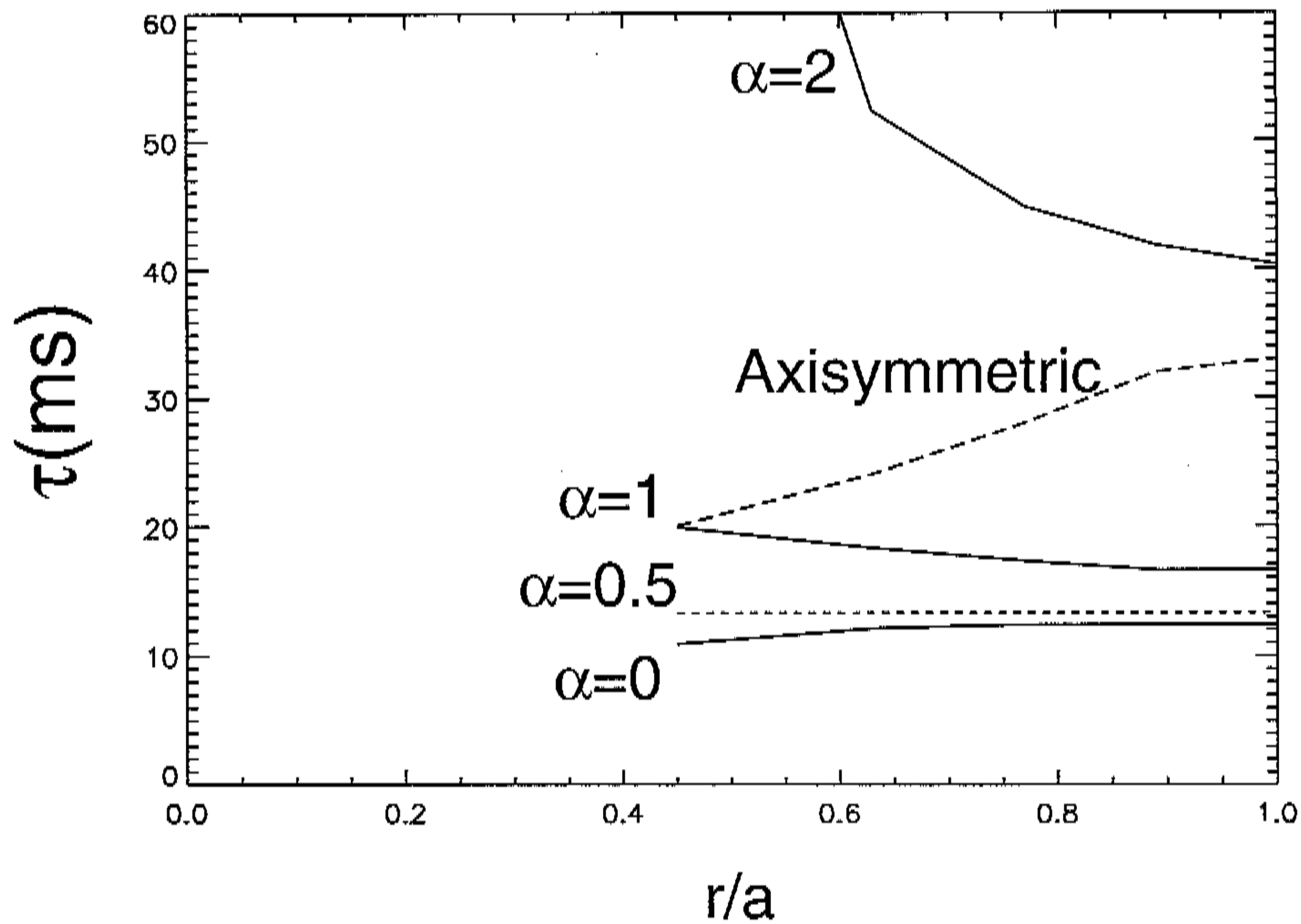
Transport Issue: Background

Early work used χ^2 ripple measure in optimizer, GC3 Monte Carlo code for standalone evaluations.

- Reasonable correlation of χ^2 with GC3.
- GC3 sees large transport unless ripple wells small. This agrees with intuitive expectations.

Switched to use of GTC in Fall '98 for standalone evaluations.

- More realistic. (GC3 monoenergetic, followed particles launched from $r/a = .5$.)
- Added model electric field with $e\phi/T \approx 1$ ($\alpha = 1$).
- GTC with $\alpha = 1$ predicts adequate confinement in C10.



E_r scan for C10

Somewhere in the neighborhood of $\alpha=1$, confinement becomes very sensitive to α.

Energy confinement time (unit=ms) C10

r/a

0.45	0.63	0.77	0.89	1.0

Non-axisymmetric:

alpha=0

8.3	10.9	14.9	17.1	17.4

alpha=0.5

10.0	13.2	17.4	20.7	20.7

alpha=1.0

13.3	16.6	24.9	29.8	29.8

alpha=1.5

20.7	29.0	49.7	66.3	66.3

Axisymmetric:

alpha=0

10.8	15.7	31.5	63.0	72.9

alpha=1.0

16.6	23.2	49.7	91.1	95.3

Transport Issue: Background (continued)

- Subsequent calculations with GTC with $\alpha = 1$ predicted cofinement comparable to that of C10 for higher ripple cases (C82, C93, reconstructed C82).

- PG2 calculation of December: Even when ripple $\chi^2 \approx 20$ times as great as C82, GTC sees only 16% reduction in confinement with $\alpha = 1$. PG2 has deep ripple wells.

- Calculations with $\alpha = 0$ show much stronger ripple effect. (Ku)

- Mynick addressing improved understanding of these results.

- The results raise question of how we compare different configurations with respect to confinement.

Comparison of Transport

- As we go to higher ι or κ, or lower R/a: poloidal flux increases, level of ripple increases.
- How do we assess whether configuration better or worse? Until now: run GTC with $\alpha = 1$.
- But: GTC with $\alpha = 1$ relatively insensitive to ripple. Likely to lead to large ripple wells.
  - Do we believe GTC calculation with $\alpha = 1$?
  - Even if we do, are we interested in configurations that are not close to quasi-axisymmetry?
- Problem to be solved in long term by calculation of transport with self-consistent electric field, and by calculation of flow damping. But need reasonable measure now for use in configuration design.
- Alternative measures for comparison that have been suggested:
  - α particle transport. Use Monte Carlo measure in optimizer.

- Ion thermal transport with $E = 0$.
- Use electron transport calculation to estimate ion thermal transport with ambipolar field. (To be discussed by Mynick.)

Need to decide now on measure to be used in plasma configuration studies.

A Related Issue: How do we set acceptable level of ripple amplitude?
Loosening constraint on ripple will allow us to improve kink stability, coils, etc. Conversely, decrease in ripple comes at expense of kink β limit, etc.

Configuration Improvement