Kink and Vertical Stability of QOS Configurations

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QOS Configurations Studied

- $\beta \sim 4\%$, low bootstrap currents;
  (Fu et al., Phys. Plasmas **7**, 1809 (2000)).

- $\beta \sim 15\%$, higher bootstrap currents.

Kink and Vertical Stability of High β QOS

- The 10% β QOS was initially calculated to be kink stable and vertically unstable. For the 15% β QOS, the Terpsichore code failed because of vacuum grid problem.
- More recently, use of more boozer modes for the equilibrium mapping solves the vacuum grid problem and the 15% QOS is found to be stable to the vertical mode !
- The results of convergence study show that both the 10% and 15% β QOS are weakly unstable to external kink modes by using more Fourier modes for the perturbation (kink eigenvalue around $\lambda \sim -6 \times 10^{-4}$). The 15% β QOS is still stable to vertical modes while the 10% β QOS is strongly unstable to vertical modes ($\lambda \sim -3 \times 10^{-3}$).
- In future, more convergence studies are desired to improve these results.

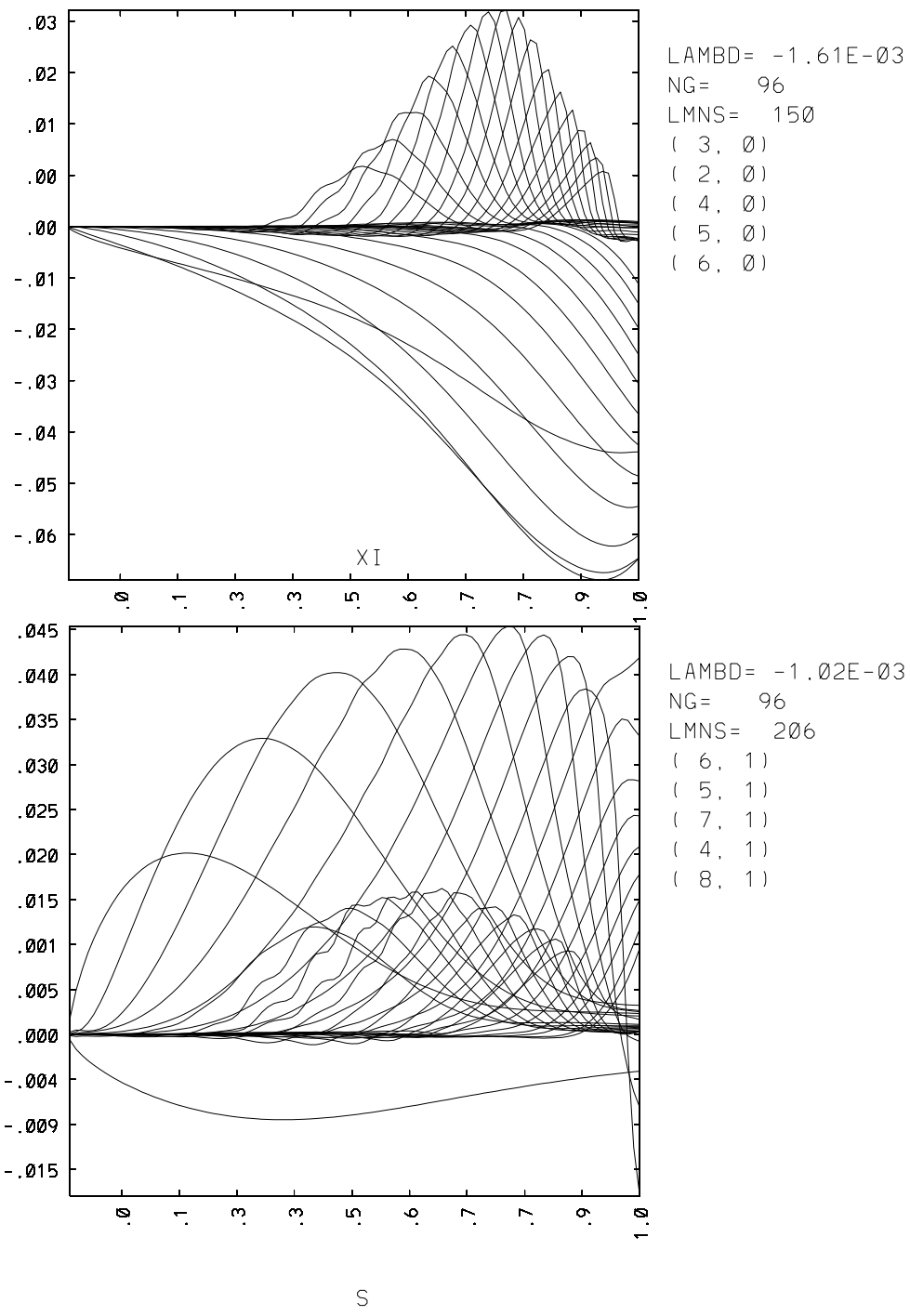

Figure 1: Vertical and kink mode eigenfunctions

δW analysis of the MHD Modes for the 15% β QOS

Table 1: The breakdown of stabilizing and destabilizing terms in the plasma potential energy normalized by the vacuum energy.

mode	vacuum	bending	kink	ballooning	multiplier
$N = 0$	1.00	1.71	-8.69	$+5.83$	$coec = 1.15$
$N = 1$	1.00	28.4	-23.7	-5.90	$coec = coep = 1.01$

$$\omega^2 \delta W_k = \delta W_p + \delta W_{vac} \tag{1}$$

$$\delta W_p = \frac{1}{2} \int d^3x [\delta \mathbf{B}_\perp{}^2 + (\delta \mathbf{B}_\parallel - \mathbf{B}\frac{\xi \cdot \nabla p}{B^2})^2 + \mathbf{j}_\parallel \cdot \xi \times \delta \mathbf{B} - 2\xi \cdot \nabla p \; \xi \cdot \kappa] \tag{2}$$

Remark:

- The $N = 0$ mode (vertical) is marginal at $coec = 1.0$;
- THe $N = 1$ mode (kink) is marginal at $coec = coep = 0.98$, i.e, the equilibrium is close to marginal stability.