Global MRI with Inflow: Role of Boundary Conditions

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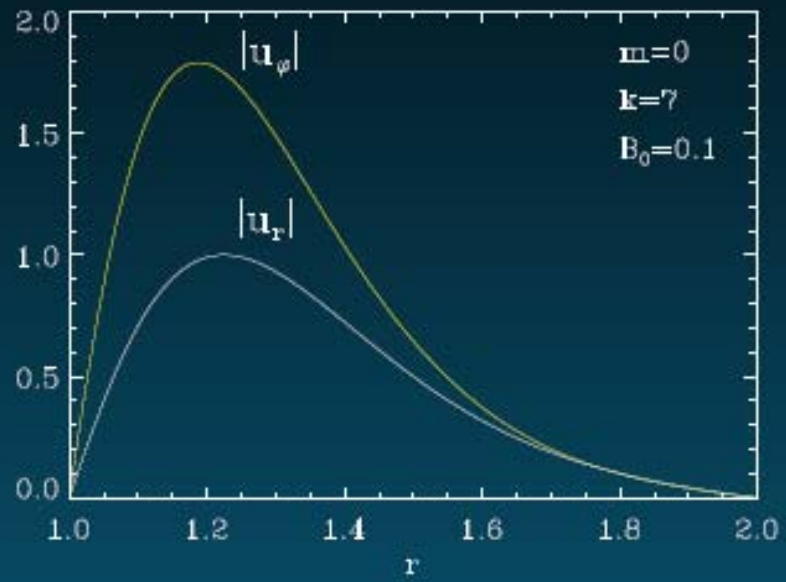
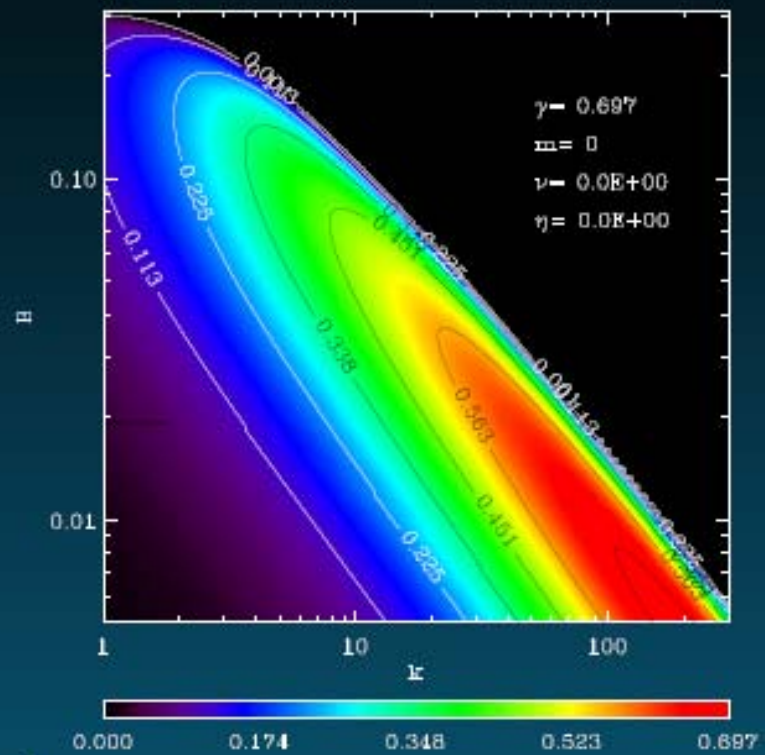
Astrophys. J. **602**, 892 (2004)
Astrophys. J. **638**, 382 (2006)

Ideal MRI Modes

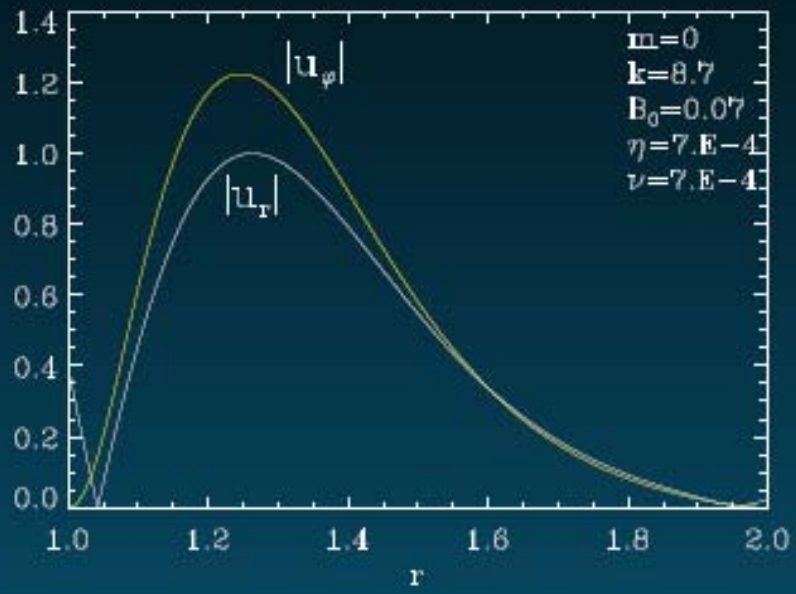
No inflow in the basic state

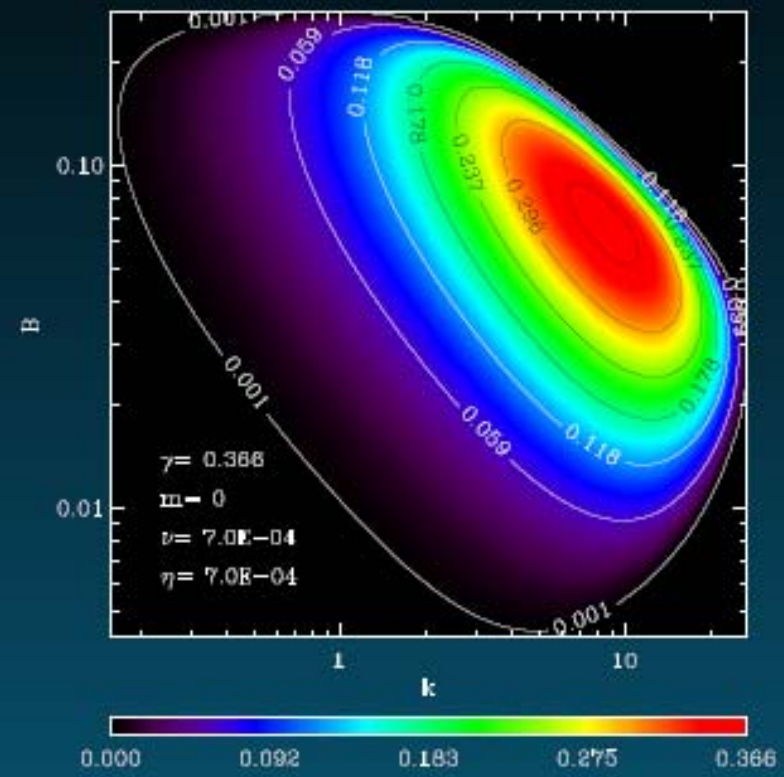




- $m = 0$ is the most unstable global mode
- Quenching by the magnetic tension
- Saturation: $\gamma_{\max} \longrightarrow r_1/2 \; |\mathrm{d}\Omega/\mathrm{d}r|_{r_1}$

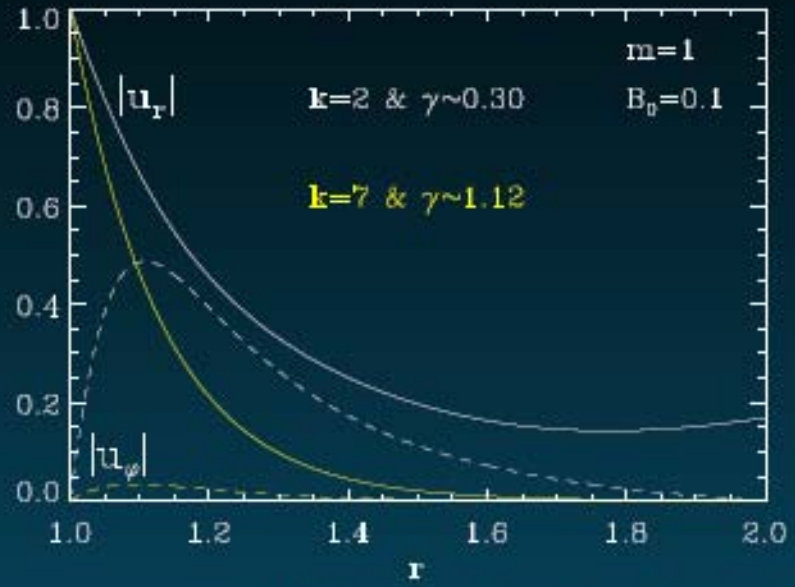
Dissipative MRI Modes

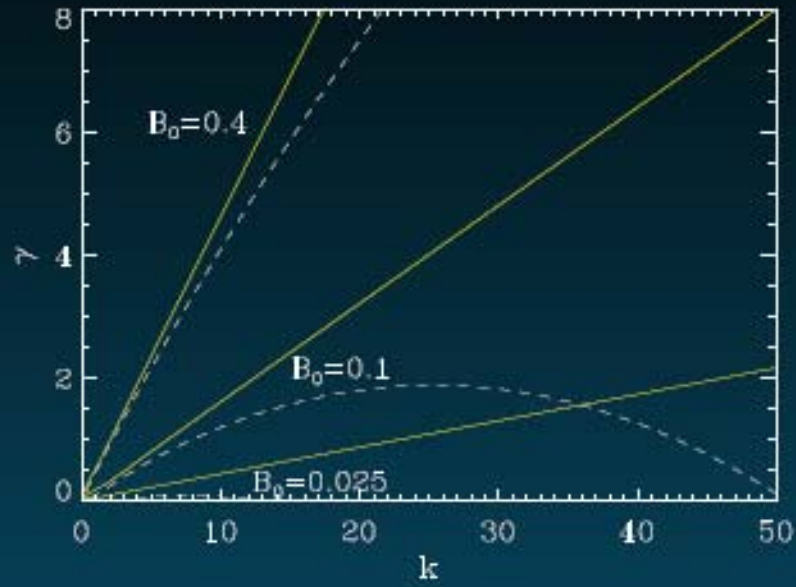




- Modes slightly modified by inflow & dissipation
- Growth rates globally reduced
- Damping of the small-scale modes

Wall Modes

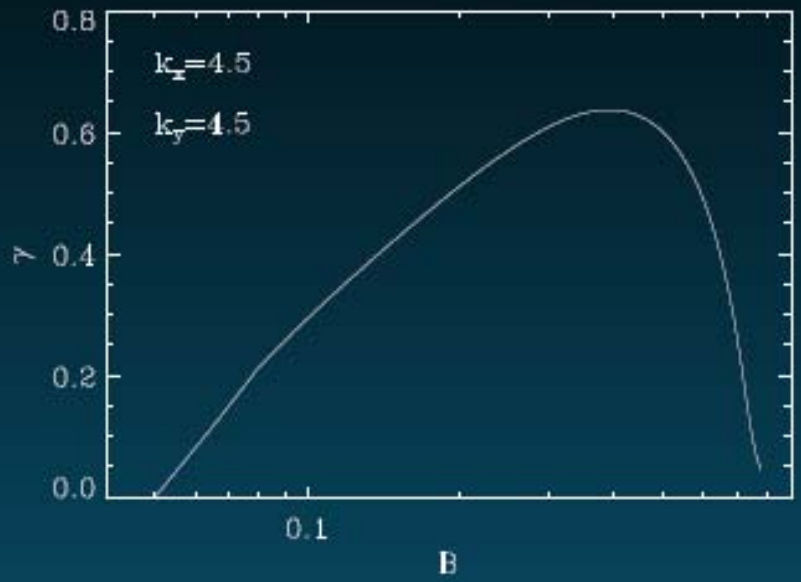


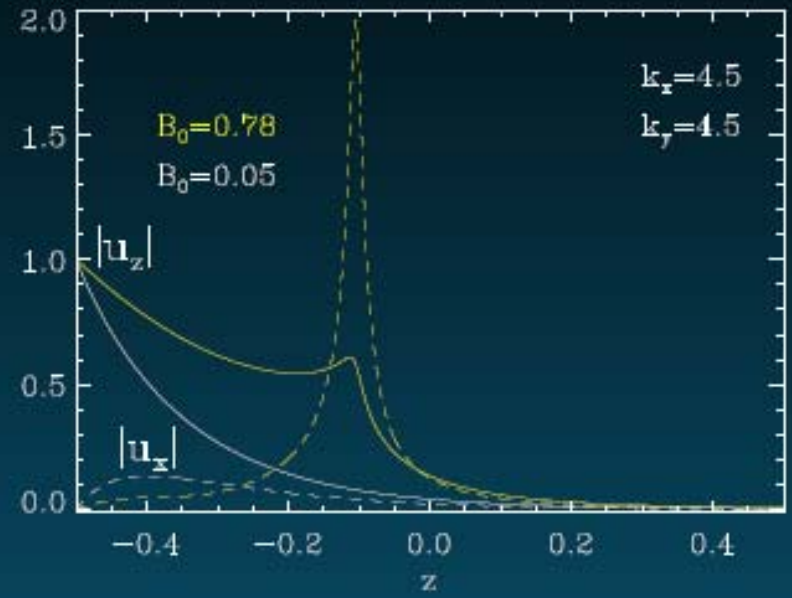


- Wall modes solutions of the linear system too
- γ too large for the free energy available and large range of k unstable
- Ideal case: γ scales linearly with k and increases rapidly with B_0
- Significant flux of energy through the boundaries to feed these modes
- Inflow, curvature and Coriolis force non crucial

Cartesian Wall Modes in MHD

Magnetic field destabilizes the wall modes





$$u_z'' - 2\frac{\omega_a^2}{\chi^2+\omega_a^2}\frac{\chi'}{\chi}u_z' - \left[k^2 + \frac{\chi''}{\chi} - 2\frac{\omega_a^2}{\chi^2+\omega_a^2}\left(\frac{\chi'}{\chi}\right)^2\right] u_z = 0$$

Singularity when $\gamma = 0$ and $\omega = -k_x U_0 \pm \omega_a$