Update on ITG Study

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in collaboration with

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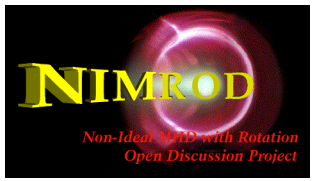
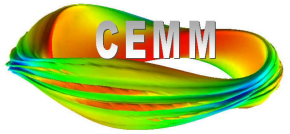




Ion Temperature Gradient (ITG) Instability

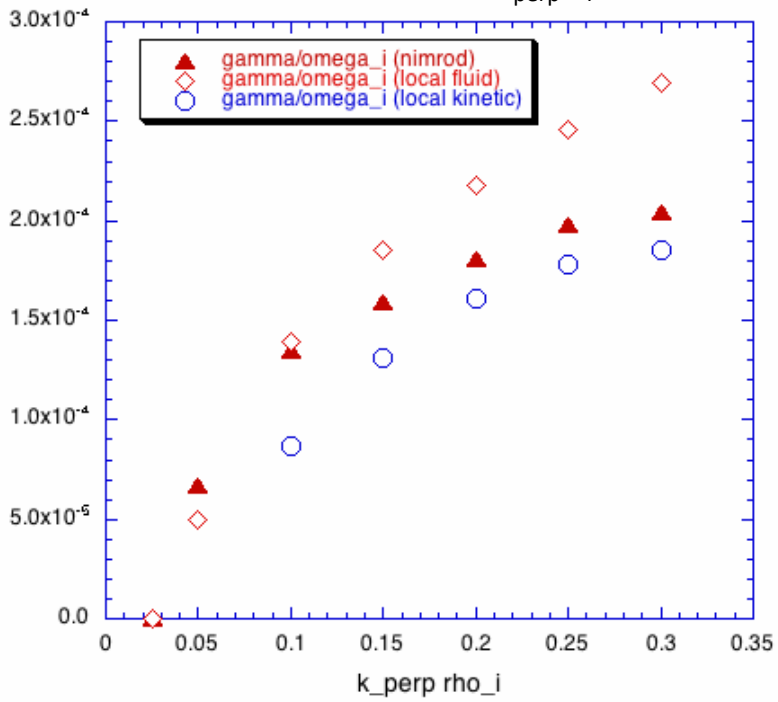
- ITG requires 2-fluid/FLR effects for instability
  - *g*-mode is stabilized by 2-fluid/FLR
  - Good validation test for 2-fluid/FLR computations
- Parallel ion sound wave driven unstable in presence of ion temperature gradient
  - $\eta_i = d \ln T_{i0} / dx > \eta_i^{crit}$
  - Interaction between parallel sound wave and perpendicular drift wave
  - Model problem in slab geometry
- Direct comparison of linear growth rate and real frequency in fluid regime ($k_{perp} \rho_i <\sim 0.25$):
  - Local fluid theory (dipersion relation)
  - Local kinetic theory (dispersion relation)
  - Global NIMROD linear computations
- Comparison between global fluid and kinetic models underway

Computations presented here have their largest *n* and *T* gradients near center of domain.

- Profiles are hyperbolic tangents to avoid boundary effects.
- Location of largest local-theory growth-rate occurs at *x*-values just below *x*=0.

ITG Growth Rate and Real Frequency

Growth Rate vs. $k_{perp}\,\rho_i$

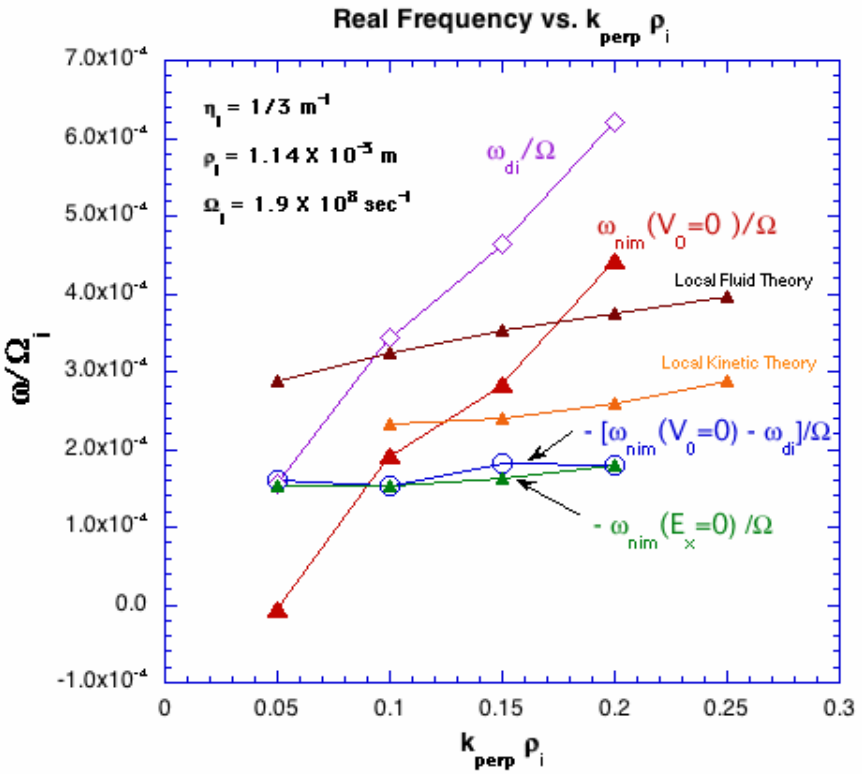


Normalized to ion cyclotron frequency

$\eta_i = 1/3\ m^{-1}$

$\rho_i = 1.14 \times 10^{-3}\ m$

$\Omega_i = 1.9 \times 10^{8}\ sec^{-1}$



- ω_{di} Ion Diamagnetic Frequency
- $\omega_{nim}(V_0 = 0)$ No Eq. Velocity (Doppler shift)
- $\omega_{nim}(E_x = 0)$ No Eq. Elec. Field (No Doppler shift)
- Minus sign (-) means mode propagates *opposite* the ion drift

Summary/Caveats

- Direct comparison between:
  - Local fluid theory
  - Local kinetic theory
  - Global NIMROD linear computations
- Reasonably good agreement
  - Validation of NIMROD 2-fluid/FLR model (Braginskii) and algorithm?
- Caveats: γ and ω_r are weak functions of x
  - Presence of other mode activity?
  - Numerical instability with k_y dependence appears at late times
- Major questions:
  - Why is the real frequency negative?
    - Disagrees with local theory (fluid and kinetic)
  - Why are γ and ω_r functions of x?
    - Impossible for a global eigenvalue
  - Why does the eigenfunction depend on the frame of reference (E_x)?
    - ???
- Comparison with GK computation (CU group) will use a smaller domain.