Simulation Result

- Fluid models often assume polytropic equation of state \( p(\rho, e) = \text{constant} \).
- Scaling laws given as \( \gamma = \left( \frac{\rho}{\rho_i}, \frac{e}{e_i} \right) \) have ambiguity.

**Templature/Pressure effect**

- For high ion temperature, the ion-finite Larmor radius (FLR) effect plays a role. Porcelli derived the growth rate including the FLR effect:\(^{16}\)

\[
\frac{d\psi}{d\tau} = 2 \left( \frac{r_a}{\rho_i} \right) \left( \frac{r_y}{\rho_i} \right) \left( \frac{r_z}{\rho_i} \right)
\]

where \( \rho_i = \frac{\rho_i}{T_i} \) is the ion sound Larmor radius with isothermal electrons and cold ions defining a typical ion scale. We formally use \( r_\perp = \frac{\rho}{\rho_i} \) as the polytropic index (adibatic).

**Conclusions**

- We have performed gyrokinetic tearing instability simulation using AstroGK for collisionless case, and investigates kinetic effects.
- Gyrokinetic tearing growth rate is slower than the two-fluid MHD model (by factor of \( \rho / \rho_i \)) implying that the equation of state needs to be re-considered.
- Gyrokinetic result is also compared with the theory based on a kinetic model. Dependence on ion temperature seems much weaker than expected.
- If we assume polytropic equation of state, the indices are \( r_\perp = 5/3 \), \( r_y = 1 \).
- However, spatially varying indices suggests non-polytropic.

**References**

1) AstroGK Web Site: http://www.physics.uiowa.edu/~ghowes/astrogk/  