Desire to predict profiles → Improve predictive transport capability via (A) validation of physics, (B) development & implementation of models

H-mode edge pedestal - prediction for pedestal height (and width)

(A) Comprehensive first-principles simulations applicable to pedestal, strong gradient
- general geometry, multiple species, **collisions, electromagnetic, flows, profiles**

(B) Tests of peeling-ballooning stability; prediction of microinstability thresholds

(B) Empirical/semi-empirical scaling of pedestal height & width?

H-mode core: thermal driven transport (next slide)

(A) Comprehensive first-principles simulations with all necessary physics:
- general geometry, multiple species, **collisions, electromagnetic, flows, global**

(B)Tests of theory-based transport models

(B) Incorporate **non-local** effects in local theory-based transport models?

H-mode core: fast particle driven transport

(A) Simulations of fast particle driven instabilities and transport (χ_e, χ_φ, $D_{j||}$)

(B) Development of theory-based models?

(B) Empirical/semi-empirical scaling of near-axis T_e, V_{tor}, $j_{||}$ profile with n_{fast}, β_{fast}, $\nabla\beta_{fast}$ etc… ?

Simulation and modeling work being done for NSTX core

Non-linear gyrokinetic simulations (GYRO)

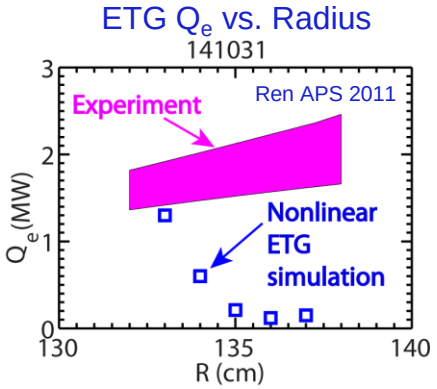
- *Local* ETG ("low beta" H-mode) →
- *Local* microtearing ("high beta" H-mode) →
- *Local* TEM ("low beta" H-mode)
- *Local* ITG (L-mode)

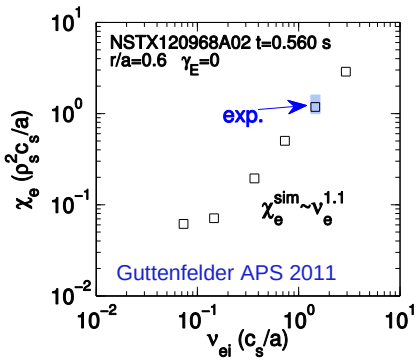
- Working towards global GYRO simulations for all of the above
  - Benefit from benchmarking (GTS,XGC1 …) but need collisions, EM, flows, etc…

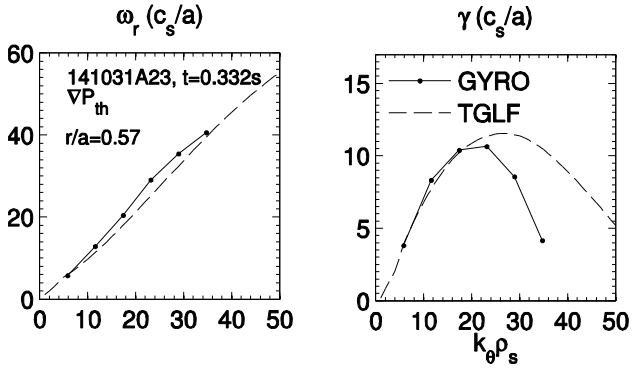
Testing TGLF reduced transport model

- Standalone tests of TGLF linear stability and transport model with linear and non-linear gyrokinetic simulations →
- Predictive transport simulations using TGYRO+TGLF+NEO →

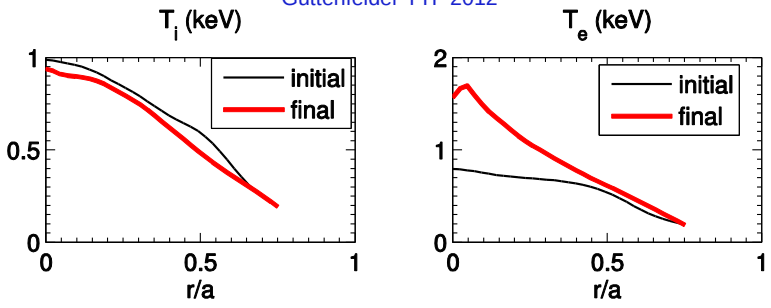
⇒ Will require boundary condition (**pedestal height**) and additional core effects (**non-local and/or fast particles**)







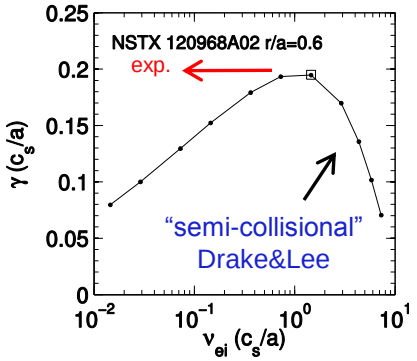
Guttenfelder TTF 2012



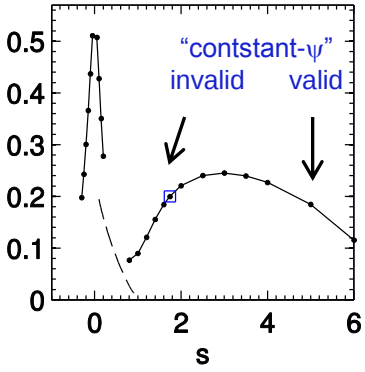
Improvements in analytic microtearing theory could be useful for developing reduced transport models

- NSTX microtearing mode considerations (Guttenfelder et al. PoP 2012a,b):

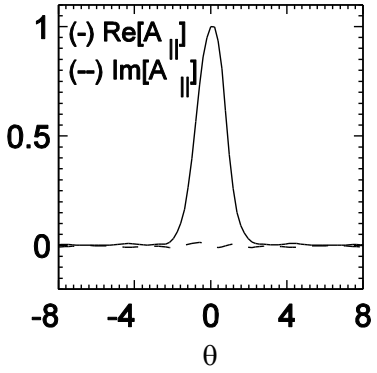
Weakly-collisional
$\nu^{e/i}/\omega \leq 1$



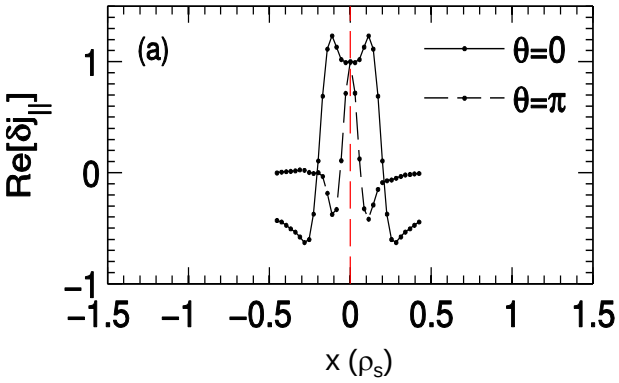
Weak magnetic shear
$s/q \leq 2$



Strongly ballooning
$A_{||}(\theta=0) >> A_{||}(\theta=\pi)$



Narrow current layer
$\Delta_j \leq \rho_s$



- Wish for improved linear stability theory with quantitative accuracy:
  - Arbitrary collisionality ($\nu^{e/i}/\omega$) and magnetic shear
  - Account for ballooning $A_{||}(\theta)$, toroidicity and trapped particles
  - Influence of electrostatic potential is unclear (shielding through Z_{eff} + adiabatic response)
  - Prediction of linear thresholds $(a/L_{Te})_{crit}$, $(\beta_e)_{crit}$

- Theory improvements for saturated spectrum?
  - Balance of linear growth and damping through non-linear transfer?
  - Influence of island overlap and stochasticity