GYRO Simulations of ETG Turbulence in NSTX

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NSTX Results Review

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Overview

Converging simulations at r/a=0.6 in NBI L-mode.

- Can use small mass ratio to speed up simulations.
- ExB shearing sets the saturation level.
- ExB shearing removes need for modes with $k_\theta \rho_s < 1$.

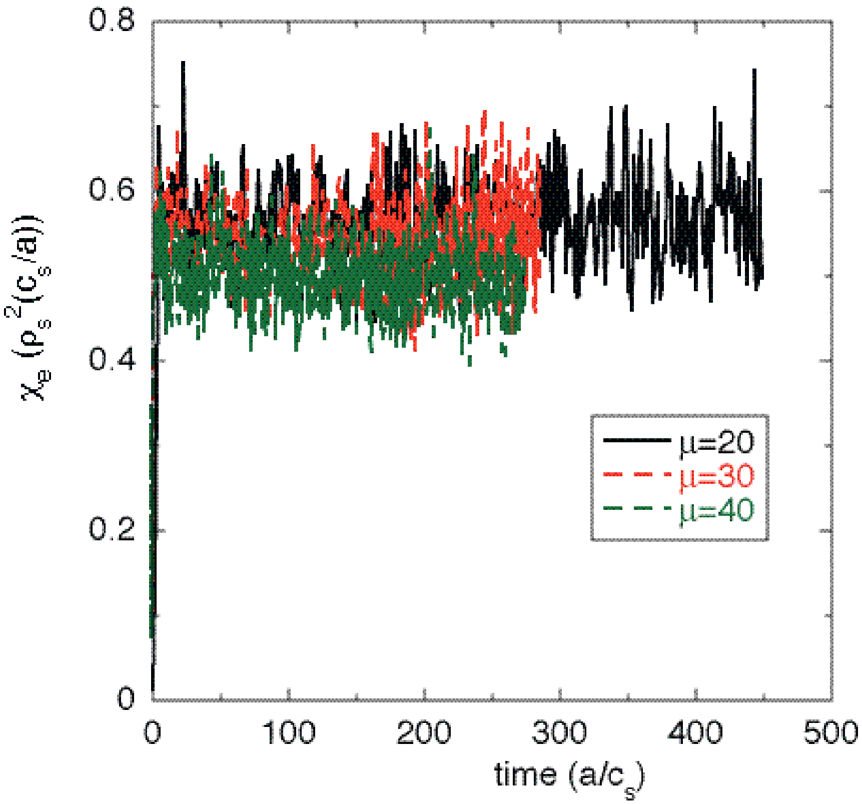
Initial studies at r/a=0.3 with HHFW are harder.
Nearly stabilized by negative magnetic shear, high Z_{eff} and high T_e/T_i, but time histories unknown.

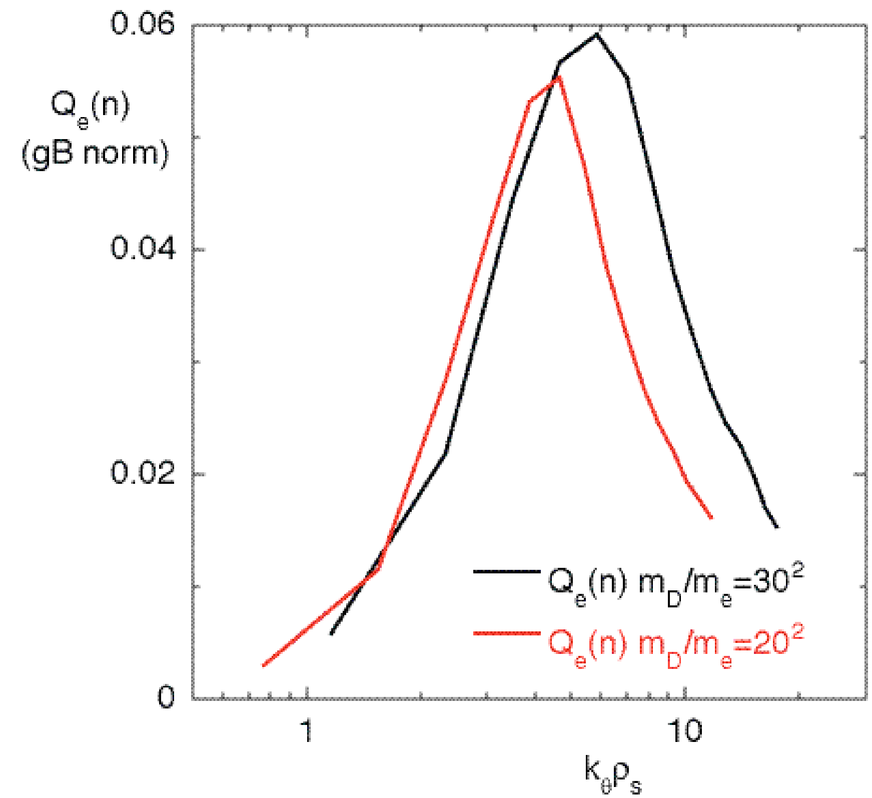
Will examine more fully documented NBI discharges to define range and effects of magnetic shear, Z_{eff} and T_e/T_i; guide simulations of HHFW plasmas.

Converged with Small Mass Ratio

Varied m_D/m_e from 20^2 to 40^2, but electron heat flux drops only ~20%.

k_θ spectrum is not pinned to either ρ_s or ρ_e scales, intermediate scales are important.



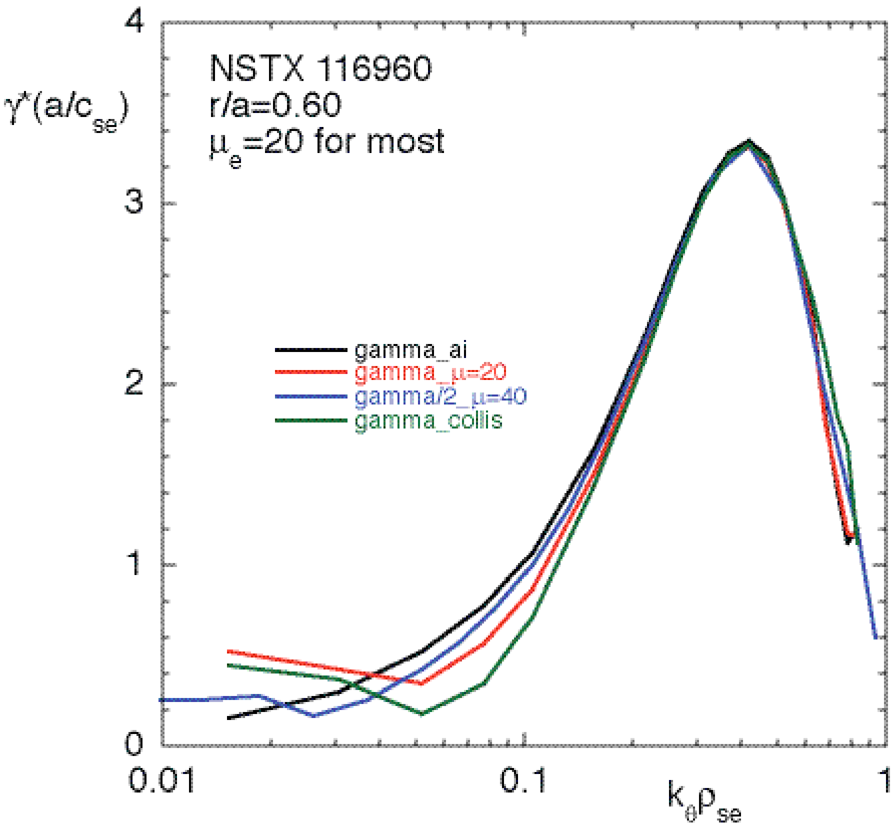


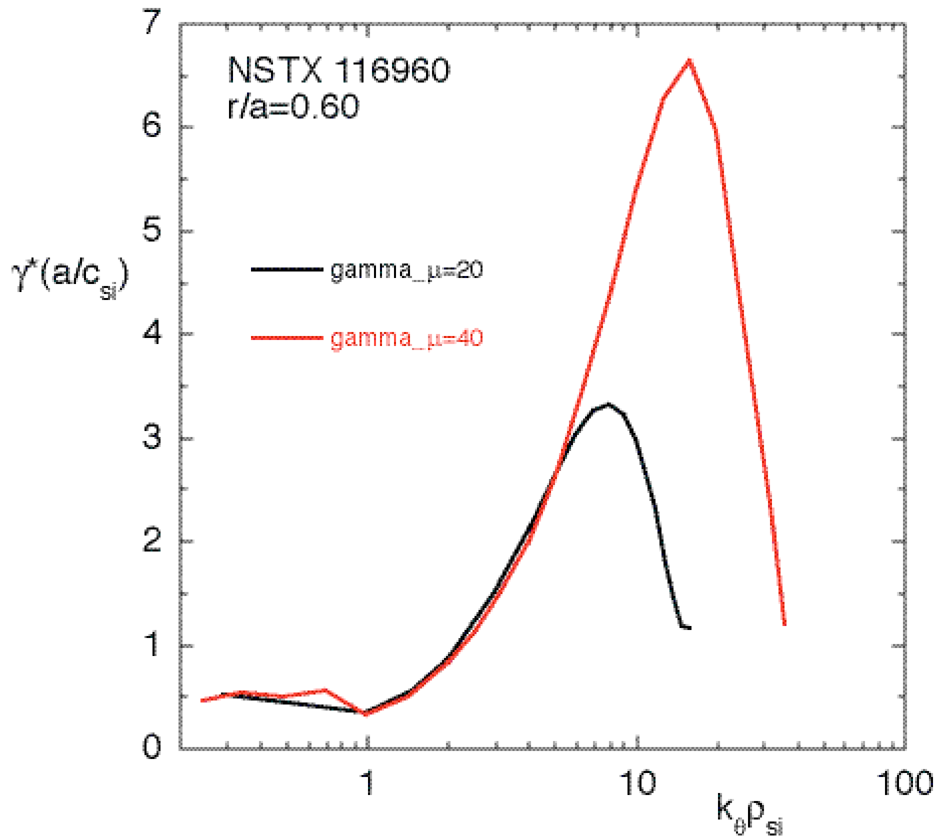
Transport not set purely by electron scale

Growth rates in electron units are independent of m_D/m_e

If saturation processes were tied to electron scales, then χ_e expressed in ion units should drop with m_e/m_D.

But transport in ion units is independent of m_D/m_e

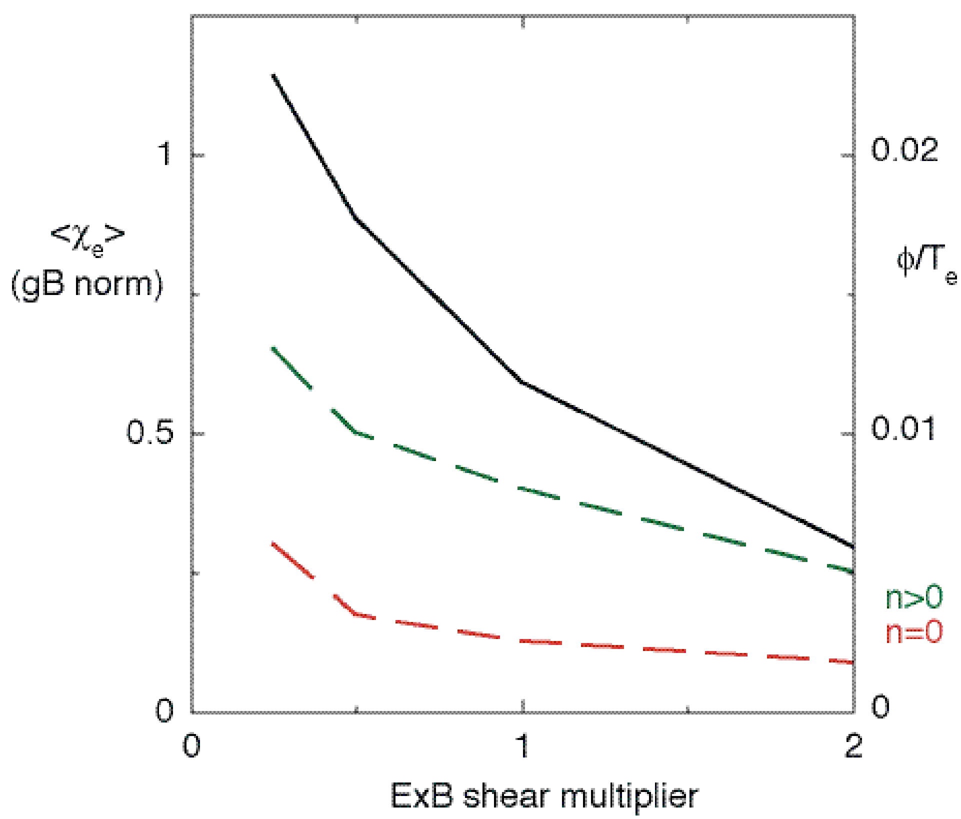


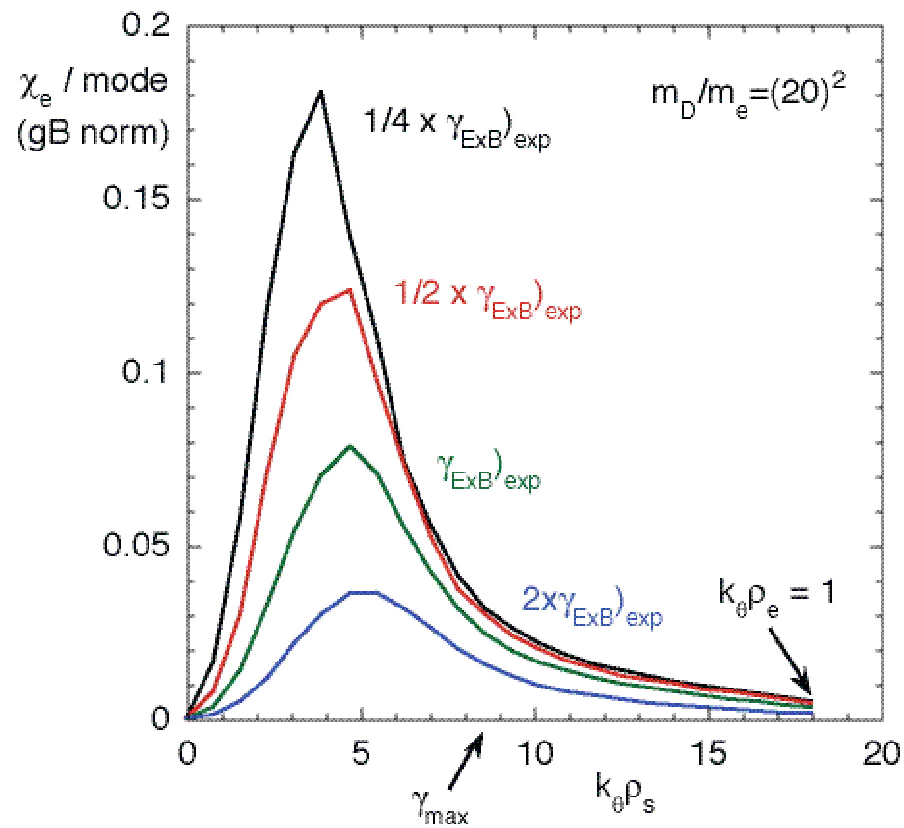


ExB Shearing Rate Sets the Heat Flux

Reducing ExB shearing rate raises χ_e, and potential fluctuation amplitude, ϕ/T_e, also rises; k_θ spectrum downshifts slightly.

Need $k_\theta \rho_s \sim 1$ to converge when ExB rate is low.





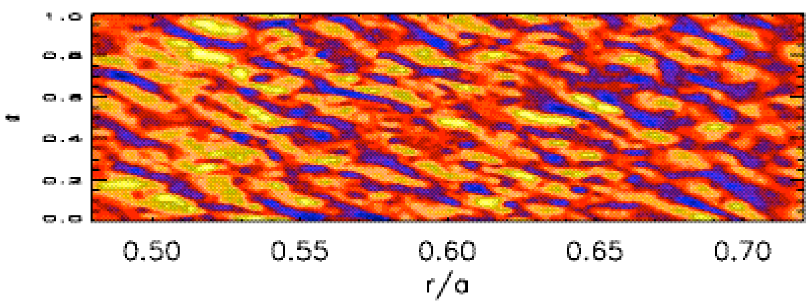
ExB Shear Controls Eddy Size

ExB shearing rate varied: 2X to 1/4X actual rate.

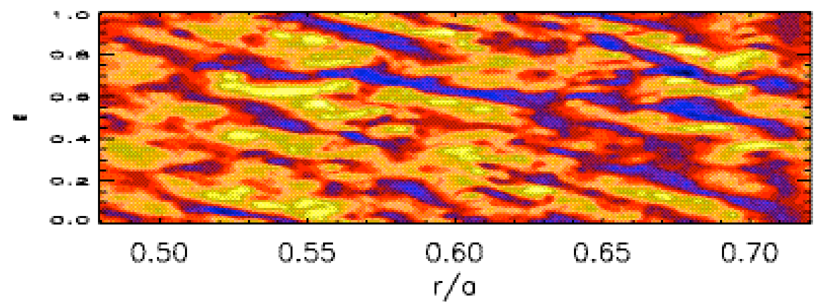
Eddies grow (in 2D) as shearing rate is reduced.

Extent of radial domain is ~400 ρ_e.

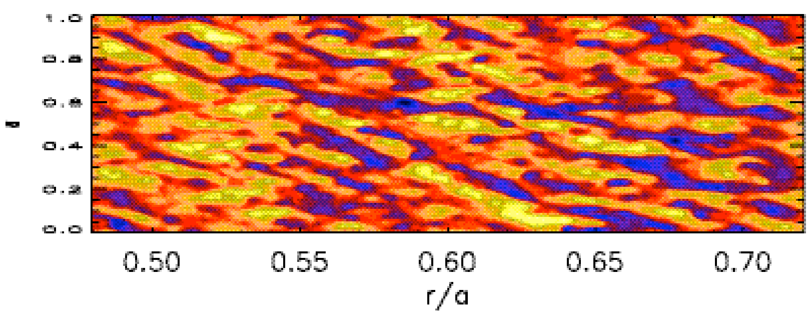
2X



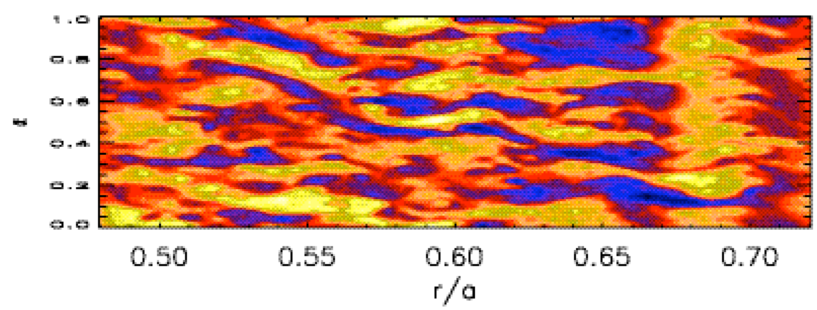
1/2X



experimental ExB rate



1/4X



Future work

Mass ratio convergence study at r/a=0.6 in NBI L-mode.
with lower ExB shearing rate and higher maximum $k_\theta \rho_s \sim 1$.

Linear stability for fully documented NBI discharges.
find dependences on magnetic shear, Z_{eff}, T_e/T_i.

Experimentally validate stabilization by:
negative mag. shear, high Z_{eff} and T_e/T_i.

Nonlinear studies in HHFW and NBI plasmas with high-k data.