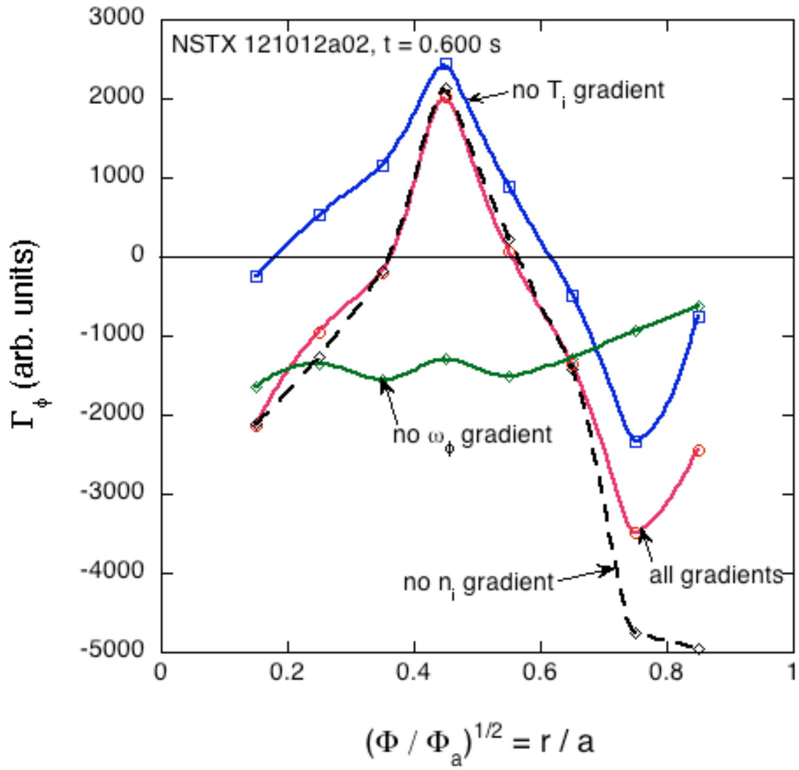
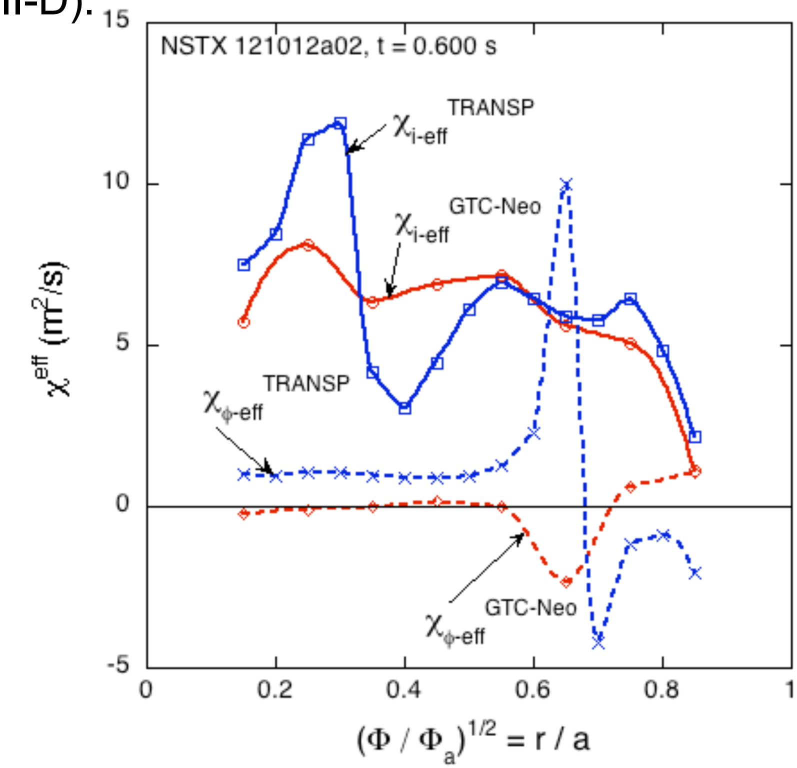
GTC-Neo Analysis of Momentum Transport in NSTX Discharges (G. Rewoldt, W.X. Wang, …)

• GTC-Neo is a global δf gyrokinetic particle-in-cell code, including finite-orbit-width (banana width) effects, which make the transport nonlocal. GTC-Neo can calculate neoclassical particle, momentum, and energy fluxes, along with E_r, E_θ, j_b, etc. The code is now routinely applied to experiments (NSTX & DIII-D).





• Here Γ_ϕ, the radial flux of toroidal angular momentum, is shown for an NSTX case (in internal code units) versus r/a. The n_i gradient contribution is small, the T_i gradient contribution is moderate and is always inward (pinch!), and the ω_ϕ gradient contribution is largest, and has both signs.

• Here we show $\chi_{I\text{-eff}}$ and $\chi_{\phi\text{-eff}} = \Gamma_\phi / [R^2 n_i m_i (d\omega_\phi/dr)]$ (in m^2 / s) versus r/a for the same NSTX case. Ion energy transport is comparable to neoclassical (so anomalous ion energy transport is small), yet angular momentum transport is much larger than neoclassical (so anomalous angular momentum transport is dominant)!

Other NSTX Cases

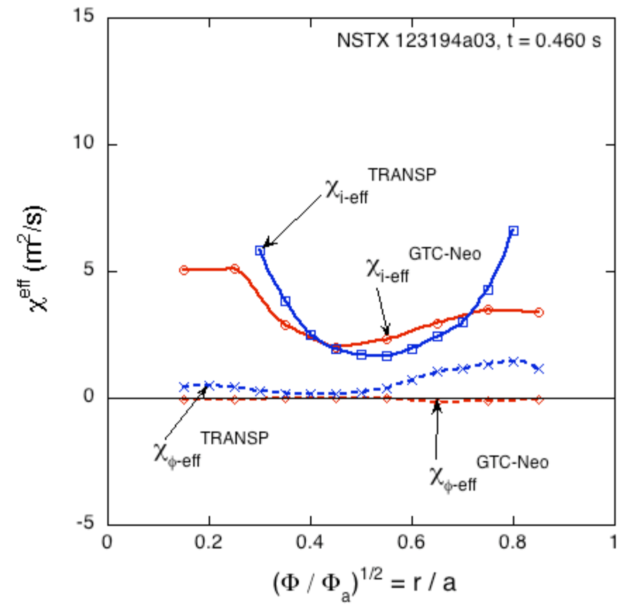
• Neoclassically, χ_ϕ/χ_i ~ 0.01 - 0.1, and neoclassical contribution to radial transport of toroidal momentum is negligibly small (i.e., toroidal momentum transport is mainly anomalous, even when ion energy transport is not)

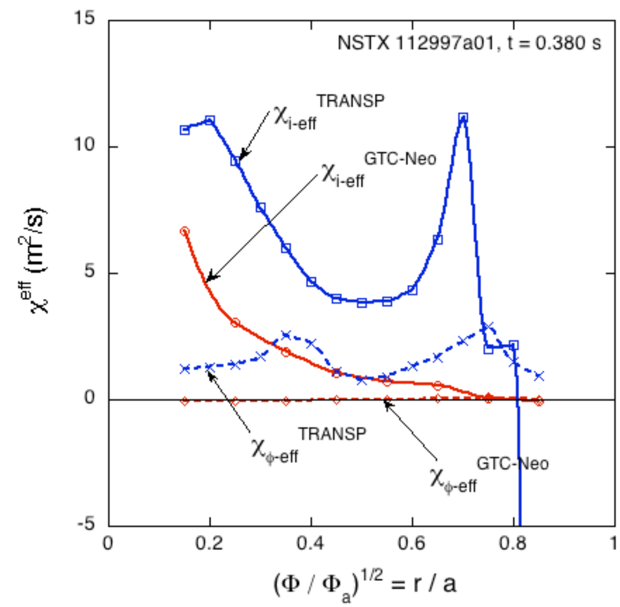
• This has been the consistent pattern in GTC-Neo results for at least 17 different NSTX shots

• For NSTX shot 123194, we again see $\chi_{i\text{-eff}}^{TRANSP} \sim \chi_{i\text{-eff}}^{GTC\text{-Neo}}$ while $\chi_{\phi\text{-eff}}^{TRANSP} >> \chi_{\phi\text{-eff}}^{GTC\text{-Neo}}$ (neoclassical ion heat transport but anomalous toroidal angular momentum transport)

For NSTX shot 112997, on the other hand, $\chi_{i\text{-eff}}^{TRANSP} >> \chi_{i\text{-eff}}^{GTC\text{-Neo}}$ while $\chi_{\phi\text{-eff}}^{TRANSP} >> \chi_{\phi\text{-eff}}^{GTC\text{-Neo}}$ (anomalous ion heat transport and anomalous toroidal angular momentum transport)

• Effective χ_ϕ/χ_i associated with low-k turbulence is on the order of unity, in broad agreement with experimental observations in conventional tokamaks (& also theory prediction) (cf. Weixing Wang's following talk)





Update on GEM (G. Rewoldt, Y. Chen [U. Colorado], …)

- The GEM (Gyrokinetic ElectroMagnetic) code is a global nonlinear particle-in-cell simulation code. GEM has been interfaced with the TRANSP experimental data system, for input data for density and temperature profiles for electrons and multiple ion species. GEM can include linear and nonlinear effects of KBM and microtearing modes, as well as ITG and TEM modes.

- The GEM code has had problems with computer time allocations at NERSC and Oak Ridge in 2008, and this has delayed progress. We have been looking for alternative places to run GEM. We have been able to do some runs recently at LLNL. Also, PPPL is about to put into operation a new 512+64 core system called "Kruskal", which will give us another suitable platform for GEM code runs. We will continue developing and applying the GEM code as much as available computer time allows.

Update on GEM-2

• For several NSTX and DIII-D shots that were looked at, the transport was many times higher than the experimental level when the **E**x**B** velocity was set to zero, yet the cases were completely stable when the **E**x**B** velocities were set to the experimental levels.

• However, DIII-D shot 128527 (one of Wayne Solomon's rotation study shots, with moderate rotation and moderate ion temperature), has transport in the experimental range for the experimental value of the **E**x**B** rotation, and was therefore selected for further exploration (sensitivity studies), and for the development of the GEM code.

• For this case, radial-maximum GEM heat flux is comparable to experimental (TRANSP) value, for experimental value of equilibrium flows (**E**x**B** and parallel).