Particle and thermal transport in the NSTX spherical torus

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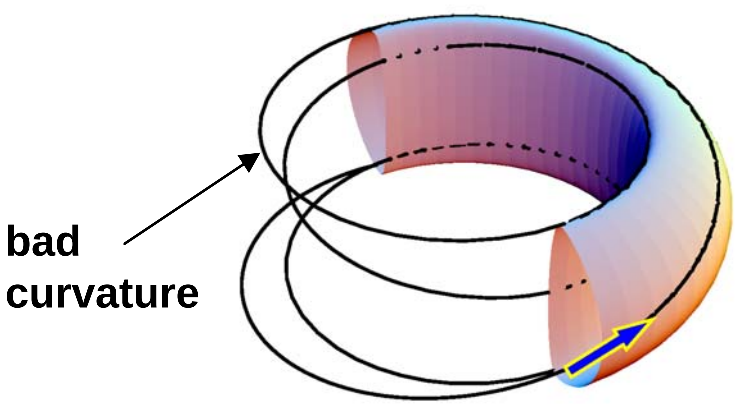
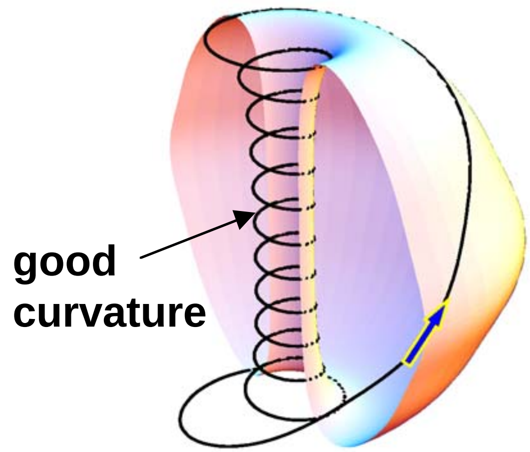
Transport in NSTX versus conventional tokamak

tokamak	**$R/a \approx 3$** **$B_t \approx$ several T** **$\beta \approx$ few %**
NSTX	**$R/a \approx 1.5$** **$B_t \approx$ fraction of a T** **$\beta \approx$ tens of %**

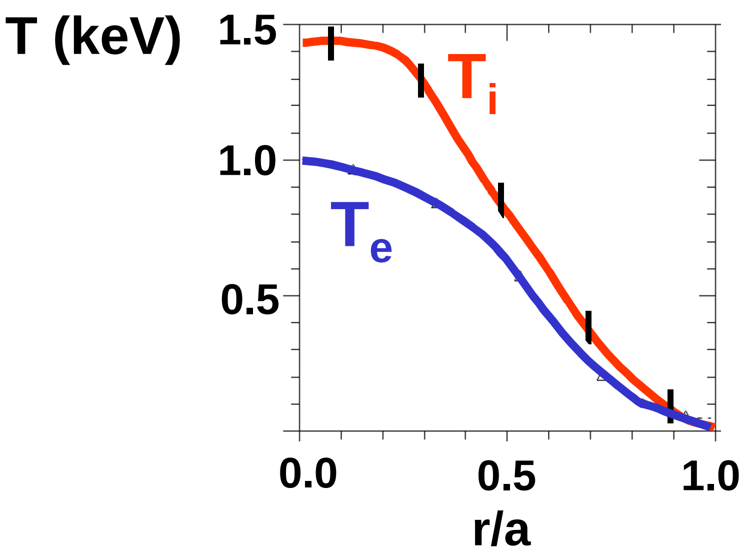




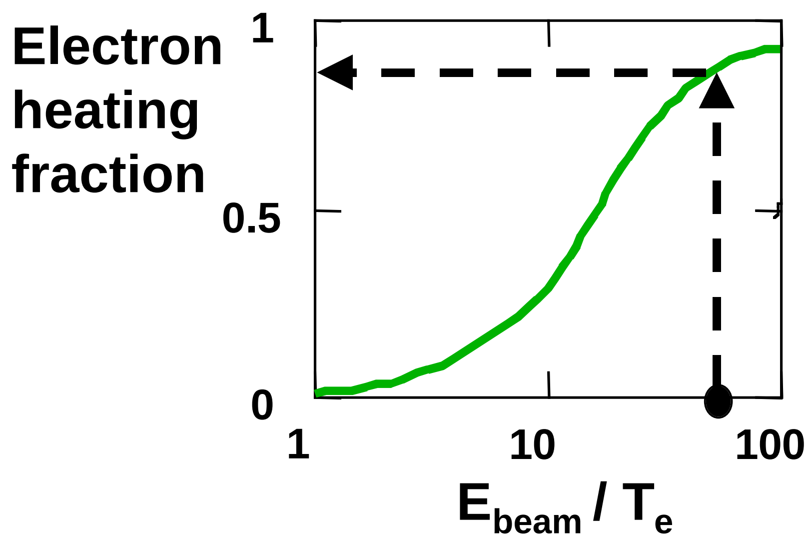
- **Microstability (ions) predicted to improve in NSTX (R/a, ω_{ExB}, β)**
- **Improvement needed because of large ρ_L/a ($D_{ion}^{turb} \approx$ tens of m^2/s)**
- **Good global confinement observed ($\tau_E \lesssim 0.12$ s in NBI discharges)**

Ion thermal transport appears to be low

Temperatures with
1.7 MW, 80 keV D beam
(L-mode edge)

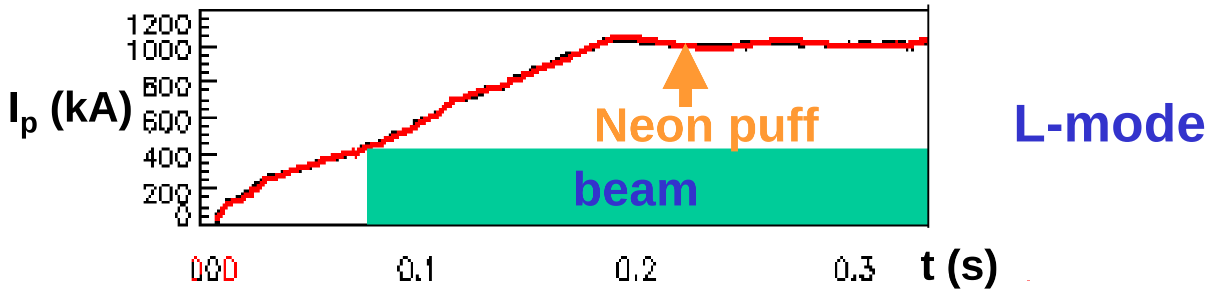


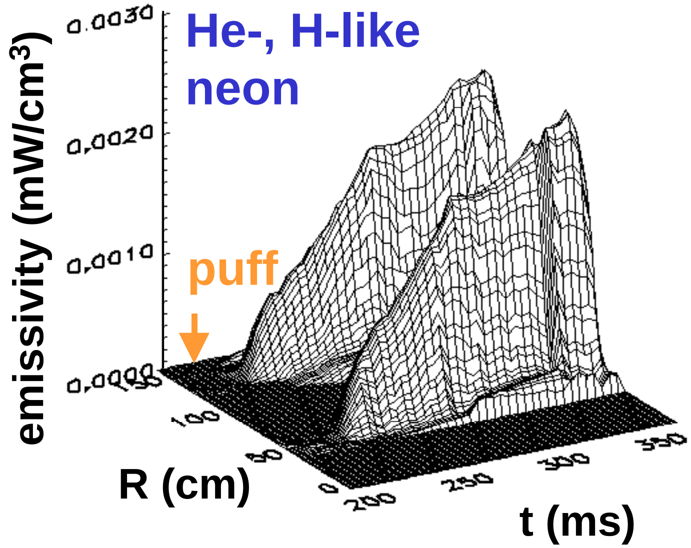
Classical beam
heating partition

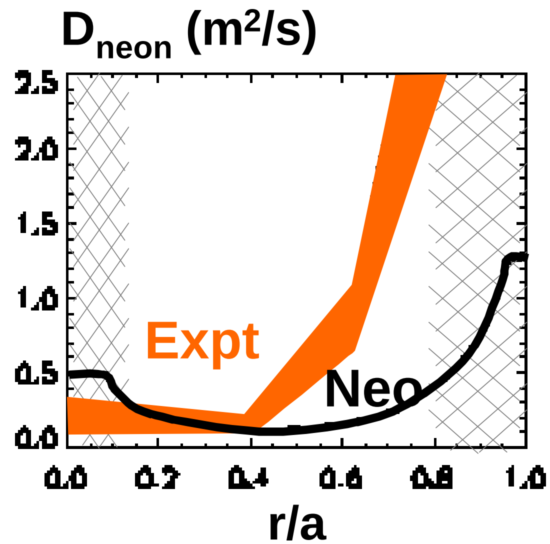


- $T_i > T_e$ when most of the beam heats the electrons
- Ion heat diffusivity $\chi_i \lesssim$ neoclassical (collisional) limit
- Ion power balance is difficult ($\chi_i << \chi_e$)

Impurity particle transport *is* low



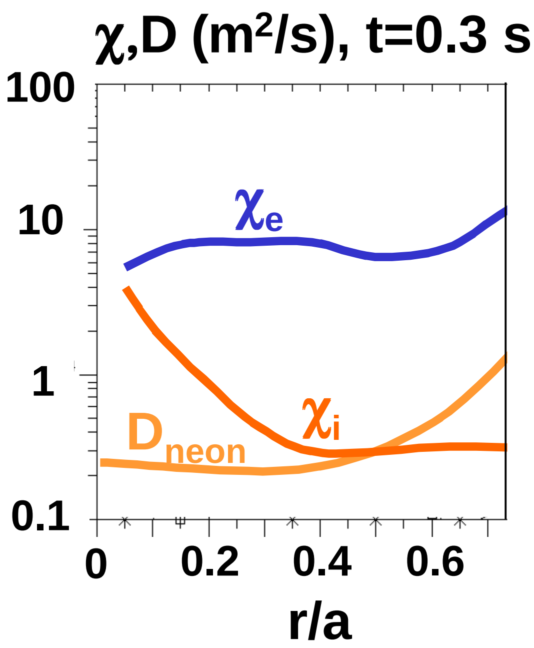




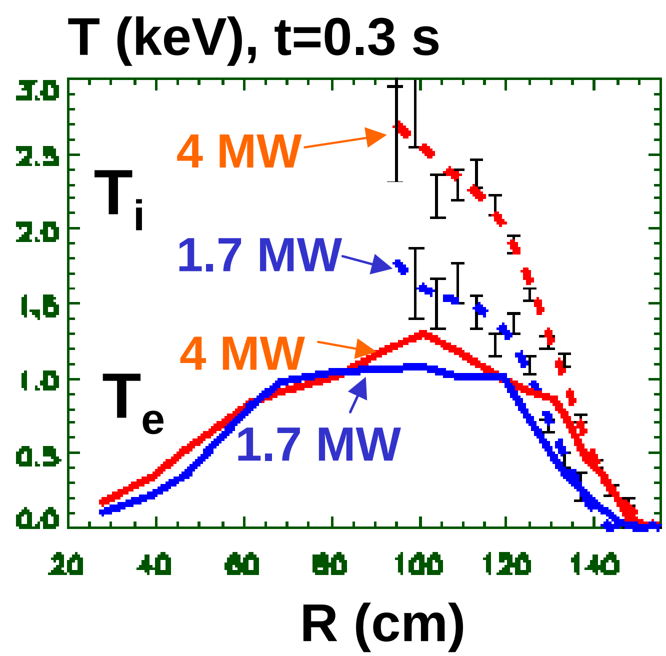
- Injected neon does not penetrate into the core
- Near neoclassical diffusivity for $r/a < 0.5$
- Ion turbulent transport seems to be suppressed (talk by M. Redi)

Electron transport is dominant

1 MA/4.5 kG L-mode



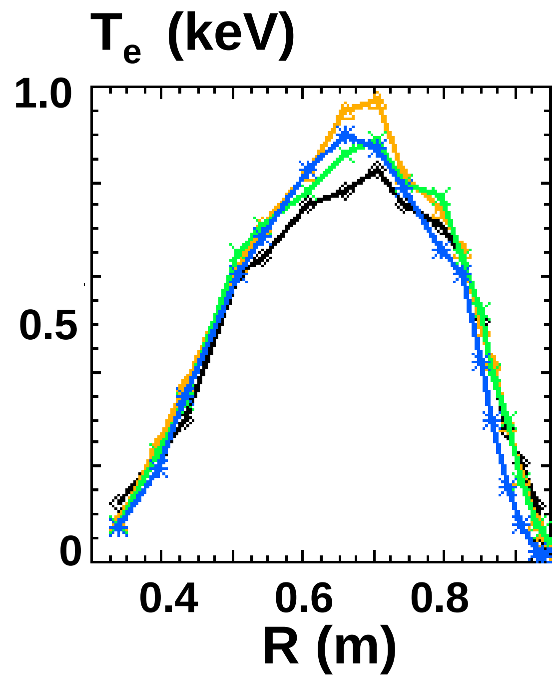
1.3 MA/6 kG L-mode

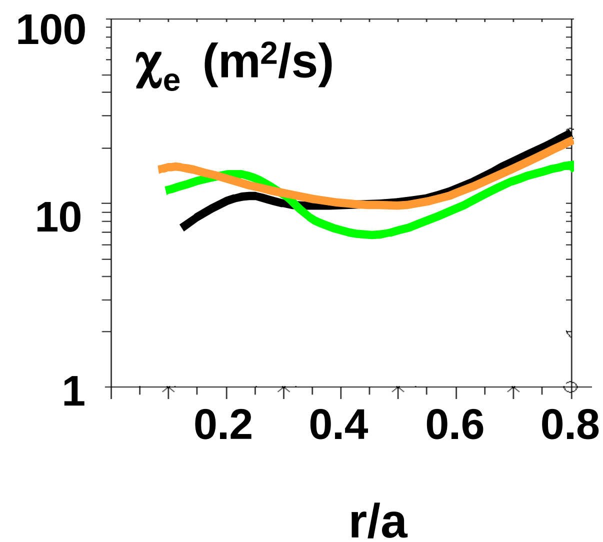


- $\chi_e >> \chi_i, D_{impurity}$ ($\chi_e \approx \chi_i \approx D_{impurity}$ in tokamaks)
- Stiff T_e profiles although beam heats electrons
- T_i profiles respond to increased P_{beam}

T_e profiles do not change with B at fixed B_t/I_p

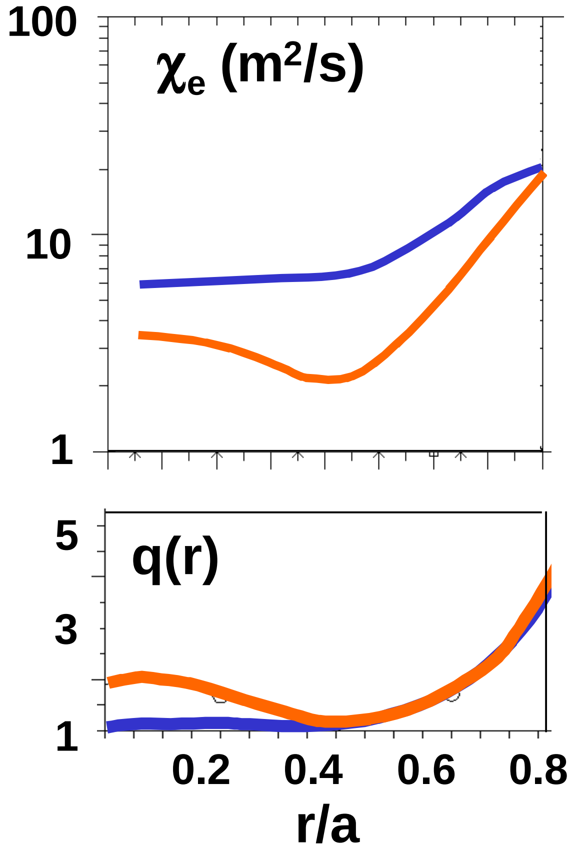
B_t (T)	I_p (MA)	β (%)
0.3	0.7	15
0.38	0.85	10
0.45	1.0	7
0.6T	1.3	5

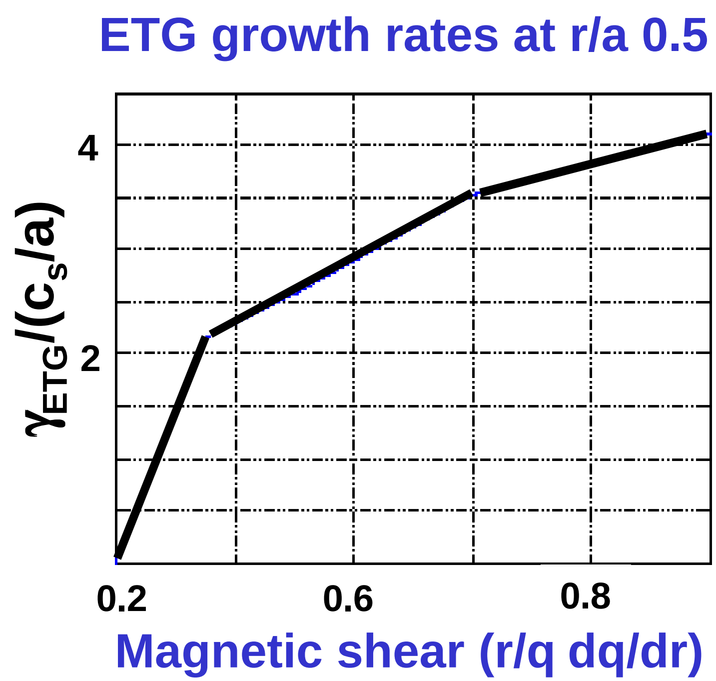




- B_t, I_p scan at fixed B_t/I_P and beam power
- T_e, χ_e unaffected by large change in B
- Electron Temperature Gradient instability (ETG) driven transport ?
- Strong ETG instability predicted in these discharges

Electron transport can be reduced in NSTX





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- χ_e decreases when negative magnetic shear is inferred
- ETG suppression by negative shear predicted in NSTX

Summary

- χ_i, D_{neon} close to neoclassical suggest turbulent ion transport suppressed in NSTX, as predicted
- Further experiments to determine whether intrinsic, ExB, or magnetic shear suppression (important for reactor)
- Strong, field independent electron transport
- ETG instability at play ?
- Improved electron confinement seems possible with negative shear
- Understanding and improving electron confinement in NSTX may lead to more economical fusion reactor