

Preliminary GYRO Studies of Momentum Transport with two Ion Species

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- New features in GYRO

1. multiple ion species
2. utility to generate input profiles from TRANSP runs
3. microturbulent angular momentum transport
4. improved visualization

- Application to various plasma regimes

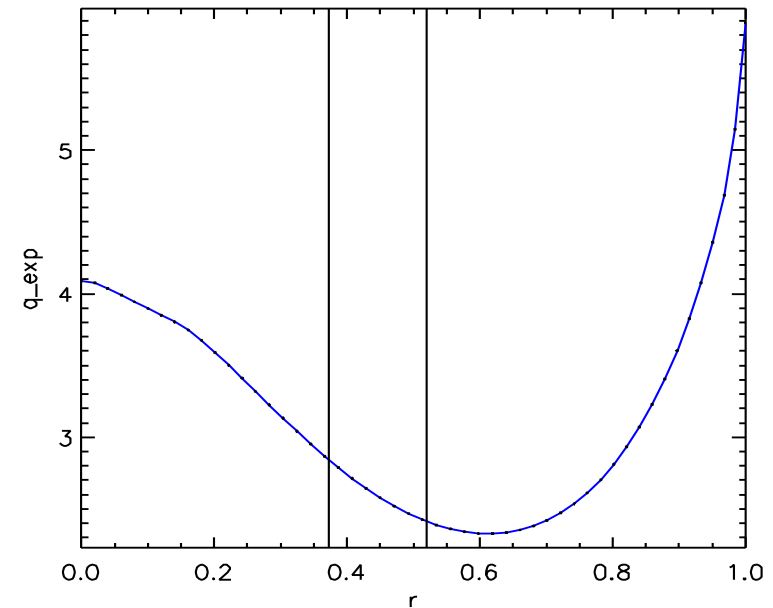
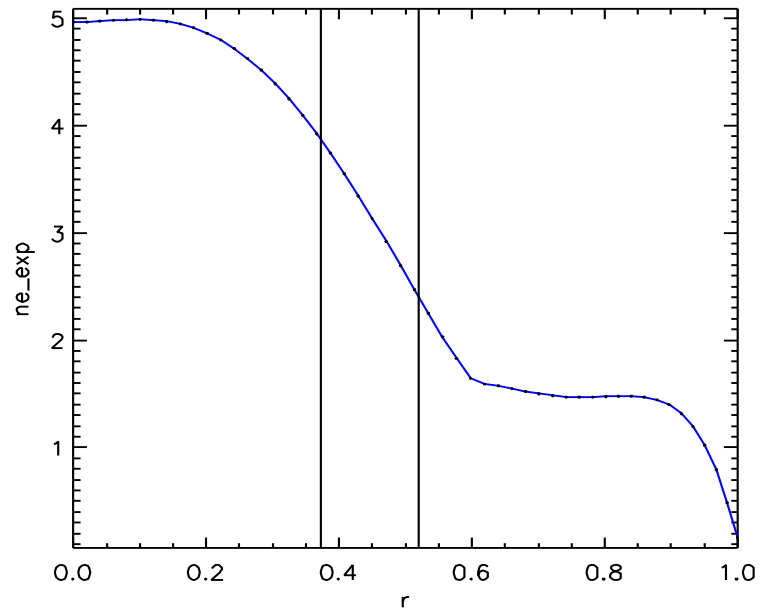
1. DIII-D L-mode ρ_* pair
2. DIII-D and JET ELMy H-mode plasmas
3. JT60-U box ITB plasma (E032844)

Assumptions for new GYRO runs

- 2 ion species: bulk hydrogenic and lumped beams and impurities
- ITG/TEM with kinetic electrons
- linear runs to study spectra in $k_{\theta}\rho_i$
- nonlinear runs to simulate transport and fluctuations
- include effects of E_r and Kelvin-Helmholtz
- only electrostatic so far
- both zero and reduced β_e

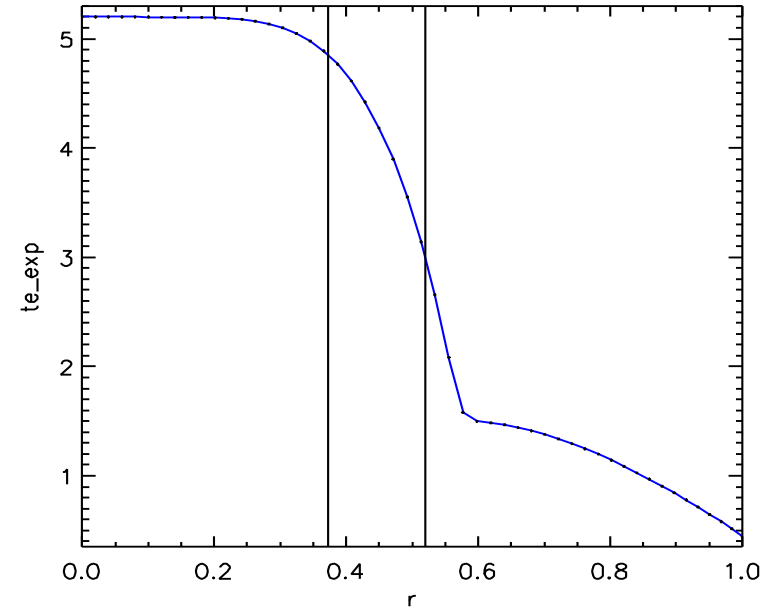
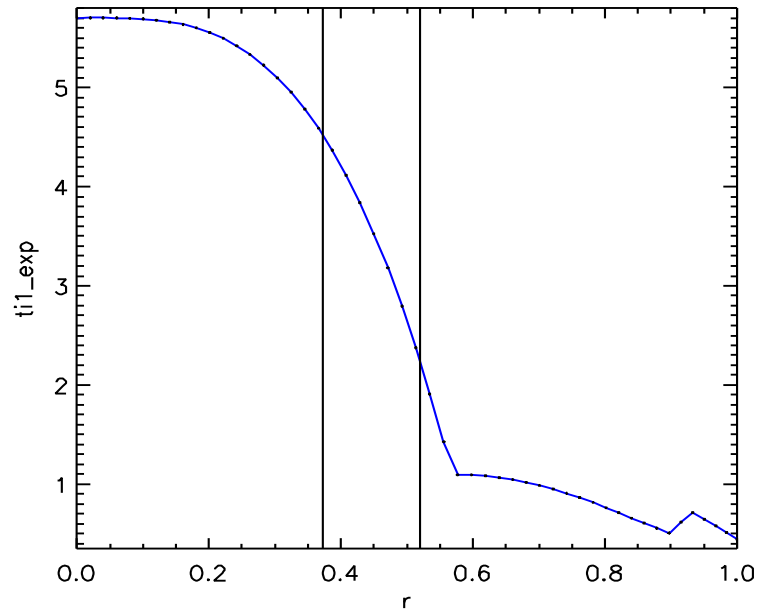
Electron density and q profiles for the JT60-U plasma

- focus on region inside barrier and q_{min}



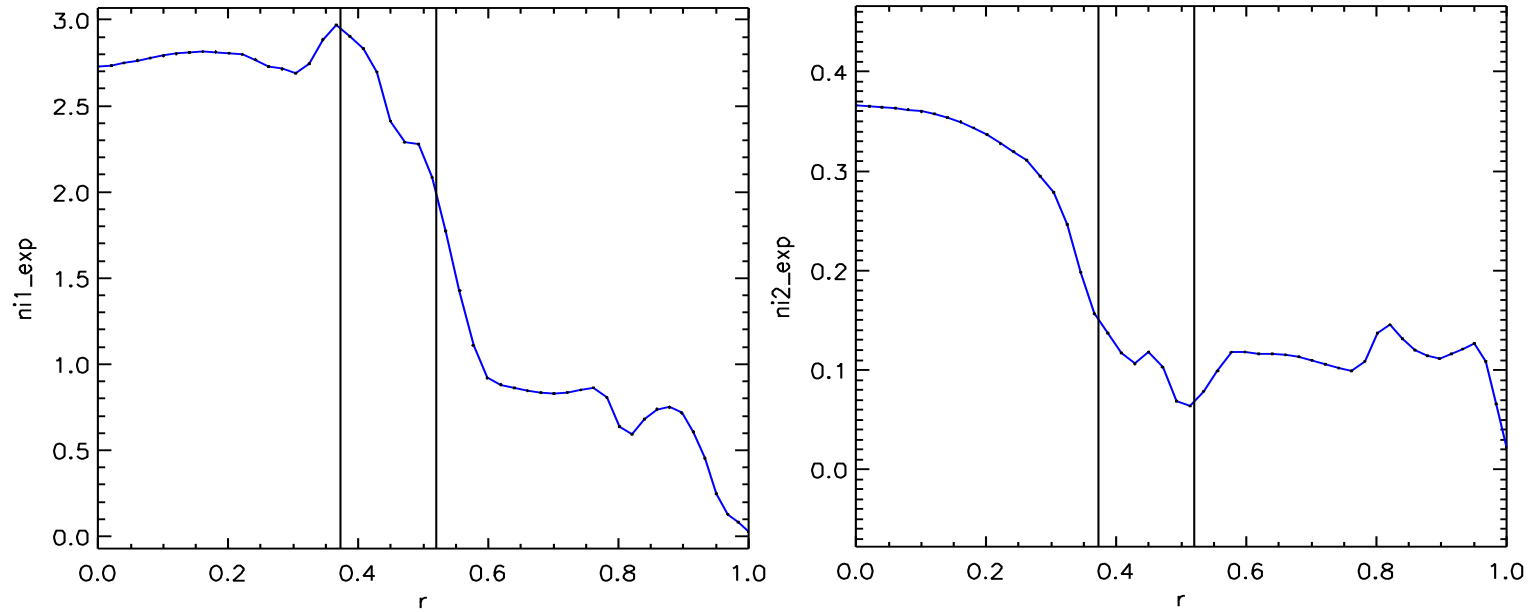
Temperature profiles for the JT60-U plasma

- strong box T_i and T_e ITB



Ion density profiles for the JT60-U plasma

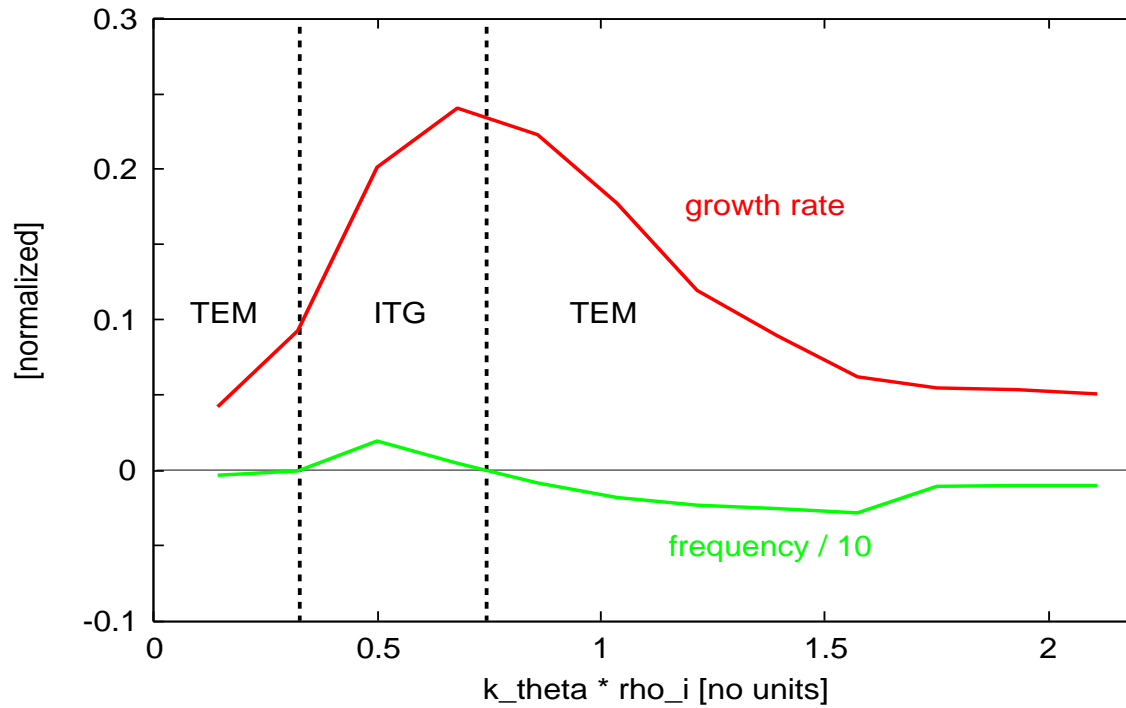
- bulk ions and lumped beam and impurity ions



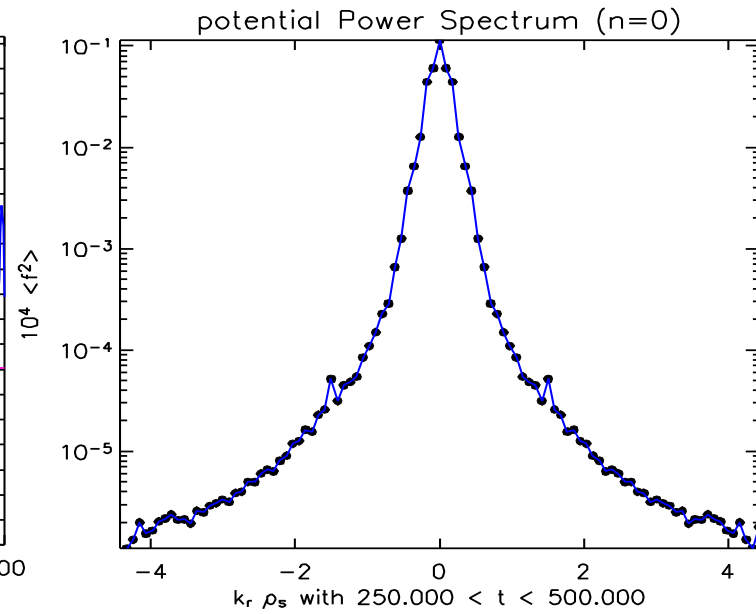
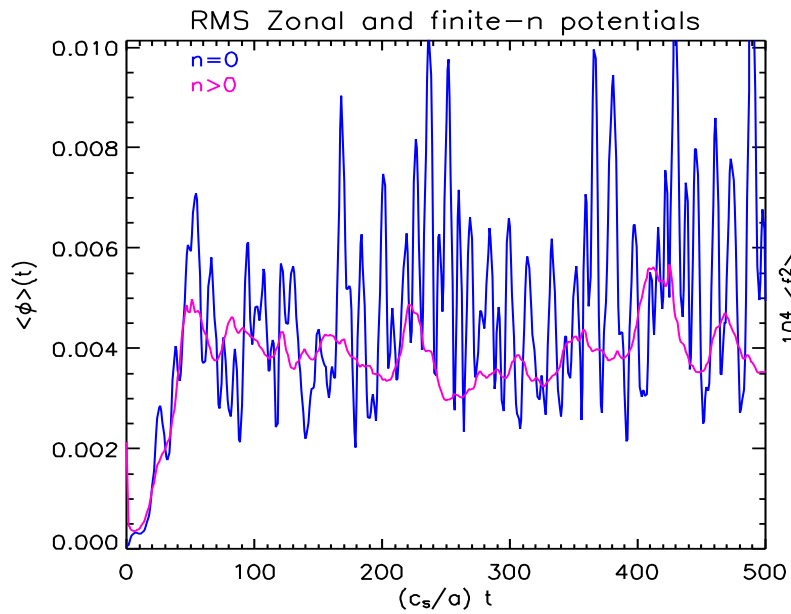
Spectrum from linear run

- TEM at low and high $k_\theta \rho_i$

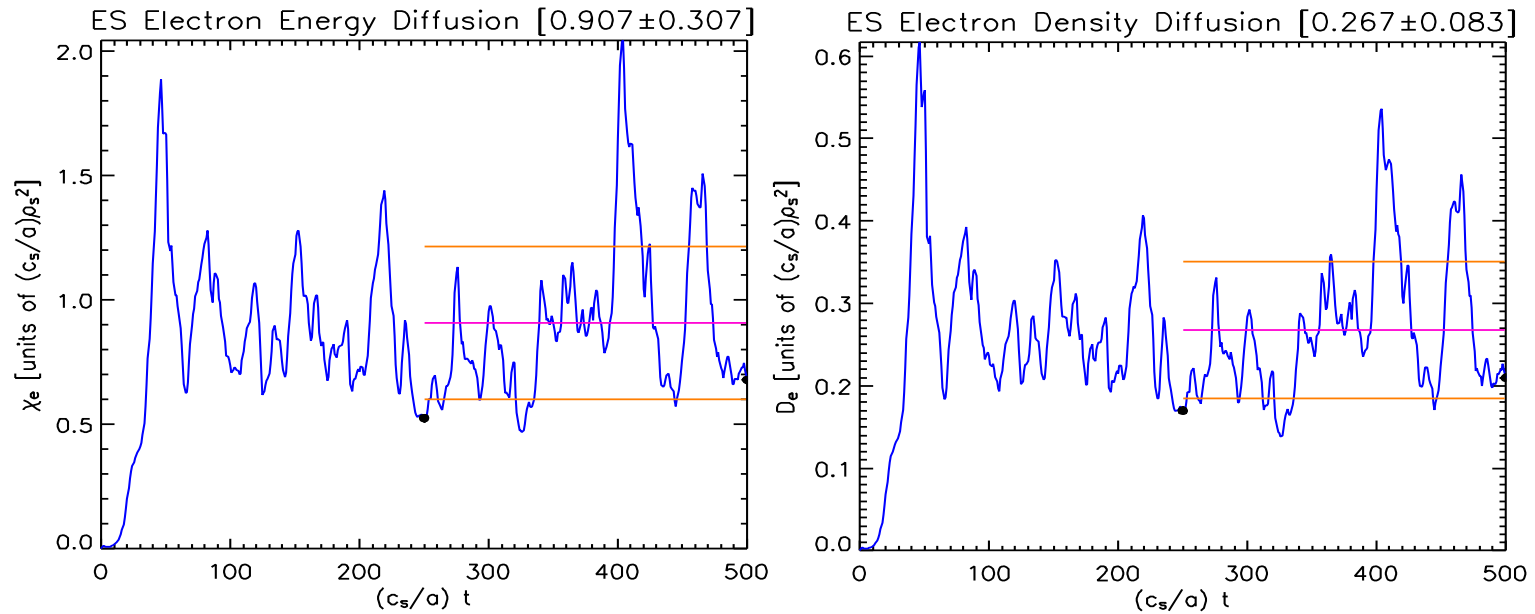
ITG linear growth rate and frequency for jt60_32844A18_1_L_sav at x=0.45, 6.0s



Saturation of Zonal Flow ($n=0$) and higher n modes

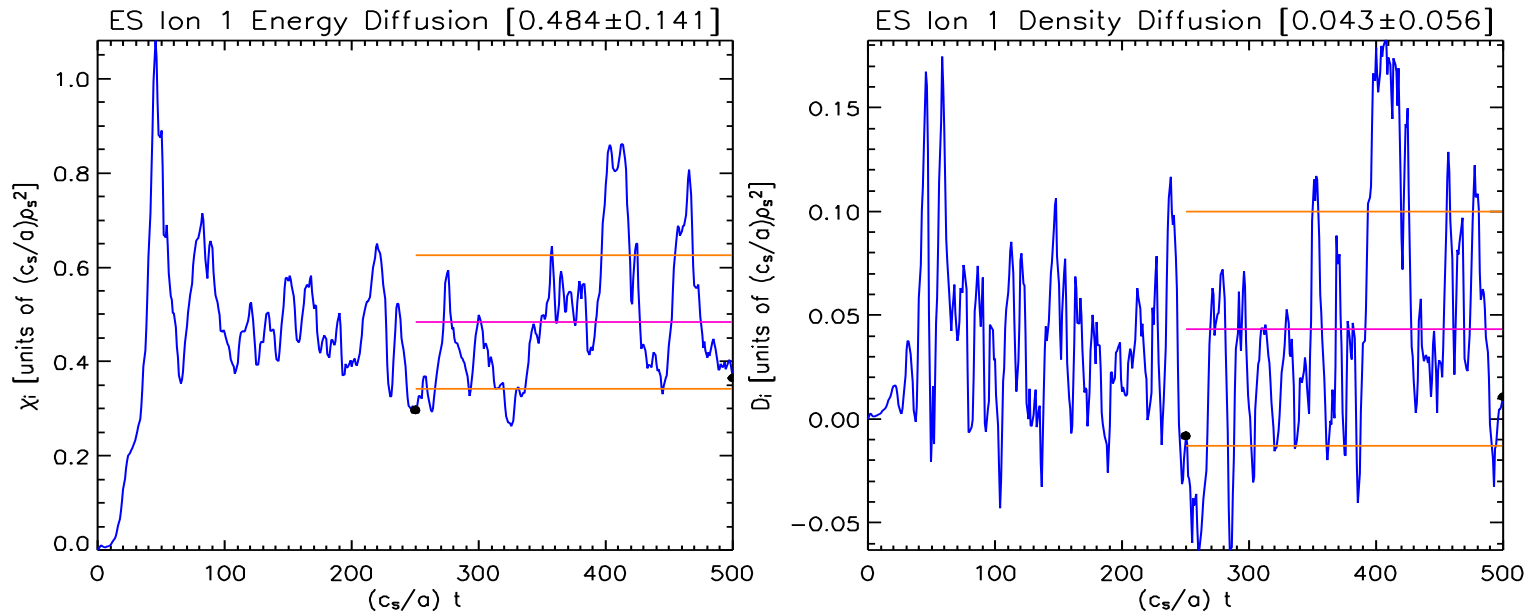


Saturation of electron energy and particle transport



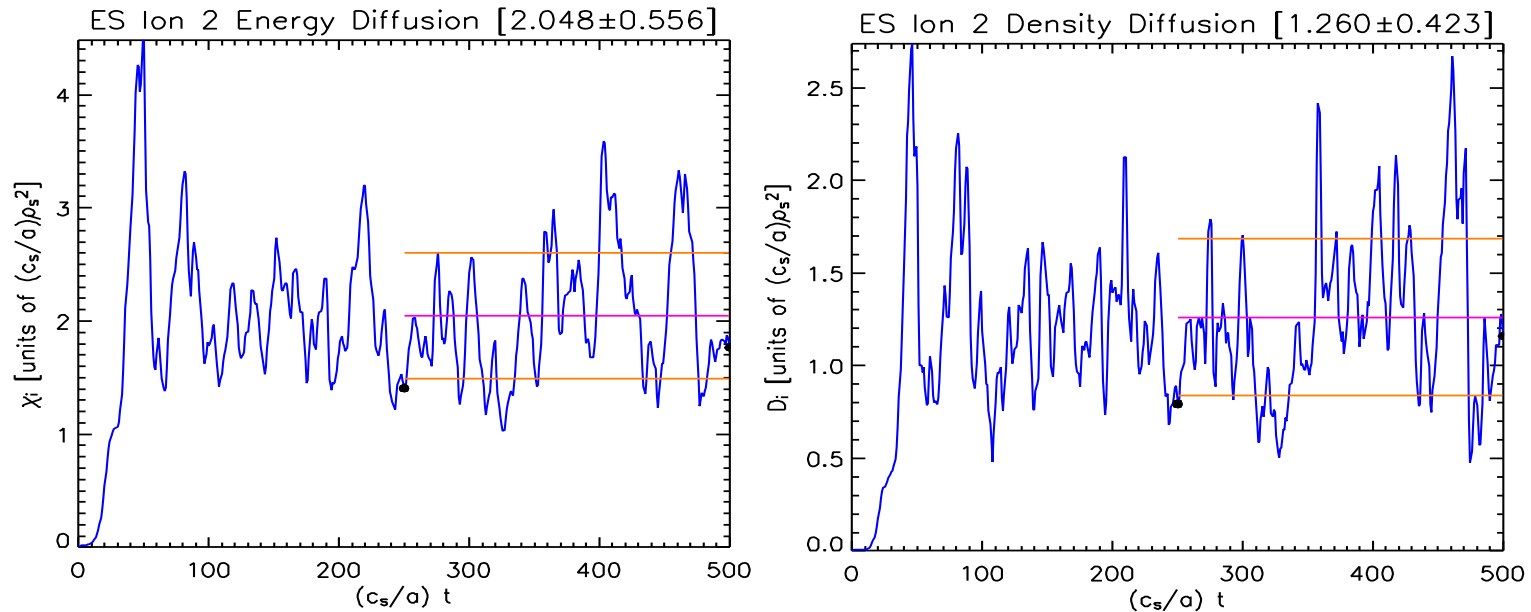
Saturation of bulk ion energy and particle transport

- relatively low energy and particle transport of bulk ions



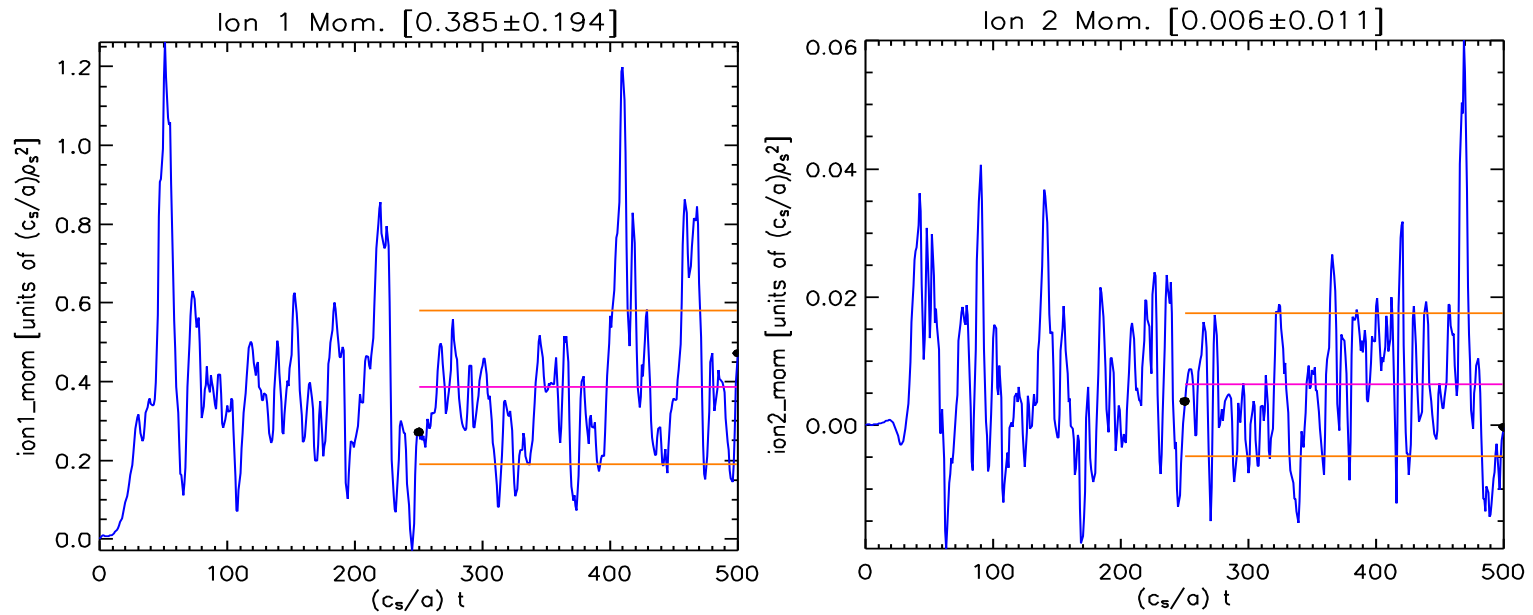
Saturation of lumped impurity ion energy and particle transport

- relatively high energy and particle transport of lumped impurity ions



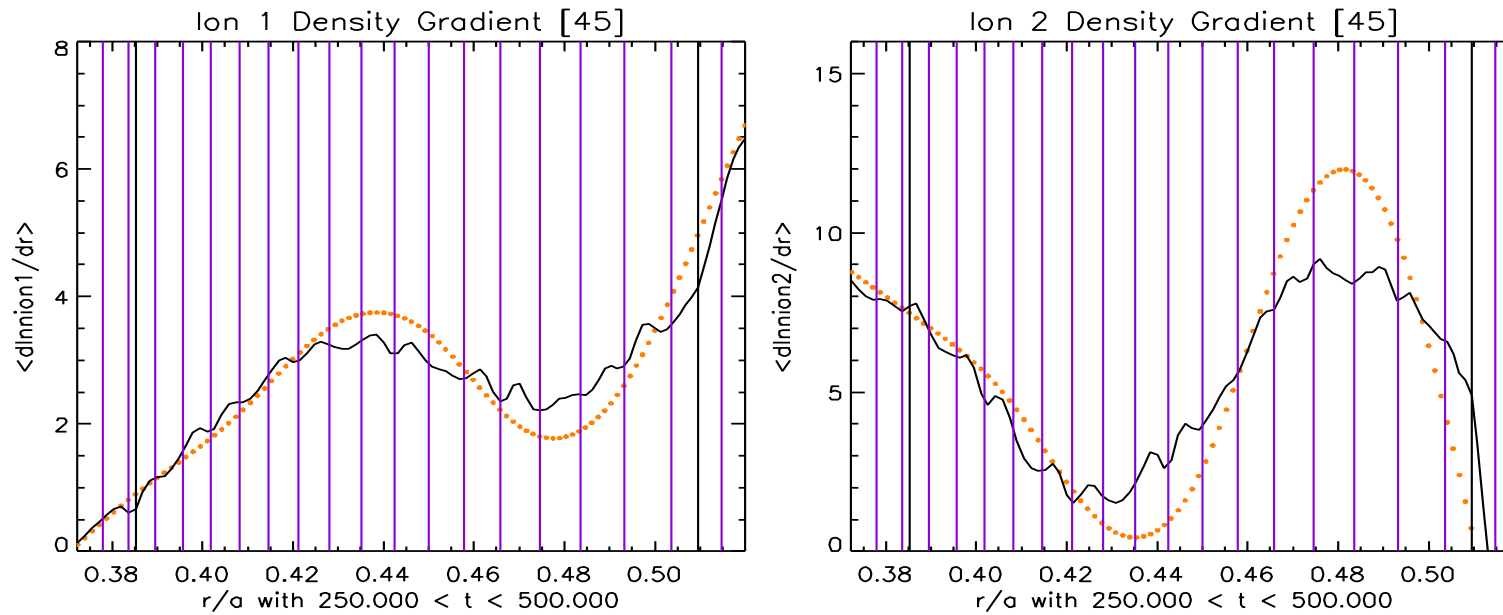
Saturation of ion momentum transport

- relatively large momentum transport for bulk ions



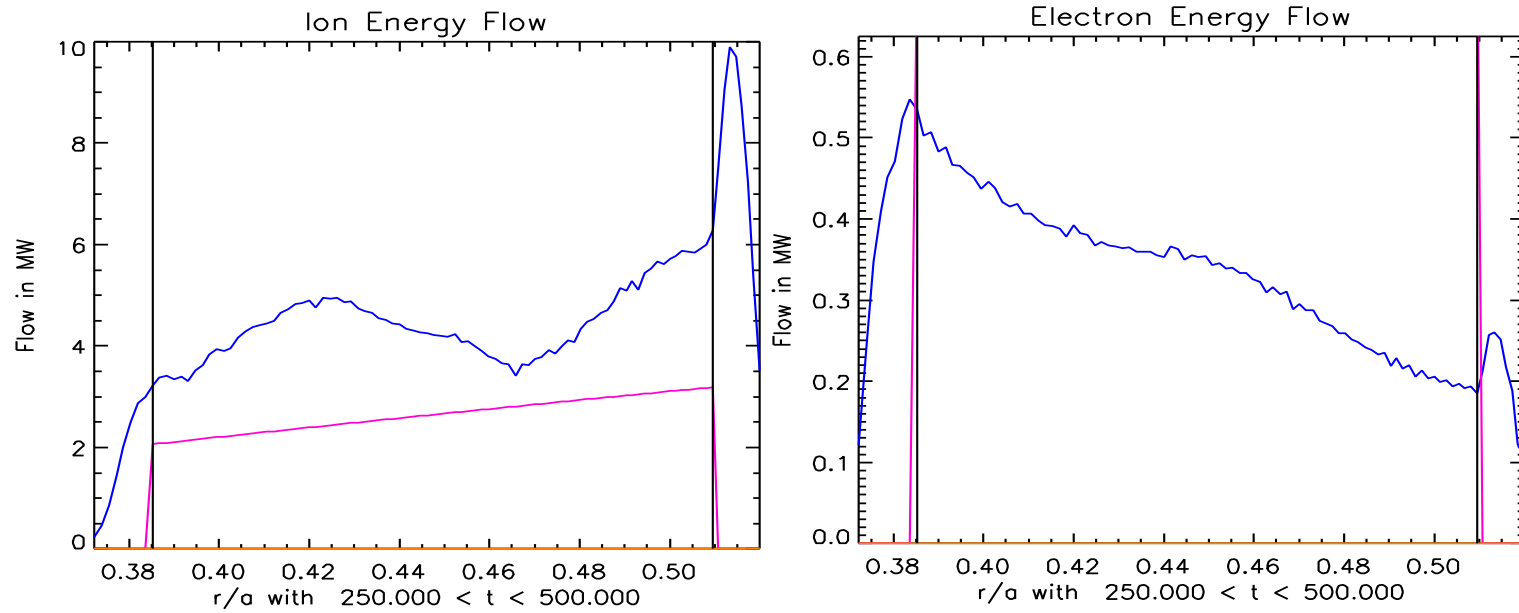
Simulated density fluctuations

- similar fluctuations for bulk and impurity ions

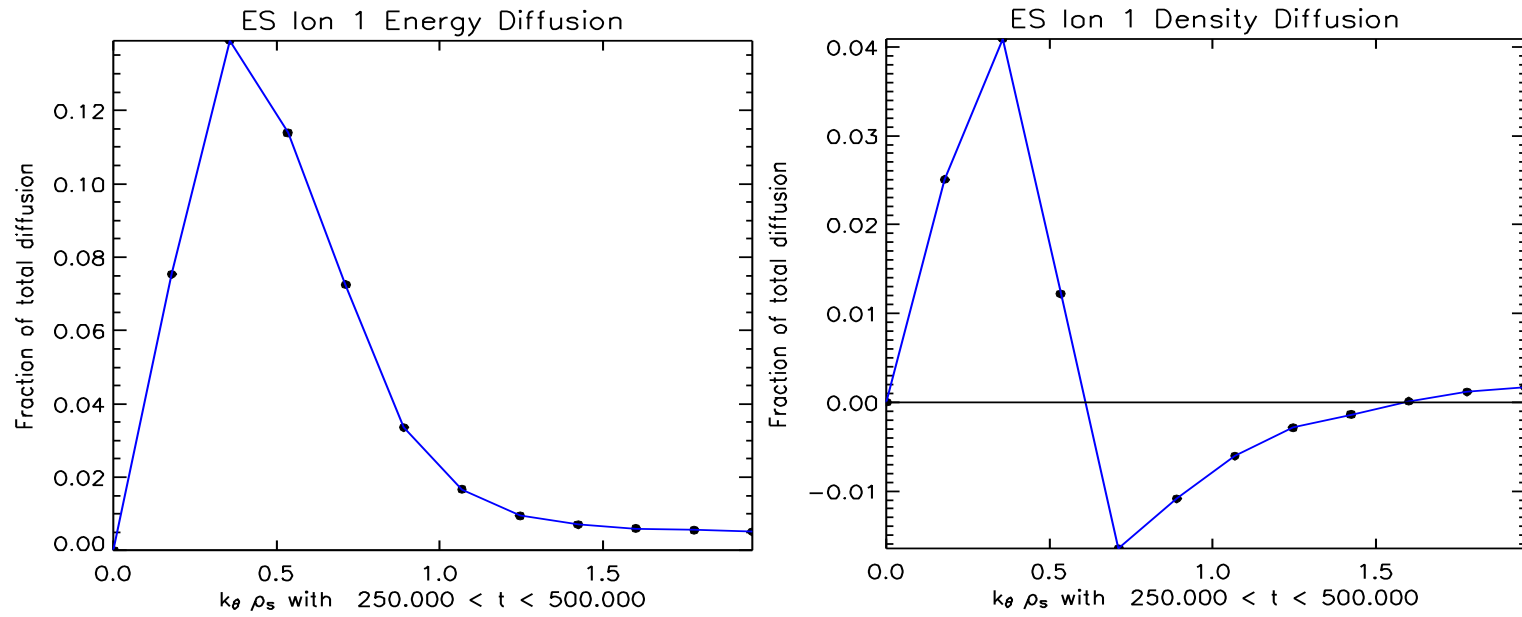


Heat flow profiles

- simulated $q_i + q_e \simeq 5\text{MW}$, TRANSP power balance $\simeq 3.5\text{MW}$



- direction of bulk ion particle flow depends on mode



Summary

- Ongoing nonlinear GYRO simulations of DIII-D, JET, and JT60-U plasmas
 1. energy, particle, and momentum transport and flows are predicted
 2. Strong sensitivity to drive terms such as $\nabla(T_i)$
- preliminary results for JT60-U box ITB plasma
 1. simulated energy flow ($q_i + q_e$) close to TRANSP power balance
 2. energy transported mainly by impurities
 3. χ_{mom}/χ_{eff} is small and in approximate agreement with measurements
 4. momentum transported mainly by bulk ions

- More work
 1. Longer runs to test convergence
 2. Variations of drive terms to study sensitivity
 3. Variations of grids
 4. Turn off E_r and/or Kelvin-Helmholtz drive
 5. Study variation of density fluctuations as $\nabla(n_e)$ varies
 6. Increase β_e above zero
 7. EM runs
 8. compare with fluctuation measurements
- EPS paper on momentum confinement in DIII-D and JET ELMy H-mode plasmas