Turbulence-driven “anomalous bootstrap current" generation

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Objectives

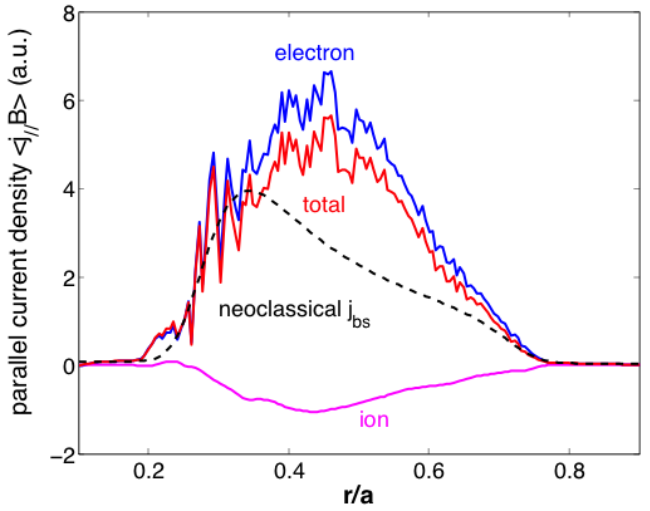
- Study self-generated, non-inductive currents in the presence of drift wave turbulence in fusion plasmas
- Use the global, Gyrokinetic Tokamak Simulation code “GTS” to carry out this work
- Challenges of this study:
  - Requires the self-consistent implementation of neoclassical physics and turbulence in gyrokinetic codes

Impact

- Non-inductive confinement techniques are critically important for ITER.
- Anomalous bootstrap current discovered through simulations may radically impact our understanding of tokamak physics, including:
  - Overall plasma confinement
  - Key magnetohydrodynamic (MHD) instabilities such as neoclassical tearing mode (NTM) and edge localized mode (ELM).

Accomplishments

- Successful implementation of self-consistent neoclassical physics in GTS gyrokinetic PIC code.
- Recent GTS simulations, which include both turbulent and neoclassical physics self-consistently and simultaneously, show that bootstrap current generation is significantly enhanced in the presence of trapped electron mode (TEM) induced fluctuations.
- Simulations reveal important plasma parameter dependence of turbulence-driven currents, which can be tested experimentally.
- The simulations also show that the TEM-driven current is essentially carried by trapped electrons, unlike the neoclassical bootstrap current, which is mainly carried by passing particles
- The simulations were carried out at NERSC on the new Edison Cray XC30 computer.



Radial profile of total bootstrap current in the presence of CTEM turbulence in comparison with neoclassical bootstrap current

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