Plans for extended-MHD simulations of NSTX – CHI and reconnecting instabilities

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Simulations of helicity injection experiments in NSTX

- Simulations provide
  1. 1) guidance for existing experiments and design of NSTX-U, 2) insight to viability of CHI for steady-state operation of ST reactor and 3) validation exercises
  2. NIMROD simulations with CHI boundary conditions and computational grid have successfully produced the basis of CHI - bubble expansion and CHI-driven current (in agreement with the existing experiment) (Hooper)
- Plans: Complement ongoing computational efforts by
  1. reproducing the CHI-driven current with the NSTX grid, and the boundary condition setup for injector and absorber
  2. analyzing the physics of non-axisymmetric simulations of CHI, including current relaxation, mode dynamics, temperature evolution, and make further comparison with the experiment
  3. performing long term simulations - couple CHI simulations with induction and compare with the existing experimental data (Raman et al. PRL 2010)

Simulations of reconnecting instabilities - the effect of magnetic and flow shear

Observations

- Strong correlation between the magnetic shear and reduced transport has been observed in NSTX. Experiments (with NBI) were conducted to generate various q with different magnetic shear, Stutman et al. 2006; Levinton et al. 2007; Yuh et al. 2011.
- the effect of magnetic and rotation shear on reconnecting tearing events also have impact on other fusion devices

Short and long term plans

- couple equilibrium reconstruction (or use TEQ, TOQ, NIMEQ?) with NIMROD
- produce NSTX relevant equilibria with low magnetic shear (monotonic q) and reversed magnetic shear
- perform simulations of reconnecting instabilities in NSTX, such as double tearing mode for equilibria with different magnetic shear (w/, w/o rotation shear)
- longer term goal, include two-fluid physics to study the possible diamagnetic stabilization. Explore synergistic implications for reconnection in the dayside magnetopause.

Collaborators: Bhattacharjee, Hooper, Sovinec, Prager, and PPPL theory group and NSTX team