Kinetic Neoclassical Transport in the H-mode Pedestal (1)

- Motivation:
  - Performance of ITER determined by H-mode pedestal properties
- Current understanding:
  - JRT11 increased confidence in predicting local and global pedestal pressure stability limits
- Urgent need:
  - Predictive capability for evolution and saturation of kinetic profiles (n,T,v) of each species in pedestal (what limits pedestal transport?)
- Goal of presented work:
  - Quantify the impact of kinetic ion effects on the interpretation of diagnostic measurements of the pedestal
  - Quantify how well kinetic neoclassical + neutrals can describe ion transport in various H-mode regimes

Kinetic Neoclassical Transport in the H-mode Pedestal (2)

- Experimental observations of kinetic and neutral effects
  - Use data to motivate self-consistent full-f model that includes neutrals
- Describe interpretative XGC0
  - Free parameters, code assumptions, etc
- First result: Kinetic effects impact interpretation of pedestal profile measurements
  - QH-mode and the ion species temperatures
  - Probe plunges right after LH transition and poloidal density asymmetry
  - Impact of results: it is important to consider kinetic effects on profiles when calculating pedestal equilibrium, stability and transport (especially at high-Ti, low collisionallity)

Kinetic Neoclassical Transport in the H-mode Pedestal (3)

- Second result: Kinetic neoclassical + neutrals is sufficient to describe multi-species ion thermal and particle pedestal transport in some situations
  - Use different transport regimes to investigate the role of neoclassical and anomalous transport in setting the ion pedestal profiles
    - EPH-mode: Neoclassical ion thermal and particle transport
    - DIII-D early H-mode: Region of near-zero anomalous ion transport in steep-gradient region
    - QH-mode: Similar to H-mode, but anomalous co-Ip torque in EHO region that enhances particle transport (NTV-like transport)
  - Describe pedestal refueling: neutrals and particle pinch
  - Impact of result: Increases confidence that kinetic neoclassical + neutral simulation is a needed tool for predicting pedestal transport limits (ie a transport floor) in future devices

Kinetic Neoclassical Transport in the H-mode Pedestal (4)

- Third result: Kinetic ion and electron solution reproduces Er and flows in the pedestal and SOL
  - Ion orbit loss leads to a neoclassical solution that is not automatically ambipolar inside separatrix → drives intrinsic rotation
  - ECH heated H-mode: Reproduce Er and intrinsic flows in pedestal.
  - QH-mode: simulation matches high res measurement of Er and rotation around separatrix. Intrinsic rotation drives rotation shear.
  - Impact of result: the dynamics of ion and electron loss to the wall defines Er and flows in the SOL (of course), but also in the pedestal. Important contribution to the intrinsic rotation in tokamaks.

- Moving forward…
  - Will present dry runs at DIII-D and PPPL (end of Oct)
  - Most analysis is in hand, big challenge is improving clarity of narrative