Overview of Gkeyll
- Gkeyll is a continuum code being developed to model gyrokinetics at the edge of tokamaks
- Particle & energy conserving discontinuous Galerkin methods implemented to solve a class of problems described by Hamiltonians and Poisson Brackets
- Methods tested on various wave mode instabilities and interaction of plasma with wall

Two-Stream Instability – cont.
- Two-stream instability occurs when beams of charged particles with different velocities flow through each other
- Two beams means free energy to drive instability – perturbations in densities reinforced through each other
- Initial condition is bump-on-tail distribution function
- Perturbation grows exponentially at first
- Growth saturates and instability goes nonlinear as particles become trapped in potential wells
- Results showed good energy conservation

KEEN Wave Modes
- Kinetic Electrostatic Electron Nonlinear (KEEN) wave modes are non-stationary, multimode oscillations
- Caused by an external electric field – drives Vlasov-Poisson system ponderomotively
- Development of the mode in the distribution function compared with Mehrenberger et al

The Plasma Sheath – cont.
- What happens to a plasma near a wall?
- Electrons and ions recombine and are lost from system, leaves plasma with net positive charge
- Potential of wall biased negative with respect to plasma, Debye shielding says potential can’t penetrate into plasma
- Potential near sheath – measured – ~Debye lengths from wall
- Differences are because theory assumes Boltzmann electrons and fluid ions. Gkeyll has kinetic ions and electrons

BGK Wave Modes
- Bernstein, Greene, and Kruskal (BGK) wave modes are class of nonlinear, electrostatic wave modes – can arise when potential varies spatially
- Initial condition is bump-on-tail distribution function
- Diagnostics (field energy, etc.) were compared with Mehrenberger et al

The Plasma Sheath – cont.
- End goal is full gyrokinetic treatment of edge of tokamak – can create effective sheath if understand relationships between fluxes of particles, temperature ratios of ions and electrons, and sheath potential
- Sheath Transmission Coefficient – ratio of heat flux to ion saturation current at wall

Two-Stream Instability
- Two-stream instability and interaction of plasma with wall
- Methods tested on various wave mode instabilities
- Perturbation grows exponentially at first
- Growth saturates and instability goes nonlinear

Future Work
- Coupled circuit plasma simulations by introducing source at left wall and evolving both walls in time like plasma is connected to RLC circuit
- Would allow for simulation of wall currents parallel to plasma in tokamak, as well as greater understanding of gyrokinetic boundary conditions
- Can capture physics such as effective capacitance of plasma

References
- http://ammar-hakim.org/sj/