Plasma Physics Seminar

UCLA College | Physical Sciences Physics & Astronomy

Physics & Astronomy Building (PAB) Room 4-330
Thursday, March 26th at 12:30 PM
Via Zoom: https://ucla.zoom.us/my/pab4330

A novel parallel-kinetic-perpendicular moment model for magnetized plasmas

Jimmy Juno (Princeton Plasma Physics Laboratory)

Many plasma systems, from pulsar magnetospheres to magnetic confinement devices, are highly magnetized. Simultaneously these myriad of plasma environments are often sufficiently tenuous and hot to be best described by kinetic theory and the full six dimensional Boltzmann-Maxwell system of equations, thus making these systems computationally demanding to model. To facilitate new kinetic models of magnetized plasmas, I will discuss a recent innovation which separates the parallel and perpendicular dynamics starting from the kinetic equation while staying agnostic to the inclusion of effects important to consider in diverse environments, such as strong flows in certain fusion reactors, relativistic energies in astrophysical plasmas, or complex boundary conditions and geometry in lab plasma modeling. The key component of the derivation lies in a spectral expansion of only the perpendicular degrees of freedom, analogous to spectral methods which have grown in popularity in recent years for gyrokinetics, while retaining the complete dynamics parallel to the magnetic field. We thus leverage our intuition that a magnetized plasma's motion is different parallel and perpendicular to the magnetic field, allowing for the treatment of complex phase space dynamics parallel to the magnetic field but at reduced computational cost. This approach also naturally couples to Maxwell's equations, thus permitting everything from a transition across energy scales in astrophysical plasmas to the straightforward inclusion of all aspects of an experiment, from vacuum regions to external coils. The utility of this approach will be demonstrated with a classical benchmark: magnetic reconnection, but in regimes beyond what typical reduced models can capture and culminating in the application of the model to flux rope merging experiments at the Large Plasma Device at UCLA.

Host: Derek Schaeffer