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Studies of plasma sheaths using novel numerical schemes with self-consistent emitting walls and full Fokker-Planck collisions[1]

PETR CAGAS, Virginia Tech

Continuum-kinetic plasma models are successfully used to study plasma sheaths by directly evolving ion and electron distribution functions using the Vlasov equation coupled with Maxwell's equations. This way, the particle distributions are available for analysis and are unaffected by particle noise. Furthermore, the shape of a distribution at the edge of a bounded plasma is the key input parameter for particle emission from the boundary. Since the emission can significantly alter the plasma, the governing boundary conditions need to be both physics-based and self-consistent. While plasma sheaths are in theory often considered collisionless, the source of particles for a sheath is in a collisional presheath and details of the collisions can have a significant impact. Further, in many machines the loss cone needs detailed understanding of the collisional processes and often can be electrically connected to the sheath. In this talk, these two key processes, Fokker-Planck collisions and self-consistent first-principles emitting boundary conditions, are discussed along with a description of their incorporation into a high-order accurate continuum-kinetic scheme. The presented scheme is carefully crafted using a novel version of the discontinuous Galerkin (DG) method based on the concepts of weak equality and recovery to obtain gradients at discontinuous interfaces. An integral part of this super-convergent scheme is a unique multi-dimensional recovery approach which utilizes computer algebra tools for efficiency. The important role of accurate collisions in the presheath and wall emissions on sheath characteristics will be presented.

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