Kinetic Simulations of Anomalous Transport in ExB Plasma Devices

Tasman Powis

Anomalous transport across magnetic field lines has remained a critically important and unresolved problem in plasma physics for decades. As well as having important consequences for high temperature and fusion grade plasmas, anomalous transport is observed in a wide range of low-temperature devices. In a Hall thruster, anomalous transport is responsible for a reduction in efficiency caused by the enhanced transport of electrons from the cathode to the anode. Within these devices, the velocity distribution functions are often non-Maxwellian, necessitating the use of kinetic simulations. The particle-in-cell method is a powerful and highly accurate tool for modeling the kinetic behaviour of low-temperature plasmas. Furthermore, modern computing architectures have reached a scale where it has become possible to simulate large and complex geometries and obtain results relevant for the engineering of such devices.

The purpose of this work is to improve upon existing PIC codes for use on massively parallel architectures. These improved codes will be harnessed to study anomalous transport within a low-temperature partially magnetized device, prototypical of a Hall thruster. This will include an investigation in the role of Bohm diffusion and the formation of large scale coherent structures on the transport rate. The long term goal is to control the formation of structures in order to reduce transport and improve efficiency.