Particle-in-cell simulation of 2D plasma thrusters

Abstract

As plasma expands nonadiabatically, generation of double layers and other accelerating mechanisms are known to set in, leading to plasma thrusters. As ions and electrons respond differently during this process, to clearly understand the physics of thrust generation mechanism and to optimise the same for laboratory scale plasma thrusters, kinetic treatment of electrons and ions becomes mandatory. Due to their computational scalability, particle-in-cell simulation tools come handy.

At the Institute for Plasma Research, Gandhinagar (IPR), a suite of PIC tools called EPPIC for 1D1V and 2D3V modelling in electrostatic limit has been developed. EPPIC suite can model expanding plasmas in 1D or in 2D - including plasma buildup from neutral gas, external circuit and OpenMPI parallelism. However, plasma dynamics induced electromagnetic effects, which become important for understanding radio-frequency (RF) heated plasma thrusters is yet to included. Furthermore, to simulate laboratory scale thrusters, it becomes necessary to fully parallelize (CPU+GPU) the code to run on IPR's HPC systems.

This project has therefore two aspects (i) to learn the nuances of EPPIC1D and 2D versions and to reproduce published work [V Saini et al 2022] in the electrostatic limit followed by optimization and development of MPI-GPU parallelism, using IPR's 1PetaFlop HPC system ANTYA (ii) to include electromagnetic effects induced by plasma dynamics and benchmark this newly added physics component with published results.

A suitable candidate would be a senior BS-MS student with preliminary exposure to PIC methods, Fortran/C/C++ languages, Python programming ability and interest in high performance computing. Candidate is expected to have strong inclination to address challenging open problems in plasma science.

Due to the nature of the project work, the Candidate is expected to work offline at IPR. To obtain meaningful upgrade and results, ideal project duration would be upto 8 months.

Academic Project Requirements:

1) Required No. of student(s) for academic project: 1

2) Name of course with branch/discipline: M.Sc. Physics

3) Academic Project duration:

(a) Total academic project duration: 32 Weeks
(b) Student's presence at IPR for academic project work: 5 Full working Days per week

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