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SPACE PROPULSION SYMPOSIUM (C4)
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COMPARATIVE STUDY ON NUMERICAL SIMULATION BY KINETIC AND FLUID MODELS FOR MHD ACCELERATOR

Abstract

For systems containing a large number of interacting particles the statistical approach becomes very convenient. The properties of plasma are transported through the channel by means of the contribution of the thermal and average motions. In kinetic theory a statistical function is used to describe the distribution of particles in the physical and velocity spaces, commonly known as phase-space, and the time evolution of the distribution function, can be described by the differential kinetic equation known as the Boltzmann equation. By solving the Boltzmann equation and by taking the moments of the distribution function, the macroscopic properties of plasma should be calculated by integrating the distribution function in the velocity space. On the other hand, in the fluid approximation model, the macroscopic properties can be calculated by solving differential system known as the fluid equations including the Navier-Stokes equation.

In this study, numerical simulations of a highly ionized argon plasma flowing inside an MHD accelerator are carried out using both approaches, with the purpose of validating the use of the kinetic model and discuss the advantages and disadvantages of both approaches. For the kinetic model, a splitting technique is used for the calculation for the advection of the distribution function in the physical and velocity spaces. The CIP method is applied for the interpolation of the distribution function. For the fluid model, the CIP method is used to solve numerically the advection term in the fluid equations. In this study, the calculations based in the kinetic and fluid model, are numerically investigated, and the differences are discussed for the efficient MHD accelerator.