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(POS-36) Rotational and Electromagnetic Effects on Plasma Acceleration in the Magnetic Nozzle

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The flow and acceleration of plasma in a converging-diverging magnetic field has many important applications including nuclear fusion in a magnetic mirror, helicon thrusters for space propulsion and plasma based etching of semiconductors. Electromagnetic effects from an azimuthal magnetic field B_ϕ and centrifugal effects due to azimuthal plasma rotation V_ϕ are analyzed for a low β, cold plasma being accelerated in a magnetic nozzle with a large expansion ratio. By solving the MHD equations in the paraxial approximation with isothermal electrons, the intrinsic coupling of azimuthal rotation and azimuthal magnetic field is studied. It is demonstrated that both rotational and magnetic energy can be converted into translational kinetic energy of ions. It was discovered that azimuthal rotational energy and azimuthal magnetic energy can each be converted into the other, with each type of conversion occurring in either the converging or diverging section of the nozzle. For a sufficiently large expansion ratio the ion flow velocity can exceed the Alfven velocity. Stationary state solutions have been obtained for both transonic and trans-Alfvenic flows. It was found that for a specific set of boundary conditions at the nozzle entrance, a unique solution for plasma flow exists that passes through all 3 critical points where the plasma flow velocity is equal to the phase velocity of the MHD modes corresponding to the slow-magnetosonic, the Alfven and fast-magnetosonic wave.

Keyword-1

Magnetic Nozzle

Keyword-2

MHD

Keyword-3

Plasma Transport

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