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(G*) (POS-13) Unraveling Plasma Acceleration in Low-β Environments: Insights from MHD and PIC Simulations

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This project explores the dynamics of plasma acceleration in low-β plasmas, where magnetic energy dominates over internal kinetic energy, confining the plasma within magnetic fields. We investigate the adherence of low-β plasmas to Alfvén's theorem, which describes the 'frozen-in' behavior of magnetic field lines. Such plasmas find applications in magnetic confinement fusion reactors, star atmospheres, and plasma-based space propulsion technologies.

Our study uses magnetohydrodynamics (MHD) and Particle-In-Cell (PIC) simulations to analyze plasma acceleration modes. We begin by reviewing Weber-Davis solar wind acceleration, following Parker's theoretical framework. Furthermore, we examine various plasma acceleration modes, including critical points responsible for transitioning solar winds from subsonic to supersonic velocities.

Transitioning from solar wind dynamics to magnetic nozzle scenarios, we investigate a convergent-divergent magnetic field configuration that converts plasma's thermal energy into directed kinetic energy. Through detailed comparisons of PIC and MHD simulations, we aim to elucidate plasma acceleration modes, with a particular focus on torsional Alfvén waves, pressure-induced acceleration, and centrifugal confinement.

Keyword-1

Plasma acceleration

Keyword-2

Low-beta plasmas

Keyword-3

Magnetohydrodynamics

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