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A study of the propagation of a solitary wave along the magnetic field in a cold collision-free plasma

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Abstract:

The propagation of finite amplitude waves across a magnetic field in a cold collision-free plasma was first investigated by Adlam and Allen in 1958.[1] .The model was applied to large amplitude waves that travel into a compressed plasma containing a magnetic field.

Subsequently, Montgomery[2] and Saffman[3] discussed the large amplitude waves propagating along the magnetic field. Recent literature numerically deals such parallel propagating solitary waves with a core filled by oscillatory structures. For example, Sauer et al.[4] and Dubinin et al.[5] discuss stationary nonlinear solutions including solitary amplitude with the oscillating phase, which look like envelope solitons in the wave frame.

Present results detail the analysis of the propagation of a solitary wave along the magnetic field in a cold collision-free plasma. With the quasi-neutral approximation and the conservation of momentum flux and energy flux in the wave-frame, the exact analytical solutions of the stationary solitary pulse in terms of particle densities, parallel and transverse velocities, and transverse magnetic fields are presented without performing numerical integration. Graphical representations of the solutions and in particular the 3D structures of the transverse magnetic and velocity field lines are presented.

References:

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