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Cosmic ray modified magnetosonic shocks, solitons and rouge waves in rotating magnetoplasma.

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We investigate the linear and nonlinear propagation characteristics of magnetosonic waves in dissipative magnetorotating plasma containing thermal gas and cosmic rays, including external magnetic field and Coriolis force due to rotation of the plasma[1]. We obtain a linear dispersion relation using normal mode analysis and observe that the wave frequency is enhanced due to the effects of cosmic ray pressure[2], while the damping characteristics are significantly modified due to cosmic ray diffusion. Applying the standard reductive perturbation technique, a Korteweg-de-Varies (KdVB) equation is derived, which describes the evolution of small amplitude magnetosonic shocks and numerically analyzes the characteristics of shock waves[3].
In the regime where the dissipative effects are too weak, we reduce a Korteweg-de-varies (KdV) equation to study the behaviours of soliton solutions. Furthermore, a nonlinear Schrodinger (NLS) equation is derived from the KdV equation for the carrier wave, which is much smaller than the wave's frequency to study rogue wave[4] solutions. The influence of the key plasma configuration parameters, viz., cosmic ray pressure, cosmic ray diffusion, thermal gas pressure, and effects of Coriolis force due to the rotation of plasma, on the characteristics of magnetosonic shocks, solitons and rouge waves solutions are studied in detail and observed that they significantly alter the nonlinear dynamics of the magnetosonic waves. The relevance of the investigation is discussed in exploring the nonlinear dynamics of magnetosonic waves in interstellar medium, like spiral galaxies.

References:
[1] J. Turi, A. Misra, Magnetohydrodynamic instabilities in a self-gravitating rotating cosmic plasma, Physica Scripta 97 (12) (2022) 125603.
[2] G. Zank, G. Webb, Weakly multi-dimensional cosmic ray-modified mhd shocks, Journal of plasma physics 44 (1) (1990) 91−101.
[3] Y. A. Hager, M. A. Khaled, M. A. Shukri, Magnetosonic waves propagation in a magnetorotating quantum plasma, Physical Review E 107 (5) (2023) 055202.
[4] S. El-Labany, W. Moslem, N. El-Bedwehy, R. Sabry, H. Abd El-Razek, Rogue wave in titan's atmosphere, Astrophysics and Space Science 338 (2012) 3−8.

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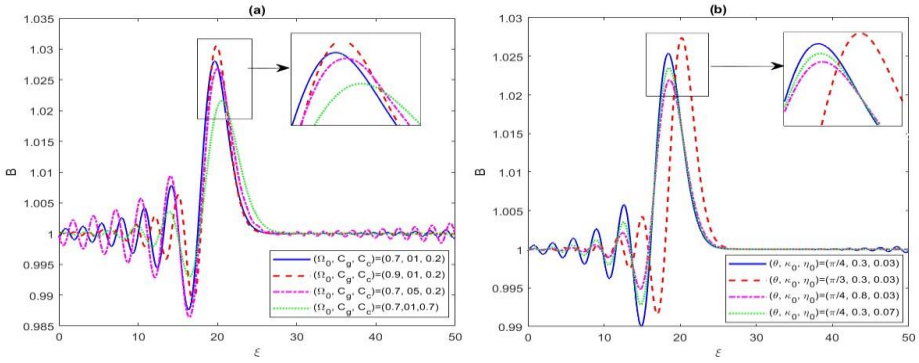

Figure 1. The magnetosonic oscillatory shock profiles B are displayed against ξ for different values of plasma parameters as mentioned in the legends.