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Dynamics and modulation of cosmic ray modified magnetosonic waves in a galactic gaseous rotating plasma

Jyoti Turi[1], Gadadhar Banerjee[2]
[1]Department of Mathematics, Siksha Bhavana, Visva-Bharati University
[2]Department of Mathematics, Burdwan Raj College, University of Burdwan
e-mail (speaker): jyotituri.maths@gmail.

The influence of the presence of cosmic fluid on the magnetosonic waves and modulation instabilities in the interstellar medium (ISM) of spiral galaxies is investigated. The fluid model is developed by modifying the pressure equation in such dissipative rotating magnetoplasmas incorporating thermal ionized gas and cosmic rays. Applying the normal mode analysis, a modified dispersion relation is derived to study linear magnetosonic wave modes and their instabilities. The cosmic rays influence the wave damping by accelerating the damping rate. The standard reductive perturbation method is employed in the fluid model leading to a Korteweg–de Vries–Burgers (KdVB) equation in the small-amplitude limit. Several nonlinear wave shapes are assessed by solving the KdVB equation, analytically and numerically. The cosmic ray diffusivity and magnetic resistivity are responsible for the generation of shock waves.

The modulational instability (MI) and the rogue wave solutions of the magnetosonic waves are studied by deriving a nonlinear Schrödinger equation from the obtained KdVB equation under the assumption that the cosmic ray diffusion and magnetic resistivity are weak and the carrier wave frequency is considerably lower than the wave frequency. The influence of various plasma parameters on the growth rate of MI is examined. The modification of the pressure term due to cosmic fluid reduces the MI growth in the interstellar medium. In addition, a quantitative analysis of the characteristics of rogue wave solutions is presented. Our investigation's applicability to the interstellar medium of spiral galaxies is traced out.

References

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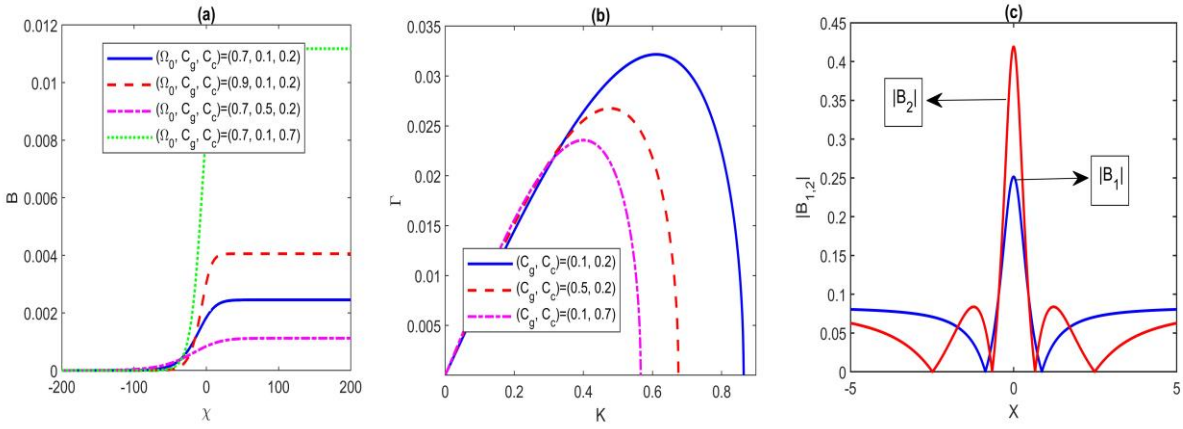

Figure 1. The magnetosonic shock profiles and MI growth are plotted in subplots (a) and (b) respectively for different parametric values as mentioned in the legends. A comparison between first- and second-order rogue wave pulses is displayed in subplot (c).