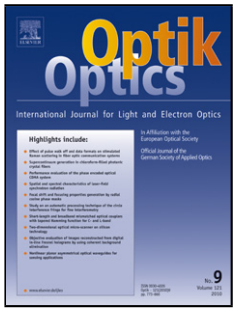

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Optical Solitary waves, Conservation Laws and Modulation Instability Analysis to the Nonlinear Schrödinger's Equation in Compressional Dispersive Alvèn Waves

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Abstract

In this paper, the sine-Gordon equation expansion method (SGEM) is used to acquire the optical solitary waves to the nonlinear Schrödinger's equation (NLSE) that arises from compressional dispersive Alvèn (CDA) waves. As a result of the operations, dark, bright, dark-bright and singular optical Solitary waves are derived. The solitary waves appear with all necessary constraint conditions which guarantee their existence. The Lie point symmetry generators of a system of partial differential equations (PDEs) obtained by transforming the equation into real and imaginary parts are derived. We prove that the system is nonlinearly self-adjoint with an explicit form of a differential substitution satisfying the nonlinear self-adjoint condition. Then we use these facts to construct a set of conservation laws (Cls) for the system using the general Cls theorem presented by Ibragimov. Furthermore, the modulation instability (MI) is studied based on the standard linear-stability analysis and the MI gain spectrum is got. Numerical simulation of the obtained results are analyzed with interesting figures showing the physical meaning of the solutions.

Keywords: Sine-Gordon equation expansion method, Soliton, Conservation laws, stability analysis.

1 Introduction

NLSEs appear in fluid dynamics, nonlinear optics, plasma and nuclear physics [1]. Recently, efficient ansatz has been reported to construct various types of solitons of NLSEs [2-8].

In this work, the CDA waves are considered. There have been two major experiments conducted on the CDA waves. The first experiment [9] considered the relationship between the CDA waves and the perturbation in a low plasma, while the second experiment [10] studied the amplitude of the waves in a magnetic electron-positron plasma. In both experiments, it was concluded that the system of equations under investigation can be conveniently written as single