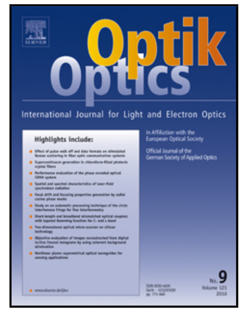
Accepted Manuscript



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PII: S0030-4026(16)30688-X
DOI: http://dx.doi.org/doi:10.1016/j.ijleo.2016.06.066
Reference: IJLEO 57852

To appear in:

Received date: 23-4-2016
Accepted date: 17-6-2016

Explicit bright and dark solitons for the variable coefficient Biswas-Milovic equation with competing nonlinearity

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Abstract

This paper is devoted in the study of Biswas-Milovic equation with variable coefficients associated with four different forms of nonlinearity, namely the Kerr law, power law, parabolic law and the dual-power law. We prove that, in presence of additional time dependent damping term, yet there exists different solitary wave solutions under some constraint relations. The generalized form of solitary wave ansatz method in context of doubly periodic Jacobi elliptic functions is carried out to obtain bright and dark soliton solutions of the governing equation. The constraint relations between the model coefficients and the damping coefficient for existence of soliton solutions are derived. In addition, it is shown that for the existence of soliton, the damping coefficient has to be Riemann integrable. The remarkable features of such solitons are demonstrated in several interesting figures.

Keywords: Solitons, Integrability, Biswas-Milovic equation, Jacobi elliptic functions
PACS: 02.30.Ik, 02.30.Jr, 04.20.Jb, 05.45.Yv

1. Introduction

The study of solitons finds application in various branches of physical and natural sciences such as plasma physics, nonlinear optics, nuclear physics, light wave communication technology, photonics, condensed matter physics and various others [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24] for the past few decades. The delicate balance between nonlinearity and dispersion effects in the medium causes envelope soliton which are stable nonlinear wave packets that maintains their shapes during the propagation in a nonlinear dispersive medium [25]. Two different types of envelope solitons, bright (non-topological) and dark (topological) can propagate in nonlinear dispersive media. The bright soliton is a pulse on a zero intensity background which has no phase change for large spatial distance, whereas the dark soliton appears as a intensity dip in an infinitely extended constant background [26]. Much attention has been paid on the propagation of solitons through optical fibers and an overwhelming progress has been made in this direction. One of the major issue about the theory of solitons is the aspect of integrability of the governing equation of the solitary wave. While a good number of numerical schemes are available that can solve these equation numerically, a closed form exact solution is always preferable and advantageous to study the properties of the solution analytically, since these exact solutions portray a better analytical picture than those numerical simulations.

In 1965, Zabusky and Kruskal [27] discovered that the Korteweg de-Vries (KdV) equation has a pulse-like solitary wave solution which interacts "elastically" with another such solution. They termed such type of solution as soliton. In mathematics and physics, a soliton is a self-reinforcing solitary wave (a wave packet or pulse) that preserves its shapes while travelling at constant speed. After a short time, Gardner et al. [28, 29] proposed a method for the exact solution of the KdV equation through the ideas of direct and inverse scattering. After the substantial generalization of these ideas by Lax [30], Zakharov and Shabat [31] proved that this method is also applicable on another physically significant nonlinear evolution equations, namely, the nonlinear Schrödinger equation. Utilizing all these ideas, Ablowitz et al. [32, 33] developed a method to determine a broad class of nonlinear evolution equations solvable by these techniques, named as the inverse scattering transform (IST) which can be treated as the nonlinear analogue of the Fourier transform method.

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Preprint submitted to Optik *April 23, 2016*