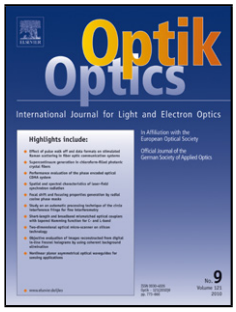

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Author: Mustafa Inc Aliyu Isa Aliyu Abdullahi Yusuf

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Solitons and Conservation Laws to the Resonance Nonlinear Shrödinger's equation with both Spatio-Temporal and Inter-Modal Dispersions

Mustafa Inc[1], Aliyu Isa Aliyu[1,2], Abdullahi Yusuf[1,2]

[1]**Firat University, Science Faculty, Department of Mathematics, 23119 Elazig/Turkiye**

[2]**Federal University Dutse, Science Faculty, Department of Mathematics, 7156 Jigawa/Nigeria**

E-mails: minc@firat.edu.tr, aliyu.isa@fud.edu.ng, yusufabdullahi@fud.edu.ng

Abstract

The resonant nonlinear Shrödinger's equation (RNLSE) with both spatio-temporal (STD) and inter-modal (IMD) dispersions which describes the modelling of fluids and propagation dynamics of optical solitons is studied using three analytical schemes. These are generalized projective-Riccati equation method (GPRE), Bernoulli sub-ODE method and the Riccati-Bernoulli sub-ODE. The presented problem is studied with Kerr law nonlinearity. Dark optical, singular, and combined formal solitons are acquired. The constraint conditions that naturally fall out of the solution structure guarantee the existence of these solitons. We derive the Lie point symmetry generators of a system of partial differential equations (PDEs) obtained by decomposing the underlying equation into real and imaginary components. Then we used these symmetries to construct a set of nonlocal conservation laws (Cls) using the technique introduced by Ibragimov.

Keywords: Optical solitons, STD, Lie symmetries, Cls.

1 Introduction

Optical solitons is one of the fast growing fields in the field of optoelectronics and nano electronics. In recent years, several results have been presented in many journals and books. A lot of progress are made in the field of nonlinear optics that deals with meta materials, optical fibers, birefringent fibers, and many more. Several models and techniques describe the dynamics of soliton [1-43]. This paper addresses the kerr law nonlinearity to a NLSE that appears with STD and IMD dispersions [22]. It should be noted that the governing equation for the propagation of optical solitons in nonlinear media is well-posed only when the additional STD is considered [5].

2 Governing equation

In the presence of IMD, the well-posed nonlinear dynamical model that will be investigated in this work is given by the following RNLSE: [22]

$$iq_t + \alpha q_{xx} + \beta q_{xt} + dF(|q|^2)q + \gamma\left(\frac{|q|_{xx}}{|q|}\right)q - i\delta q_x = 0, \quad i = \sqrt{-1}, \tag{1}$$

where x represents the non-dimensional distance along the fiber and t is the temporal variable. The term $q(x,t)$ representing the dependent variable is a complex valued wave profile, α and β