Nasir Ganikhodjaev
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VOLUME 1

$$x' = 2xy$$
$$y' = 2xz$$

INVESTIGATIONS ON PURE MATHEMATICS, FINANCE MATHEMATICS AND OPTICS

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$$\varphi_1(x, y, z) = z$$

$$z' = x^2 + y^2 + z^2 + 2yz$$

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WAVE PROPAGATION IN NONLINEAR AND HOMOGENEOUS MEDIA: KERR MEDIA

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Assoc. Prof. Dr. Bakhram Umarov

Abstract. *The basic structure and the propagation of wave has been study in this paper by implementing a numerical routine to solve the nonlinear paraxial equation. Start by implement the basic wave equation, we be able to derive the nonlinear Schrödinger equation which is define by the special character of Kerr media. Along the process of propagation, both linear (dispersion) and nonlinear operator undergo the special method known as split step method. This method involves the separation of calculation between two non commuting operators. This paper also provides the solution of nonlinear Schrödinger equation in the form of spatial soliton. The solitary wave (soliton) is a wave that propagates at uniform velocity without changing its form It can maintain it form because the Kerr effect help to balance the group dispersion in optical propagation medium. The resulting effect of this balance is the propagation of solitons, which has the form of a hyperbolic secant. Throughout the process of calculating, several notations have been normalizing in order to develop the code using the MATLAB software. By relies on pulse propagation*

1 Introduction

Wave is disturbance that propagates through space and time, with transference of energy. Wave travels and transfer energy from one point to another and often with little or no associated mass transport; they consist instead of oscillations or vibrations around almost fixed locations. Wave propagates in any ways which enable it to travel. All waves can experience reflection, refraction, diffraction, interference, dispersion and rectilinear propagation. The waves also can propagate in three main medium which are homogeneous, linear and isotropic medium (Daintith, 2005).

The main objective of this project paper is to investigate about the wave propagation in nonlinear and homogeneous media using the special media called Kerr media. In order to fulfil this objective, the nonlinear Schrödinger equation has been derived. This equation lead to the spatial soliton solution and the numerical approach has been used to complete the solution. The medium is nonlinear if its properties depend on the amplitude of the field in the medium. Meanwhile, the medium is called homogeneous if its properties are not function of space.

The Kerr media is caused by Kerr effect, which is known as the quadratic electro-optic effect. It is the change in the refractive index of a material because it response to a practical electric held. According to Weinberger (2008), the Kerr effect is different from the Pockels effect, where the induced index change is directly proportional to the square of the electric field instead of varying linearly with it. Moreover, all materials demonstrate the Kerr effect but certain fluids show it strongly than others. The optical Kerr effect is one of the special cases that we study in this paper.

The optical Kerr effect is the cause in which the electric field is due to the light itself. Then it causes a variation in index of refraction and it is proportional to the local irradiance of light. The refractive index vibration lead to nonlinear optical effect of self focusing, self-