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Application of the theory of nonlinear optics and solitons in optical fiber transmission

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$$Min \sum_{i=1}^{n} w_i . x_i \quad s.t \;\; A_{(n+w)\times n} X_{n\times 1} \geq b_{(n+w)\times 1}$$

$$Min \sum_{i=1}^{n} w_i . x_i \quad s.t \;\; y = A_{n\times n} X_{n\times 1} \geq b_{n\times 1}$$

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ABSTRACT

Soliton in an optical fiber, a fine example of the profound impact technology provides a mathematical concept in real-world. There soliton theory, the first in 1934 by John Scott Russell queries. Solitary waves in search of nature, as is done in the realm of speculation. Soliton waves may also exist in biological systems, so that in 1979, but Henry Tuck, who was then a member of the University of British Columbia equations to study the concentration of potassium and calcium in the modeling of the nervous system to filtrate. When the system is in a local increase in potassium can cause problems - which happened during the passage of a nerve stimulator is probable - that of the equations, and the calcium reduced the waves increased potassium in a single filtrate moving were foretold .In the near future, solitary waves can lead to innovations in technology.

Introduction

Soliton in an optical fiber, a fine example of the profound impact technology provides a mathematical concept in real-world. There soliton theory, the first in 1934 by John Scott Russell queries. Solitary waves in search of nature, as is done in the realm of speculation. Soliton waves may also exist in biological systems, so that in 1979, but Henry Tuck, who was then a member of the University of British Columbia equations to study the concentration of potassium and calcium in the modeling of the nervous system to filtrate. When the system is in a local increase in potassium can cause problems - which happened during the passage of a nerve stimulator is probable - that of the equations, and the calcium reduced the waves increased potassium in a single filtrate moving were foretold .In the near future, solitary waves can lead to innovations in technology. Optical fiber cables, optical communication systems may be based on the systems that are designed to exploit the individual waves. Nvrgsyl by Light Emitting Diode (LED) or laser light is produced at the other end of the cable to be received by the detector. Information that must be transmitted to the digital language of ones and zeros are displayed and can slice through rapid switching of the optical signal, and thus the signal comes in the form of a train of pulses in the carrier of the information. The transfer rate is measured in bits per second. Fiber optic cable across the Atlantic since it can carry 296 million bits per second. Optical signal transmission medium consists of an optical fiber made of glass and sometimes plastic. The main obstacle in long distance transmission, the loss of the sharp decline in the dim distance Syknal is over. One of the factors. Dissipation of absorbed light in the fiber is not never going to be completely transparent. But another important factor in this loss, a mess .At long distances, the different frequency components are spread because these components are moving with different speeds in the fiber and the scattered signal amplitude is small. Disintegration, even if the fiber optic signal amplitude does not decrease even if the phenomenon is a problem that must be stopped. In 1973, Akira Haskava Taprt person (from Bell Labs) have suggested that a single wave of light can be now used Kraft . Absence of dispersion, the fiber reduces waste and increases the transfer rate. But Hasgava system and a laser Taprt needed was not available at that time .

Solitary waves in a fiber optics requires that light intensity and wavelength of a hill so that the interaction can be characterized by a characteristic linear dispersion is compensated. Principle, light pulse in an optical fiber moves, it is severe enough, it can be non-linear characteristic. In practice, very intense light in the optical properties of a material that will pass through it, creates a moment of change . However, in 1970 there was a ridge laser light with sufficient intensity to produce a frequency range in which other types of waste is low in tar to an acceptable level .1991, Anderson and his colleagues at Bell Labs Olson , isolated waves with tracks 2 billion bits per second transmitted . They do it with a super narrow pulse to about 15 Pykvsanyh did. The transfer rate is equivalent to putting 500,000 simultaneous calls on a single line. Currently, no single system is not used for profit dim light waves. But creating a single wave fiber optic signal is being studied for use later in the Atlantic. Solitary waves in describing plasma proteins, general relativity, high energy physics and condensed matter physics also appear. Thus , the lack of scattering waves, are known, the scattered nature .Discovery of the soliton dispersion managed solitons in the application of innovative aid delivery system is considered real . Nonlinear Schrödinger wave equation model for optical coatings are widely used in the general analysis of optical transmission was introduced, and now used as standard.

The advent of fiber-optic telecommunications systems in the world in general has changed a lot since it is able to move at light speed or slow exchange between the two places .Advanced electronics and photonics science, quality of life has improved. One of the keys to success in the advancement of photonics , the use of solitons in optical fiber communication systems Tones , which can be a certain kind of light through an optical fiber hillside, over thousands of kilometers, without change they arise. Solitons forming method, an appropriate balance between

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the opposing forces of the particles and their distribution - the distribution of them.

In this paper, the basic concepts of optical solitons propagation of optical pulses are reviewed .

When an electromagnetic wave through free space (vacuum) is published seven times the speed of rotation moves around the earth every second. Similarly, when the light is emitted through a vacuum release at a slower rate than moves.Electric and magnetic fields of the light is polarized by the electron cloud. This action causes the polarization of the light passing through difficult material, so light must move faster than the above value .Refractive index of the material, the speed of light is reduced. High refractive index usually happens in high-density environments such as high density, indicating a high concentration of electron cloud that reduces the speed of light .First, we propose several optical concepts. A pulse represents a single piece of information is a broadcast system. Pulse, the manufacturer of hundreds or thousands of light particles known as photons are Usually the shape of the light pulses are characterized by a special type known as a Gaussian pulse.Optical pulses by a monochromatic light source such as a laser can be made. If the light source is quite monochromatic photons of the same frequency and make it through the photons are emitted at the same speed but in reality, a small thermal fluctuations and quantum uncertainty, which may hinder the monochromatic light source is properly .This means that the photons in a light pulse consists of a range of different optical frequencies is a result of the speed of photons is related to the frequency of a photon in a fiber It is located at a photon pulses with different speed than the other photons are transmitted component.

Kromatic Dispertion

One way to understand the concept of chromatic aberrations for optical transmission systems, first understand the nature of an optical pulse. If the photons that make up light pulse frequency and the different speeds are emitted, photons with photons faster than fast and pulse lag behind the wider disruption forward, of this phenomenon is called chromatic aberrations distribution is divided into two color

1)Normal distribution: the distribution, frequency short optical pulse shaping, higher frequencies travel faster and will overtake them

2)Non-normal distribution in this type of distribution, unlike the normal distribution, the higher the the frequency, the faster the frequency, the shorter runs and they are overtaking Hence disruption of the pulse dispersion widescreen color can be a big problem and is evident in fiber optic communication systems. A wide pulse relative to a main pulse peak intensity is much less clear that the problem is in the transmission of the pulse inside the fiber.

But colors scattering may not always be a bad thing , but getting flattened two adjacent pulses , they may be strengthened and coherent when connecting two pulses , the color dispersion unusual to Hedayat it may be obtain information about the optical solitons .

Light scattering, a fundamental mechanism for wave energy loss is from random fluctuations of the molecules is Dispersive medium, such as pulses of different frequencies travel at different speeds. As a result, the speed of the wave packet group velocity, will depend on the frequency. As a result, the wave packet will suffer dispersion , the group velocity of the scattered wave, the inherent properties of fiber comes from. This phenomenon, and the color dispersion fiber, called dispersive waveguide. If ω_0 and n_0 the natural frequency of the refractive index and the wave number k is a natural fiber, can be written as

$$k' = \frac{\partial k}{\partial \omega} = \frac{1}{V_g} = \frac{\partial}{\partial \omega}\left[\frac{\omega n_0(\omega)}{c}\right] = \frac{1}{c}\left[n_0(\omega) + \omega \frac{\partial n_0(\omega)}{\partial \omega}\right] \quad (1)$$

$$k'' = \frac{\partial k'}{\partial \omega} = \frac{1}{c}\left[2\frac{\partial n_0(\omega)}{\partial \omega} + \omega \frac{\partial^2 n_0(\omega)}{\partial \omega^2}\right] \quad (2)$$

k', k'' Equations (1) and (2) will depend on the wave frequency. The characteristics of the dispersive medium in which scattering occurs colors Color distribution of the electric field wave interaction with the bound electrons, which has a dielectric is due. In other words, the primary factor, the interaction of electrons bound state dielectric resonance frequency of passing wave of

We assume each particle bound fiber, the electrical power from the electric field of the wave, the size be displaced from its equilibrium position. As a result of this shift, bound electrons, are polarized. If N the electron is bound in a single volume, is the resultant polarization

$$\vec{P} = -Ne\vec{r} \quad (3)$$

On the other hand, one can write $\vec{F} = -e\vec{E} = k\vec{r}$ (4)

K is a constant force on the electron is The insertion of equation (4) in equation (3) can be written as

$$\vec{P} = \frac{Ne^2}{k}\vec{E} \quad (5)$$

If the electric field varies with time under the influence of a bound electron in an electric field can be damped harmonic oscillators are simple, the resulting differential equations are as follows

$$m\frac{d^2 r}{dt^2} + m\gamma\frac{dr}{dt} + kr = -eE \quad (6)$$

$m\gamma$ Attenuation of the friction force is proportional to the electron oscillation velocity shows. If we assume that the applied electric field and the dielectric bound electrons oscillate in tune with the times, and then fit the result of the equation (6) The would following simple

$$\left(-m\omega^2 - im\gamma\omega r + k\right)r = -eE \quad (7)$$

The relations (4), (5) and (7) will be closed the following polarization

$$\vec{P} = \left[\frac{Ne^2}{-m\omega^2 - im\omega\gamma + k}\right]\vec{E}$$

If $\omega = 0$ equation (7) as the stationary state of equation (5) becomes the Azay can say to a certain extent, the applied electric field and polarization, can change with time Considering the resonant frequency of the bound electrons $\omega_0 = \sqrt{\frac{K}{m}}$

The polarization can be written in a simpler

$$\vec{P} = \left[\frac{Ne^2/m}{\omega_0{}^2 - \omega^2 - i\gamma\omega}\right]\vec{E} \quad (8)$$

In this regard, a driving range, a harmonic oscillator because in fact, the elastic displacement of the polarization of bound electrons can therefore expect a resonant optical phenomena occur in the vicinity of the resonance frequency of the following, we will prove that this phenomenon intensified, a large change in refractive index of the medium and strong absorption of light at frequencies near the resonant frequency, or it becomes apparent.

To evaluate the effect of polarization of light emission, the general wave equation we consider

$$\vec{\nabla}\times(\vec{\nabla}\times\vec{E})+\frac{1}{C^2}\frac{\partial^2\vec{E}}{\partial t^2}=-\mu_0\frac{\partial^2\vec{P}}{\partial t^2}-\mu_0\frac{\partial\vec{J}}{\partial t} \quad (9)$$

For dielectrics, the conductivity of the second term is absent, and the following relations $\vec{\nabla}.\vec{E}=\frac{\rho}{\varepsilon_0}=-\frac{\vec{\nabla}.\vec{P}}{\varepsilon_0}\Rightarrow\vec{\nabla}.\vec{E}=0$ and $\vec{\nabla}\times\vec{\nabla}\times=\vec{\nabla}\vec{\nabla}.-\nabla^2$ (10)

We will

$$\nabla^2E-\frac{1}{C^2}\frac{\partial^2E}{\partial t^2}=-\mu_0\frac{\partial^2P}{\partial t^2} \quad (11)$$

By putting the value of equation (8) in equation (11) we have

$$\nabla^2E-\frac{1}{C^2}\frac{\partial^2E}{\partial t^2}=\mu_0\left[\frac{Ne^2/m}{\omega_0{}^2-\omega^2-i\gamma\omega}\right]\frac{\partial^2E}{\partial t^2}\Rightarrow$$

$$\nabla^2E=\frac{1}{C^2}\left[1+\frac{Ne^2}{m\varepsilon_0}\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega}\right]\frac{\partial^2E}{\partial t^2} \quad (12)$$

Assuming a wave of coordinated bed and answer the following homogeneous equation (12) we consider

$$-E_0k^2e^{i(kz-\omega t)}=\frac{1}{C^2}\left[1+\frac{Ne^2}{m\varepsilon_0}\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega}\right]\left(-\omega^2E_0e^{i(kz-\omega t)}\right)\Rightarrow \quad (13)$$

$$k^2=\frac{\omega^2}{C^2}\left[1+\frac{Ne^2}{m\varepsilon_0}\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega}\right] \quad (14)$$

Imaginary part in the denominator of the above equation, denotes the complex wave number, so we write it as follow $k=K+i\alpha$ (15) This is equivalent to a U-shaped complex refractive index $N=n+iK$ (16) The electric field (13) becomes as follows:

$$E=E_0e^{i(Kz+i\alpha z-\omega t)}=E_0e^{-\alpha z}.e^{i(Kz-\omega t)} \quad (17)$$

Equation (17) shows that the amplitude decreases exponentially. This means that the energy of wave propagation in the atmosphere is absorbed by the atmosphere.

Note that the of energy per wave at a given point proportional to the square of the amplitude of the wave energy, proportional to the absorption coefficient varies with distance from the imaginary part of the refractive index and of means that the call extinction coefficient. According to equation (17) shows that the phase velocity of the wave harmonic of a wave is defined as $V_P=\frac{\omega}{K}=\frac{C}{n}$ (18) And therefore $K=\frac{n\omega}{C}$ (19) And similarly, we can write $\alpha=\frac{K\omega}{C}$ (20) Thus, the relationship between the complex wave number and the complex refractive index is as follows: $k=\frac{\omega}{C}N$ (21) By inserting equation (21) in equation (14) we have

$$\frac{\omega^2}{C^2}N^2=\frac{\omega^2}{C^2}\left[1+\frac{Ne^2}{m\varepsilon_0}\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega}\right]\Rightarrow$$

$$N^2=1+\frac{Ne^2}{m\varepsilon_0}\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega} \quad (22)$$

In equation (22), the second the number of bound electrons N By inserting the equation (16) in equation (22) and separating the real and imaginary parts, we get

$$(n+iK)^2=1+\frac{Ne^2}{m\varepsilon_0}.\frac{1}{\omega_0{}^2-\omega^2-i\gamma\omega}.\frac{\omega_0{}^2-\omega^2+i\gamma\omega}{\omega_0{}^2-\omega^2+i\gamma\omega}$$

$$=1+\frac{Ne^2}{m\varepsilon_0}\left[\frac{\omega_0{}^2-\omega^2+i\gamma\omega}{\left(\omega_0{}^2-\omega^2\right)^2+\gamma^2\omega^2}\right]=1+\frac{Ne^2}{m\varepsilon_0}\left[\frac{\omega_0{}^2-\omega^2}{\left(\omega_0{}^2-\omega^2\right)^2+\gamma^2\omega^2}+i\frac{\gamma\omega}{\left(\omega_0{}^2-\omega^2\right)^2+\gamma^2\omega^2}\right]$$

Equal to the real and imaginary parts on both sides of this equation can be written as

$$n^2-K^2=1+\frac{Ne^2}{m\varepsilon_0}.\frac{\omega_0{}^2-\omega^2}{\left(\omega_0{}^2-\omega^2\right)^2+\gamma^2\omega^2} \quad (23)$$

$$2nK=\frac{Ne^2}{m\varepsilon_0}.\frac{\gamma\omega}{\left(\omega_0{}^2-\omega^2\right)^2+\gamma^2\omega^2} \quad (24)$$

$$E=E_0e^{i(kz-\omega t)}$$

The two equations (23) and (24), and both are frequency dependent. In such environments where the refractive index is related to the are wave frequency dispersive environments Refractive index for frequencies smaller than the unit is close to the resonant frequency, the frequency increases. This mode is called normal dispersion. At or near the resonant frequency, the refractive index decreases with increasing frequency. This mode is called anomalous dispersion.

Conclusions

Solitary waves (solitons) can lead to innovations in the 1 - psychiatric and medical technology systems. 2 - Telecommunications systems based on optical fiber cables more, systems that take advantage of the individual waves, are outlined. Solitary waves in a fiber optics requires that light intensity and wavelength of a hill, so the interaction can be characterized by a haracteristic nonlinear dispersion compensated 3- Solitary waves (solitons) can be caused by innovations in technology. More optical telecommunication systems based on optic cables, systems that take advantage of the individual waves, are planning. Solitary the waves in a blurry light, the intensity and wavelength of light required Tphayy such interactions may be characterized by a characteristic nonlinear dispersion to be compensated.

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