ABSTRACT

In our model, the electromagnetic field and the dopant atoms are described quantum mechanically. The resulting solitary waves take the form of ultra short (picoseconds) laser pulses which propagate through fiber doped with rare earth atoms such as Erbium; solitary wave formation involves the combined effects of group velocity dispersion (GVD), nonlinearity and resonant interaction with dopant atoms .We drive the nonlinear Schrödinger wave equation(NLSE)for single mode optical fiber laser.

Pulse amplification is governed by a (NLSE) that includes gain saturation, gain dispersion, fiber dispersion, fiber nonlinearity and the detuning effects occurring when the carrier frequency of the input pulse does not coincide with gain peak.

We present theoretical study of Saturable Absorption mode locking technique with self phase modulation (SPM) in a unidirectional ring cavity.

The pulse propagation in fiber laser requires chirping, our results show the conditions which the fiber laser require to produce soliton pulses. The stability of the soliton takes place after 30 loops.

The effect of cross phase modulation (XPM)on the evolution of co propagating ultra short pulses in an optical fiber laser is discussed theoretically by solving the coupled nonlinear Schrödinger equations which include the contribution of self phase modulation ,cross phase modulation ,group velocity dispersion and gain dispersion .The separation time between two neighboring solitons is important to determine how close two solitons can come without affecting each other .Interaction between two solitons has been studied analytically .Our

result shows the initial separation time J=4 ps between two solitons is necessary to avoid soliton interaction for 30 loops.

The modulation instability in erbium doped fiber laser is studied through a stability analysis of the underlying nonlinear Schrödinger equation .Modulation instability generates multiple pulses when a single pulse is amplified .It can also create multiple sub pulses in mode locked fiber lasers

Our results show continuous wave optical signal converted into a train of high repetition rate depend on the gain dispersion and nonlinearity.

When a high power optical signal is launched into a fiber laser the linearity of the optical response is lost. One such nonlinearity effect, which is due to the third order electrical susceptibility is called four wave mixing (FWM) and occurs when two pump powers is lunched into a fiber laser. This work notes how to transfer energy from a strong pump wave to signal wave, our result shows the gain responsible (parametric gain) depends on the pump power and net phase mismatch and it is increasing with increasing the nonlinearity and the gain becomes maximum when the linear mismatching is equal to the nonlinear mismatching.

Supervisors Certification

We certify that this thesis was prepared under our supervision at the University of Al-Mustansiriyah - College of Science - Department of Physics, in partial fulfillment of the requirements for the degree of ph.D of Science in Physics.

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Studying Some of the Nonlinear Effects in Fiber Laser

A Thesis
Submitted to the College of Science, Department of Physics– Al-Mustansiriyah University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy of Science in Physics

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