

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 $T=4$ ps between two solitons is necessary to avoid soliton interaction for 30 loops.

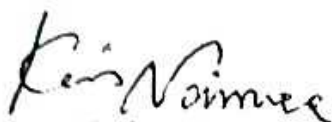
The modulation instability in erbium doped fiber laser is studied through a stability analysis of the underlying nonlinear Schrödinger equation. Modulation instability generates multiple pulses when a single pulse is amplified. It can also create multiple sub pulses in mode locked fiber lasers.

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 launched 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.

Signature: 
Dr. Kias A. AL-Naimee
(Asst. Prof.)


Date: 19 / 12 / 2005
*


Signature:

Dr. Ali Abid D. Al-Zuky
(Asst. Prof.)

Date: / / 2005

In view of the available recommendation, I forward this thesis for debate by the examining committee.

Signature: 
Name: Dr. Kadhem H. Al-Mosawiy
(Asst. Prof.)

Head of Physics Department

Date: / / 2005

Examination Committee Certification

We, the members of examining committee, certify that reading this thesis entitled "Studying some of the nonlinear effects in fiber laser" and examining the student "Younis Mohamed Atiah" in its contents, think it is adequate with "for awarding the degree of Doctor of Philosophy of Science in Physics, and with degree "Excellence".

Signature: *I. S. Al-Nakeshli*

Name : *Dr. Inaam S. Al-Nakeshli*

Title : *Professor*

Address : College of Education Al-Mustansiriyah University

Date : / / 2006

Signature: *Ali A-K. U.*

Name : *Dr. Ali A-K. Hussain*

Title : *Professor*

Address : College of Science
University of Baghdad

Date : / / 2006

Signature: *Ahmed*

Name : *Dhia H. Al-Ameidy*

Title : *Professor*

Address : College of Science Woman
University of Baghdad

Date : / / 2006

Signature:

Name : *Dr. Kais Al-Naimee*

Title : *Assist Prof.*

Address : College of Science

University of Baghdad

Date : / / 2006

Signature: *K. ahmad*

Name : *Dr. Khalid A-Ahmed.*

Title : *Professor*

Address : College of Science

University of Al-Mustansiriyah

Date : / / 2006

Signature: *Dr. Hassan A. Hassan*

Name : *Dr. Hassan A. Hassan*

Title : *Researcher*

Address : Ministry of Science and Technology

Date : / / 2006

Signature: *Dr. Ali A.-D. Al-Zuky*

Name : *Dr. Ali A.-D. Al-Zuky*

Title : *Assist Prof.*

Address : College of Science

University of Al-Mustansiriyah

Date : / / 2006

Approved by the Al-Mustansiriyah University committee of graduate studies,

Signature: *K. H. Al-Mosawi*

Name : *Dr. Kadhem H. Al-Mosawi*

Title : *Professor.*

Address : Dean of College of Science

Date : / / 2006

Republic of Iraq
Ministry of Higher Education
and Scientific Research
Al-Mustansiriyah University
College of Science



Studying Some of the Nonlinear Effects in Fiber Laser

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Philosophy of Science in Physics

By

Younis Mohamed Atiah Al-zahy

(B.Sc.1994) Al-Basrah University, Iraq

(M.Sc.2000) Al-Mustansiriyah University, Iraq

Supervisors

Dr.Kais A. AL-Naimee

Dr.Ali Abid D.AL -Zuky

1427 A.H.

2006 A.D