Thesis Title of Master: Chaos in Laser

ABSTRACT

In this work we present an intensive study to the chaos phenomena that different types of laser suffer from. Lasers are divide according to relaxation rates of electric field, k, γ polarization, γ ,and population inversion, , to three categories: Class A, Class B, and Class C.

Lasers behavior can be described by three equations (Maxwell Bloch Equations) which are similar to the Lorenz equations that describe bconvective motion of fluids. When $k \sim \gamma \sim \gamma$ lasers are described by this same set of equations and by two equations when γ k, γ and by one equation when γ, γ k. Three degrees of freedom are needed to assure the occurance of chaos, hence modifications are needed to the two sets of equations that describe Class A and B. To study chaos detuned Ammonia laser (FIR) was chosen as a candidate of Class C which makes the M.B. equations complex. This changes M. B. equations to five coupled equations. The effect of random dynamics on Lorenz equations was studied too through the addition of mathematical functions with the effect of a cloud of initial conditions. The effect of modulation of the pump parameter is presented too. CO_2 laser was chosen to represent Class B. T0 ensure the number of degrees needed to reach chaos, a modulation of losses is added. He-Ne laser represented Class A. Modulation of both population inversion and electric field was added to ensures chaos. All set equations were solved using the Runge-kutta numerical method. Emphasis given to study types of attractors, frequency contents in output of lasers using the fast fourier transform (FFT) technique, bifuractions and attractors that was generated using retardation processes presented too.