NUMERICAL STUDY OF BIFURCATIONS IN QUANTUM DOT LASERS

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This project is a continuation of research on the area of numerical studies of nonlinear delay differential equations in the area of semiconductor laser instabilities. These instabilities typically arise from optical feedback resulting from coupling radiation into a fiber. The premier model in the understanding of this dynamics is the well-known Lang-Kobayashi DDEs. This set of equations has been extensively studied by numerical, analytical and qualitative methods, but a complete understanding is still lacking.

In 1980, Lang and Kobayashi formulated a model consisting of two delay differential equations for the complex electrical field E and the carrier number N. Numerical simulations have shown that these equations correctly describe the experimentally observed dominant effects. The equations are given by

$$dE/dt = (1+i\alpha)NE+\eta\, e^{-i\omega\tau} E(t-\tau)$$
$$T\, dN/dt = P-N-(1+2N)|E|^2$$

Here α is the linewidth enhancement factor, ω is the angular frequency of the solitary laser, T is the ratio of the carrier lifetime to the photon lifetime, η is the external feedback level, P is the dimensionless pumping current and τ is the external cavity round-trip time.

A very interesting question which we investigate is the behavior of a brand new technology, quantum dot lasers. These lasers have an ultra small linewidth enhancement factor. We explore the possibility of the above described phenomena for quantum dot lasers.