NUMERICAL STUDY OF BIFURCATIONS FOR MUTUALLY DELAY-COUPLED SEMICONDUCTOR LASERS

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Our primary research focus is on equations modeling the behavior of external cavity semiconductor lasers. Semiconductor lasers offer many advantages not only due to their compact size but also because of their enormous application in various fields, particularly in optical data recording and optical fiber communications. A new and exciting case is the simple setup of two mutually delay-coupled semiconductor lasers in a face-to-face configuration. This system is of great importance as it is seen as the basic model for the dynamics of coupled semiconductor lasers. The present technological trend is the integration of semiconductor lasers into more complicated optical devices in microprocessors and in the future for the use of all-optical signal processing.

In non-dimensional form the equations for the complex electrical fields E and the carrier numbers N are

$$dE_1/dt = (1+i\alpha)N_1 E_1+\eta e^{-i\omega\tau} E_2(t-\tau)-i\Delta E_1$$
$$dE_2/dt = (1+i\alpha)N_2 E_2+\eta e^{-i\omega\tau} E_1(t-\tau)+i\Delta E_2$$
$$TdN_1/dt = P-N_1-(1+2N_1)|E_1|^2$$
$$TdN_2/dt = P-N_2-(1+2N_2)|E_2|^2 .$$

Here α is the linewidth enhancement factor, ω is the average of the lasers' optical angular frequencies, T is the ratio of the carrier lifetime to the photon lifetime, η is the external feedback level, P is the dimensionless pumping current, τ is the external cavity round-trip time and Δ is the detuning between the lasers.

We try to identify parameter domains which allow for Hopf bifurcations in the case of delay-coupled lasers. Certain parameter domains were not studied extensively before, and we hope to illustrate that some areas exhibit interesting mathematical and physical behavior.