Theoretical modeling of the dynamics of a semiconductor laser subject to double-reflector optical feedback

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Abstract

We theoretically model the dynamics of semiconductor lasers subject to the double-reflector feedback. The proposed model is a new modification of the time-delay rate equations of semiconductor lasers under the optical feedback to account for this type of the double-reflector feedback. We examine the influence of adding the second reflector to dynamical states induced by the single-reflector feedback: periodic oscillations, period doubling, and chaos. Regimes of both short and long external cavities are considered. The present analyses are done using the bifurcation diagram, temporal trajectory, phase portrait, and fast Fourier transform of the laser intensity. We show that adding the second reflector attracts the periodic and perioddoubling oscillations, and chaos induced by the first reflector to a route-to-continuous-wave operation. During this operation, the periodic-oscillation frequency increases with strengthening the optical feedback. We show that the chaos induced by the double-reflector feedback is more irregular than that induced by the single-reflector feedback. The power spectrum of this chaos state does not reflect information on the geometry of the optical system, which then has potential for use in chaotic (secure) optical data encryption.

Keywords

KeyWords Plus: COHERENCE COLLAPSE; NUMERICAL-ANALYSIS; EXTERNAL FEEDBACK; CHAOS; FLUCTUATIONS; INTENSITY; ROUTE

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