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Semiconductor Quantum-Dot Lasers with Optical Feedback

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In this work we investigate the complex dynamics of semiconductor quantum dot (QD) lasers subjected to weak external optical feedback from a distant mirror, which generating a time-delayed feedback term. The system is modeled with a modified Lang-Kobayashi equation for the electric field combined with microscopically based rate equations for the carriers in the quantum dots and surrounding wetting layer.

By varying the feedback strength we obtain complex bifurcation scenarios. For large linewidth enhancement factors ($\alpha>3$) we find a bifurcation cascade leading to chaotic regions alternating with short regions of stable steady state (cw) operation. This resembles the behaviour found in quantum well lasers. However, for low $\alpha$-factors ($\alpha\approx 1$), typical for QD devices, the laser exhibits a reduced feedback sensitivity and performs stable cw operation over a wide range of increasing feedback strength.

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