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Dynamics of single mode semiconductor lasers with passive dispersive reflectors

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Abstract

We discuss the impact of a passive dispersive reflector (PDR) on the dynamical behaviour of a single mode diode laser. It is shown that the PDR enters the single mode equations via two specific functions of the carrier density. Depending on the parameters of these functions, the resonance frequency of the laser as well as the damping of its relaxation oscillations become modified. A bifurcation analysis yields both subcritical and supercritical Hopf-bifurcations separating regions of stationary and self-pulsating operation. On this basis the conditions for achieving high self-pulsation frequencies with a large modulation depth are derived.

Keywords: Semiconductor laser; Distributed feedback; Modelling; Dispersive reflector; Self-pulsations; Switching

1. Introduction

Optical feedback can considerably influence the dynamical behaviour of a semiconductor laser. Already simple reflections at distant external mirrors like fiber connectors can cause interesting phenomena as, e.g., coherence collapse, low frequency fluctuations, or self-pulsations (SP). These phenomena have been investigated intensively since many years (see, e.g., [1–3] and references therein).

In this paper, we focus on a situation where the feedback comes from a Bragg grating that is integrated together with the laser within a compound and compact device as sketched in Fig. 1. The main differences to typical external mirrors are the extreme short separation between laser and reflector, typically few hundred μm, and the dispersion of the Bragg reflector. Similar devices are used for generating high-frequency single mode self-pulsations [4] and serve very successful as optical clock in all optical data regeneration [5]. The basic dispersive self-Q switching mechanism of these SP is well understood [7–9]. In contrast to Fig. 1, however, the DFB reflector sections of these devices are *active*, i.e., they are contacted and a pump current is ap-

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