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Investigating the Dynamics of Quantum Well and Quantum Dot Semiconductor Lasers in the Presence of Injection Current Modulation

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Abstract:

we compare the dynamics of both quantum dot and quantum well semiconductor lasers in the presence of injection current modulation through the variation of level of the dc and ac parts of the injection current and the modulation frequency . The addition of the third degree of freedom enhances vast range of dynamics ranged from periodic to chaotic . Obtained results proved the similarities and discrepancies in the dynamics of both lasers.

Keywords: Quantum dot lasers , Quantum well lasers , Injection current modulation , Periodic dynamics , Chaos.

1 . Introduction

Semiconductor lasers (SCLs), are widely used as the coherent light sources for technological applications such as capacity optical transmission and ultra fast optical processing .They are preferable to any other types of lasers in the field of optical communications because of their compactness , low cost and convenience of operation . Another advantage of SCLs is the opportunity for direct modulation of its injection current .The influence of current modulation on the dynamics of SCLs is of interest for many applications[1-2] . The short optical pulses required for optical communications can be generated by the modulation of input current since SCLs in general are candidates for class B lasers [3]. They lack the third degree of freedom needed for any system to show all kinds of instability and chaos. In class B lasers the

polarization of the laser medium vanishes quickly since the relaxation rate of laser medium polarization γ_L is much large than that of the electric field k , and population inversion γ_I , so that the laser system is left with two degrees of freedom only [3]. The power output of any SCLs depends on the injection current , and so the modulation of the SCLs injection current results in the modulation of the power output of the laser. Since the refractive index of active medium of the SCLs and its cavity length depend on the SCL injection current there takes place both the amplitude and frequency modulation of the laser radiation spectrum [4]. Most SCLs dynamics were tested against the injection current modulation extensively [5-7] while the quantum dot QD semiconductor lasers injection current modulation have