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Recent advances in optically-injected Q-cascade lasers

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Quantum(Q) Cascade lasers offer many advantages such as compactness and high power while operating in single or multimode, pulsed or continuous wave mode and can be widely used in optical communications, high-resolution spectroscopy, imaging, and remote sensing. The dynamics of Q-Cascade lasers is controlled by the ultrafast carrier lifetime, which is on the order of picoseconds. The combination of optical nonlinearities and ultrafast dynamics being one of the major characteristics of Q-Cascade, nonlinear dynamics studies are extremely relevant for understanding the underlying physics as well as for the next generation of Q-Cascade devices. A particular feature of Q-Cascade lasers is the clear absence of relaxation oscillations, which comes as a consequence of the relatively large carrier lifetime compared to the photon lifetime. Although injection locking is a known to be a robust technique for synchronizing a free-running laser (slave) to another one (master) having a higher spectral purity and frequency control, its application to Q-Cascade lasers operating under external control. In order to do so, the developed rate equations take into account the upper and lower lasing levels, the bottom state as well as the gain stage cascading in the carrier dynamics. Numerical calculations dealing with complex bifurcation scenarios, stability maps and laser's modulation dynamics will be presented and discussed in details. Nonlinear dynamics studies being of prime importance for the performance enhancement of Q-Cascade lasers, an optical injection-locked experiment is currently under development. To this end, preliminary experimental results could be also presented at the time of the conference.

Biography

Frederic Grillot (SM IEEE & SPIE) received MSc in Physics from the University of Dijon, France (1999), PhD in Electrical Engineering from the University of Besançon, France (2003) and the Research Habilitation in Physics from the University of Paris VII, France, (2012). He is currently an Associate Professor at Telecom Paristech (formerly Ecole Nationale Supérieure des Télécommunications), France. He is the author or coauthor of 52 journal papers, one book, two book chapters, and more than 110 contributions in international conferences. His current research interests include semiconductor lasers, quantum optoelectronics, ultrafast optics, nanostructure materials as well as nonlinear photonics studiesfor optical communications and microwave photonics applications.

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