Temporal Localized Structures in Degenerate-Cavity Lasers: from Patterns to Spatio-Temporally Reconfigurable Light

A Bartolo[1,2], N Vigne[2], M Marconi[1], G Beaudoin[3], K Pantzas[3], L Le Gratiet[3], I Sagnes[3], S Gurevich[4], F Maucher[5], J Javaloyes[5], A Garnache[2], and M Giudici[1]

[1]*Institut de Physique de Nice, Université Côte d'Azur, Nice, France*
[2]*Institut d'Electronique et des Systèmes, Univ. Montpellier, Montpellier, France*
[3]*Centre for Nanosciences and Nanotechnology, Universite Paris-Saclay, CNRS, Paris, France*
[4]*Institute for Theoretical Physics, , University of Munster, Munster, Germany*
[5]*Departament de Física and IAC-3, Universitat de les Illes Balears, Palma De Mallorca, Spain*
Contact Email: massimo.giudici@inphyni.cnrs.fr

Spatiotemporal mode-locking is a promising lasing regime for developing coherent sources for multi-mode nonlinear photonics. We show that a degenerate-cavity Vertical External-Cavity Surface-Emitting Lasers (VECSELs) can be operated in this regime. The emitted pulses exhibit a spatial profile which depends on the resonator parameters. Approaching the self-imaging condition, we observe mainly two kinds of non homotetic patterns: hexagons and rolls. These pulsating patterns are temporally localized, *i.e.*, they can be individually addressed by shining optical pump pulses. Our result reveals that large-aspect-ratio VECSELs offer unique opportunities for studying fully developed spatiotemporal dynamics and for applications to multidimensional control of light. As an example, we provide a proof of principle of a VECSEL capable of generating spatio-temporally reconfigurable light.