

# Introduction to the issue on Physics and Applications of Laser Dynamics (IS-PALD 2013)

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**Abstract:** We introduce the Optics Express special issue of the 3rd symposium on Physics and Applications of Laser Dynamics (IS-PALD). This issue consists of expanded papers related to oral and poster presentations. Selected papers represent the best of IS-PALD 2013.

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As Guest Editors we are pleased to introduce this focus issue on Physics and Applications of Laser Dynamics. This issue collects original peer-reviewed papers related to oral or poster contributions of the International Symposium IS-PALD held in Paris on October 29–31, 2013. This symposium is the third of a series of symposia on laser dynamics organized in collaboration between France and Taiwan. The 2013 edition was cochaired by Frédéric Grillot, Associate Professor at Telecom ParisTech (France), and Marc Sciamanna, Professor at Supélec (France). Both conference chairs have greatly contributed to the field of laser physics, dynamics, and applications and have organized and chaired several conferences in this field.

This special issue covers new research topics and state-of-the-art developments in the area of semiconductor lasers, nonlinear dynamics, ultrafast laser dynamics, and related photonic devices including quantum dot and dash semiconductor materials, mode-locked lasers, vertical-cavity surface-emitting lasers, and quantum cascade lasers. All 14 contributions to the focus issue are written by international researchers who comprehensively treat various topics describing some of the most exciting work in the field and are a testament to the creativity and continuing vitality of the subject area.

Several contributions report on new physics explaining experimentally observed laser nonlinear dynamics. For example, Lin *et al.* confirm a long-standing theoretical prediction of so-called elliptically polarized injection locking in a VCSEL subject to optical injection. Virte *et al.* report on one of the few experiments showing self-pulsating polarization dynamics in a free-running VCSEL, but with additional bistability between two self-pulsating dynamics of slightly different frequencies. Interestingly, the dynamics of a laser diode with external modulation and time-delayed feedback is analyzed by Aragonés *et al.* in the context of symbolic dynamics.

Other contributions revisit several well-known issues related to laser diode nonlinear dynamics. First, Lenstra *et al.* make a self-consistent theoretical derivation of a rate equation model for a multimode laser diode that explains several of the antiphase mode dynamics observed experimentally. Friart *et al.* report on a new, in-depth analysis of the Hopf bifurcation that explains polarization square-wave switching in a laser diode with polarization rotated optical feedback. New experimental measurements are reported by Romanelli *et al.* and contribute to a systematic analysis of the synchronization properties of driven oscillators

across a Hopf bifurcation. Chuang *et al.* analyze how the measurement of the linewidth enhancement factor in a laser diode is influenced by the parameters of an external optical feedback. Finally, several other papers contribute to our improved knowledge of the laser diode device physics. Lingnau *et al.* analyze the influence of the carrier scattering dynamics on the phase-amplitude coupling parameter. Lester *et al.* explain optical injection experiments in a quantum dash laser by the contribution of the laser differential gain. Through Monte Carlo modeling, Chusseau *et al.* present new results on the steady-state dual-mode regime that is theoretically predicted for specially designed quantum dot semiconductor lasers thereby acting as a CW microwave or terahertz-beating source, whereas it does not occur for quantum well lasers. Gosset *et al.* propose an asynchronous under-sampling technique used for extracting periodic signals, particularly those generated in nonlinear dynamical systems and to retrieve intrinsic features of periodic signals that are contaminated by noise or unwanted perturbations. Columbo *et al.* pioneer the investigation of the self-injected quantum cascade lasers showing that coherent multimode oscillations can arise under optical feedback with spontaneous phase-locking.

Read *et al.* report a new gain characterization method that is applied to an optically pumped continuous-wave InGaAs-GaAs quantum well VECSEL to measure its gain bandwidth and curvature. The method does not require a tunable probe laser source and also allows for the observation of semiconductor laser build-up dynamics in the class-A regime. Finally, Moloney *et al.* present experimental and theoretical research to reach ultrafast femtosecond timescale dynamics with VECSEL by employing different types of saturable absorbers and Kerr Lens elements. Microscopic simulations within the Maxwell Bloch semiconductor equations are used to model the laser dynamics.

This focus issue would not have been possible without the professionalism, dedication, and expertise of all the members of the OSA publication team. In particular, the Guest Editors would like to express thanks to the authors, both invited and contributed, for submitting comprehensive and thought-provoking papers. Special thanks go out to the international peer reviewers who donated their time and skill to maintain the technical quality of this special edition while also staying within tight deadlines. We would like to also specially thank the OSA staff for their assistance and support. The conference coauthors acknowledge Professor Yung-Fu Chen for assisting them as an associate editor of *Optics Express* to select the contributed papers of this focus issue. Finally, the Editors would like to thank Professor Andy Weiner from Purdue University (USA), Editor-in-Chief of *Optics Express*, for inviting us to serve the semiconductor laser community and for helping us complete this challenging, yet enjoyable task.