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EDITED AND REVIEWED BY
Costantino De Angelis,
University of Brescia, Italy

*CORRESPONDENCE
Anbang Wang,
abwang@gdut.edu.cn

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Editorial: Semiconductor laser dynamics and its applications

Anbang Wang[1]* and Cheng Wang[2]

[1]School of Information Engineering, Guangdong University of Technology, Guangzhou, China, [2]School of Information Science and Technology, ShanghaiTech University, Shanghai, China

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Editorial on the Research Topic
Semiconductor laser dynamics and its applications

This Research Topic focuses on the dynamics and nonlinear dynamics of semiconductor lasers as well as the applications. Over the past 30 years, semiconductor laser dynamics have undergone significant development. Rich dynamical phenomena, such as periodic oscillation, low-frequency fluctuation, spiking, chaos, and synchronization have each been detected. Notably, semiconductor laser dynamics have been incorporated into a significant number of applications, such as secure communication, optical measurement, microwave generation, and photonic information processing. In line with the ongoing development of semiconductor lasers and their updated application requirements, research focused on laser dynamics and its applications will continue to expand, introducing novel devices and methods.

This Research Topic comprise three articles, which provide insight into the state of the art of semiconductor laser dynamics. Xiao et al. report a chaotic microlaser without any external perturbations. The physical mechanism of the chaos generation originates from the internal mode interaction of nearly degenerate modes. Based on this self-chaotic laser source, physical random number generation as fast as 10 Gb/s is successfully demonstrated. On the other hand, Chomet et al. present a spontaneous mode locking laser without any saturable absorbers. Continuous wave generation of picosecond pulses at a rate of 100 GHz is demonstrated, and the timing jitter of the pulse trains is as low as 110 fs. Through a theoretical model analysis, the physical mechanism is attributed to the interplay between self-phase modulation and anomalous dispersion together with light-matter interaction-induced time symmetry breaking. In addition, Roos et al. discuss the spontaneous emission noise resilience of the phase locked operation of delay-coupled nanolasers. The numerical result reveals that a polarization dephasing time of two to three times the cavity photon lifetime maximizes the system's ability to remain phase-locked in the presence of noise-induced perturbations. The strong parameter dependence of the noise tolerance is helpful for the design of robust on-chip integrated networks of nanolasers.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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