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Eliminating dual-polarization laser emission and spatial hole burning by using parity-time-symmetric eigenstates

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Spectral purity in laser emission is key for several applications such as remote sensing, non-linear optics and laser spectroscopy. However, producing single mode emission at high power in free-space, standing-wave resonators is challenging. Nanostructured laser mirrors can be used to achieve that in compact microchip monolithic laser resonators without using any additional intra-cavity element [1,2]. For instance, using a pair of mirrors displaying a π phase shift between orthogonal polarization states at reflection produces the twisted mode operation, which allows one to eliminate the contrast of the standing wave inside the cavity and makes it possible to eliminate multi-longitudinal mode operation originating from axial spatial hole burning. However, dual-polarization emission remains an issue if there is no mechanism to suppress competing polarization states, and this may give rise to unstable emission, in addition to producing dual frequency emission. In this presentation, we propose a resonator made of anisotropic mirrors displaying both birefringence and diattenuation as a mean to eliminate both spatial hole burning and dual polarization emission. The relative angle of the two mirrors' principal axes is adjusted such that the laser operates just at the transition between broken and unbroken parity-time symmetric polarization states. At this transition point, the two eigen-polarization states are found to merge to a single state, called an exceptional point, while the counter-propagating waves are orthogonal, and no spatial hole burning takes place [3]. Hence, microchip PT-symmetric states are an attractive option to achieve single mode operation from a miniature microchip laser without the need to introduce any additional intracavity element.

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Author: BISSON, Jean-Francois

Co-author: Mr NONGUIERMA, Yves Christian (Université de Moncton)

Presenter: BISSON, Jean-Francois

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