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Putting Spin into Lasers[1]

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Considering circular polarization, an optical analog of electron spin, semiconductor lasers with spin-polarized carriers can open up unexplored possibilities for spin-controlled devices. Once spin-polarized carriers are introduced in the gain region of lasers, by circularly polarized light or electrical spin-injection, the operation of such spin-lasers should be revisited to incorporate their novel properties. Spin-polarized carriers can enhance the performance of lasers for communication and signal processing [1]. In the steady-state, such spin-lasers already demonstrated a lower threshold current for the lasing operation [2] compared to their conventional (spin-unpolarized) counterparts, however, the most exciting opportunities come from their dynamical operation. We reveal that the spin modulation in lasers can lead to an improvement in the two key figures of merit: enhanced bandwidth [3] and reduced parasitic frequency modulation—chirp [4]. Analyses are carried out under generalized modulation regimes we propose. Different mechanisms for quantum dots and quantum wells as a gain medium are also discussed and we provide a mapping between the two gain media. Spin states in quantum dots may also enable elusive phonon lasers [5], which emitts coherent phonons instead of photons. This work was performed in collaboration with R. Oszwałdowski, C. Gøthgen, G. Boeris, and I. Žutić.

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