Coherent diffusive photonics and the photon gun

N. Korolkova[1]
[1] *School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews KY16 9SS, United Kingdom*
E-mail: nvk@st-andrews.ac.uk

We present a robust deterministic generator of sub-Poissonian states of light using engineered dissipative coupling. This specific kind of loss induces irreversible dynamics, which robustly and deterministically drive a wide range of initial states toward the same specified state. In this scheme, the few-photon and ideally the single-photon states can be produced on demand from a classical input [1]. The key element here is nonlinear loss [1,2] leading to two-photon absorption mechanism, which results in the rapid narrowing of the photon number distribution shifting it toward the single-photon state. The proposed quantum source is based on a novel paradigm in photonic devices: coherent diffusive photonics [3] operating with dissipatively coupled optical waveguides. We show that light can flow diffusively while retaining coherence and even entanglement, can be effectively equalized and distributed in a controlled way by means of dissipative coupling [3]. Quantum thermodynamically, these systems can act as catalytic coherent reservoirs by performing perfect non-Landauer erasure. For lattice structures, localised stationary states can be supported in the continuum, similar to compacton-like states in conventional flat-band lattices. Such unique light propagation regimes can be realized with the help of a photonic analogue of a tight-binding lattice using coupled waveguide networks in linear and non- linear glass materials. The decisive role is played by the linear and nonlinear engineered loss. These coherent photonic devices are fabricated by ultrafast laser inscription. The dissipative coupling is realised by coupling each pair of the waveguides carrying optical signal to a linear chain of waveguides that act as a dissipative reservoir. We expect coherent diffusive photonic devices to find applications in photonic networks and in a range of metrology tasks, potentially also for simulations of complex quantum dynamics.

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