Coherent Diffusive Photonics: Quantum engineering by nonlocal loss.

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Coherent Diffusive Photonics (CDP) [**1**] emerges from a combination of collective behaviour through coupling to the common environment and coherence supported through an engineered nonlinear loss mechanism. The combination of these opposites allows for coherent light control that can be exploited in simulation of complex quantum dynamics in open systems or to design practical deterministic integrated sources of non-classical light [**2**, **3**] with previously inaccessible operational regimes.

The key element here is engineered nonlocal loss, where we also leverage nonlinear dynamics. Engineered loss has already turned into a powerful and intensively researched tool for quantum state manipulation. However, it is considerably harder to engineer losses in photonic circuits. In this work we exploit the effects of nonlocal and nonlinear loss, in the first-place nonlinear coherent loss, and devise photonic circuits with unusual and attractive features. The core element is a system of bosonic modes coupled pairwise to a common reservoir. Crucially, the dissipation into these reservoirs is nonlinear in field operators. That is, in the master equation, the Lindblad operator is in general a nonlinear function of bosonic creation and annihilation operators and the exact form of this function is a handle to unlock a particular type of quantum dynamics in this open system and to attain a particular quantum state at the output. In this talk, I will present the theoretical foundations for Coherent Diffusive Photonics and discuss several schemes for integrated quantum sources and optical routing devices based on CDP and will outline the ideas for topological effects in the system. As an example, the schematic of CDP-based source of path-entangled photon pairs with a unique pump self-rejection mechanism is shown in Fig. 1.

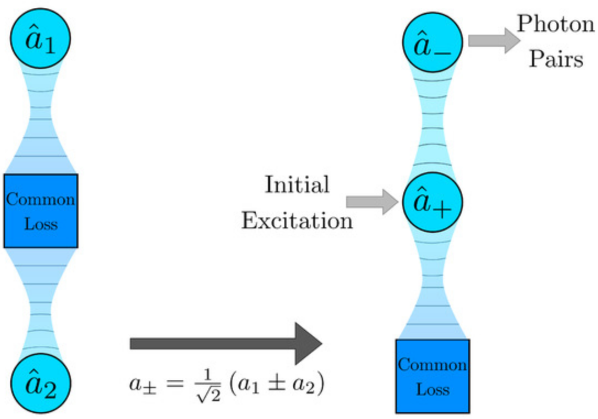

FIG. 1: The scheme of the photon-pair generator on the basis of two single-mode waveguides coupled to the common loss reservoir. Note that nonlinear loss mechanism leads to an efficient decay of $\hat{a}_+$ mode enabling efficient in-built pump rejection, whereas $\hat{a}_-$ containing entangled photons is preserved.

References

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