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(G*) POS-H76 – Continuous-variable entanglement in a ring resonator: An analytic solution

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We prove that the state created via spontaneous parametric downconversion in a two-mode lossy cavity is a squeezed thermal state. We examine the case of generation in a side-coupled ring resonator.

In the context of quantum optics, two-mode squeezed states are routinely used as a source of continuous-variable (CV) entanglement for applications in the field of quantum information [1]. They can be generated via a nonlinear interaction such as spontaneous parametric downconversion (SPDC), where a strong coherent pump field interacts with a material that has a $\chi^{(2)}$ nonlinearity. The resulting squeezed light exhibits correlations between the quadratures of photons in the two modes.

In this work, we model the nonlinear generation of a squeezed state inside a lossy multimode cavity using the Lindblad master equation and show that the exact solution to this model is a two-mode squeezed thermal state, with time-dependent squeezing amplitude and thermal photon number in each mode. We also derive an analytic expression for the entanglement between the modes, and calculate the degree of entanglement in a side-coupled ring resonator.

These results will be of use to researchers that are trying to optimize CV entanglement in lossy cavities when the losses of each mode are different.

[1] Samuel L Braunstein and Peter Van Loock. Quantum Information with Continuous Variables.Rev. Mod.Phys., 77:513, 2005.

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