How A single Polariton Condensate can recognize Quantum States

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Modern computing is at the edge of two revolutions. Quantum technologies are expected to prove their value for practical problems in the near future. Oftentimes, the platform on which such a technology is implemented requires optical quantum states. It is then a crucial task to characterise these states [5]. The second revolution involves neural networks [3]. While Neuromorphic architectures have largely remained in obscurity in the past compared to the von-Neumann architectures of typical computers; the situation may change with the now growing spread of Generative AI.

As neuromorphic computing is excellently suited for pattern recognition tasks, it is a natural candidate for the task of recognising optical quantum states [4]. At the same time, we are still in the Noisy-Intermediate Scale Quantum (NISQ) regime, meaning that fluctuations from the environment cannot be dismissed, and a certain simplicity and robustness of the setup is required [2], which may seem difficult to reconcile with the typical observation that a performant network requires many degrees of freedom.

During this talk, I will present some of our recent results on how to achieve this neuromorphic state recognition with only a single polariton microcavity [1]. We show that network nodes don't need to be physically sepatated. From only the spectrum of the condensate (i.e. the frequency modes), squeezed states can be characterized through reservoir computing. This approach is robust also in the sense that limited fine-tuning of the microcavity parameters or the pumping scheme is required.

Depending on time, I will go deeper into the theoretical modeling of the continuous injection of the quantum states into the reservoir.

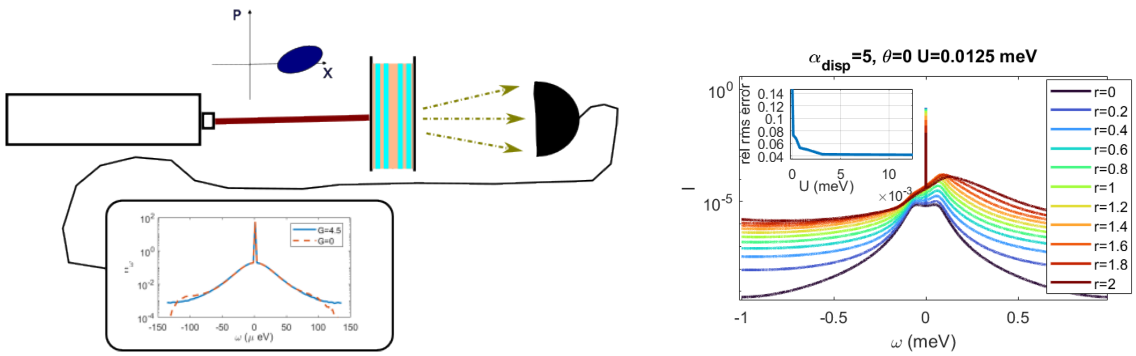

Figure 1: Left: A squeezed state is continuously injected into a polariton microcavity. The output spectrum of the cavity is then analysed to learn the squeezing properties. Examples shown of OPO spectra. Right: Examples of spectra for directly generated squeezed states for different squeezing values. Inset: polariton nonlinearity reduces the error.

Acknowledgments

This work was funded by the Quantum Optical Networks based on Exciton-polaritons" (Q-ONE, N. 101115575, HORIZON-EIC-2022-PATHFINDER CHALLENGES EU) project

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