# Experimental Quantum Excitation of a Quantum Emitter

**L. M. Hansen[1], J. C. López Carreño[2], I. Arrazola[3], and J. C. Loredo[1]**

[1] *Vienna Center for Quantum Science and Technology (VCQ) and Christian Doppler Laboratory for Photonic Quantum Computer, Faculty of Physics, University of Vienna, 1090 Vienna, Austria*

[2] *Insitute of Theoretical Physics, University of Warsaw, Pasteura 5, 02-093 Warsaw, Poland*

[3] *Instituto de Física Teórica UAM-CSIC, C/ Nicolás Cabrera 13-15, 28049 Madrid, Spain*

The interaction between a single atom and single photon is at the heart of Quantum Optics. Thus, a quantum light-matter platform allowing for such an elementary interaction, permits the study of fundamental quantum processes, including atom-mediated single-photon scattering and effective single-photon interactions. Although recent experiments have demonstrated the production of near-optimal sources of single photons [1,2], and theoretical works have explored the phenomena arising from the excitation of quantum emitters with quantum light [3,4], empirical observations of such a fundamental interaction have not been implemented experimentally, and only partial approximations have been possible. In this study, we report the first experimental demonstration of a genuine quantum light-matter interaction at the single-particle level, namely quantised light resonantly excites a solid-state quantum emitter, as sketched in Fig. 1(a). We observe quantum coherent scattering involving the absorption and re-emission of one photon, optical nonlinearities occurring at the one-photon level, and instances of stimulated emission processes. Our findings are well reproduced the theory of cascaded systems [5], and they demonstrate a solid-state platform where one photon is sufficient to achieve an atomic population, and efficient atom-mediated photon-photon interactions are feasible. These results suggest future possibilities for enabling quantum information transfer in a quantum network and building deterministic entanglement gates for photonic quantum computing.

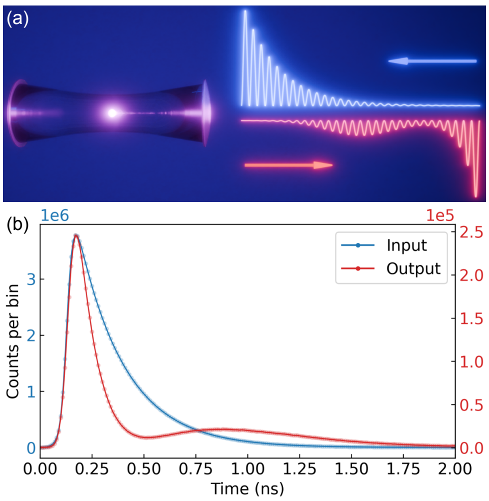


Figure 1: Single-photon interference mediated by a quantum emitter. (a) A non-classical photon wave packet (blue) is sent to a quantum dot coupled to a cavity. (b) When an input single photon interacts with the quantum dot, a significant change in the output field is observed, resulting in a two-peak structure. For comparison, the measured temporal profile of the single-photon input is plotted in blue, while the observed output field is shown in red. The scattering process involves the quantum interference of two scenarios: attenuated propagation of the input photon, and reemission after absorption of the photon.

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