

Stimulated emission at the single atom-single photon level

Sondos Elsehimy,^{1,*} Romain Veyron,¹ Laura Zarraoa,¹
Tomas Lamich,¹ and Morgan W. Mitchell^{1,2}

¹*ICFO- The Institute of Photonic Sciences, Castelldefels, Spain*

²*ICREA-Institutio Catalana de Recerca i Estudis Avancats, Barcelona, Spain*

The ability to control the interaction between single atoms and individual photons constitutes a fundamental building block of quantum technologies. For instance, a single atom interfaced with two orthogonal coherent beams can generate light with controllable photon statistics [1]. One can exploit the intrinsic frequency selectivity of atomic transitions to detect weak optical signals while rejecting broadband background light such as sunlight [2, 3]. This capability is particularly useful for background-limited applications, such as free-space classical and quantum optical communication in daylight.

However, entering the full quantum regime using non-classical light remains largely unexplored. Stimulated emission, for instance, has been studied mainly using coherent states and whether this mechanism still persists at the single photon-single atom level -and what properties the two emitted photons carry- is still a fundamental open question. Our aim is to implement and study stimulated emission at the single atom-single photon level using an SPDC source interfaced with a single ⁸⁷Rb atom. We excite the atom with the π -pulse, followed by a single photon to start the stimulated emission process. To implement this, using an FPGA we implemented a fast π -pulse on demand, to prepare the atom in the excited state after the detection of the idler photon, which indicates the presence of the signal photon at the atom. This approach opens a way for studying stimulated emission using non-classical light. First, I will briefly introduce our recent works in the lab and then present the experimental progress towards studying stimulated emission.

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- [1] D. Goncalves *et al.*, Unconventional quantum correlations of light emitted by a single atom in free space, arXiv:2404.07451 (2021).
 - [2] L. Zarraoa *et al.*, Quantum jump photodetector for narrowband photon counting with a single atom, arXiv:2403.08674 (2024).
 - [3] L. Zarraoa *et al.*, Detection of photon-level signals embedded in sunlight with an atomic photodetector, arXiv:2512.02521 (2025).

* sondos.elsehimy@icfo.eu; <https://www.icfo.eu/>