Vacuum mediated two photon emission by a single atom

P. Farrera*[1], **G. Chiarella** [1] **T. Frank** [1] **G. Rempe** [1]
1. Max-Planck-Institut für Quantenoptik, Garching, Germany

Single atoms coupled to high finesse optical cavities provide an important platform for quantum information processing, in which single photon qubits can be efficiently generated, stored and processed. In recent years the attention is focused in increasing both the number of emitters that are strongly coupled to the cavity [1], and the number of cavity modes that are coupled to the emitter. The development of miniaturized high finesse Fabry-Perot resonators [2] has made it possible that multiple independent resonators are coupled to the same emitter in the high atom-photon cooperativity regime. Such a system has enabled the implementation of a novel photon receiving scheme used as a heralded quantum memory [3] and a photon tracking scheme used as a nondestructive qubit detector [4]. However, the two-cavity mediated photon emission of by single atom was not yet explored. In our recent work we consider the situation where a single atom has three energy levels that are coupled to two optical resonators in a ladder configuration. We implement such a scheme experimentally, allowing us to generate pairs of single photons in an efficient way and study the correlation properties of the photonic fields. We also study theoretically the regime where both cavities are coupled to the atom in the strong coupling regime. In this parameter regime we observe that an atom in the upper state can be transferred to the ground state without populating the intermediate state while generating photons in the two cavities. Such a process is analogous to STIRAP but mediated by the vacuum field in both cavities. We study the properties of the cavity light fields and consider parameters that are feasible in order to observe this effect in an experiment.

References

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*pau.farrera@mpq.mpg.de