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Strong coupling regime in fibre microcavities: from EIT to multi-particle entanglement

I will report on recent results obtained with cold atoms in fibre microcavities at Imperial College London and at the Laboratoire Kastler-Brossel in Paris. In the London experiment, we show how the Hamiltonian eigenstates of the system can be revealed through spectroscopic measurements despite the fast decoherence rate of the microcavity. We observe an avoided crossing in the dressed cavity spectrum, usually taken as evidence of strong coupling, notwithstanding the complete overdamping of Rabi oscillations in our experiment. We interpret this as dipole-induced transparency of the cavity, relying on destructive quantum interference to uncover the normal modes which might be expected to lie obscured [1]. In the Paris experiment instead, the atom-cavity coupling rate greatly exceeds every loss rate allowing to reach the single-atom strong coupling regime and to perform almost non-destructive measurements. Building on this we have developed a method based on the quantum Zeno dynamics to create symmetric entangled states in ensembles of several tens of atoms. We characterize the resulting states by performing quantum tomography, yielding a time-resolved account of the entanglement generation. In addition, we study the dependence of quantum states on measurement strength and quantify the depth of entanglement. Our results show that quantum Zeno dynamics can be used as a versatile tool for fast and deterministic entanglement generation [2].

[1] Y.-H. Lien, G. Barontini, M. Scheucher, J. Goldwin, and E. A. Hinds, in preparation

[2] G. Barontini, L. Hohmann, F. Haas, J. Estéve, and J. Reichel, Science 349, 1317 (2015)