Purcell-enhanced single-photon emission from colour centers in diamond coupled to tunable microcavities

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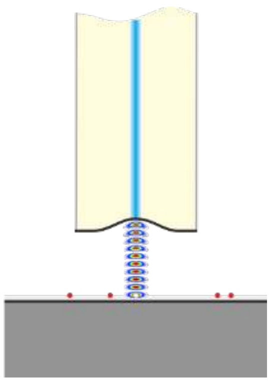
Optical microcavities are a powerful tool to control spontaneous emission of individual quantum emitters. Fabry-Perot cavities built from laser-machined and mirror-coated optical fibers are particularly promising in this context, since they offer small mode volumes and large quality factors combined with full tunability and direct access to the cavity field [1]. For quantum emitters coupled to the cavity, this gives rise to the Purcell effect, which enables enhancement of fluorescence emission and high collection efficiency. This offers a route for bright and narrow-band single photon sources as well as efficient spin state readout.

In our experiment, we couple colour centers in diamond such as the nitrogen vacancy center to a cavity with a mode volume as small as 1 λ^3 [2]. We record cavity-enhanced fluorescence images and study several single emitters with one cavity. We observe lifetime changes by more than a factor of two and obtain cavity-enhanced single photon emission rates exceeding 10^6 photons per second.

Alternatively, we study silicon vacancy centers in diamond, which offer a dominant zero phonon line with narrow linewidth also under ambient conditions. Coupled to a cavity, this offers the potential for Purcell factors beyond 10 and up to GHz single photon rates [3].



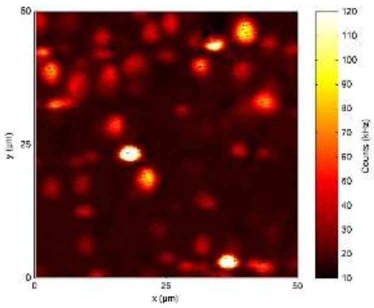


Figure 1 Left: Schematic setup of a tunable Fabry-Perot microcavity formed by a lasermachined endfacet of an optical fiber and a macroscopic mirror. The sample is placed on the planar mirror and can be raster scanned through the cavity mode to achieve optimal spatial and spectral overlap. Right: Scanning-cavity fluorescence image of NV centers in nanodiamonds

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[2] H. Kaupp, T. Hümmer, M. Mader, B. Schlederer, J. Benedikter, P. Haeusser, H.-Ch. Chang, H. Fedder, T. W. Hänsch, D. Hunger, "Purcell-enhanced single-photon emission from nitrogen-vacancy centers coupled to a tunable microcavity", arXiv:1606.00167 (2016)

[3] J. Benedikter, H. Kaupp, T. Hümmer, J. Liang, A. Bommer, C. Becher, A. Krueger, J. M. Smith, T. W. Hänsch, D. Hunger, „Cavity-enhanced single photon source based on the silicon vacancy center in diamond", Phys. Rev. Appl. 7, 024031 (2017)