On the efficient interaction of single photons and single emitters

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In the 1990s, many pioneering experiments demonstrated the potential of single organic molecules embedded in solids as quantum mechanical two-level systems. However, coherent interactions were not studied because those experiments relied on recording the fluorescence signal, which only accesses populations of the excited state and not the coherences. Recently, we showed theoretically that in the linear excitation regime, an atom can block a propagating light beam by up to 100% if it is confined to an area comparable with its scattering cross section [1].

I will present an overview of our recent experimental work on the efficient interaction of light and single organic molecules both in the near and far fields [2, 3]. We will see that at T<2K, a single molecule can attenuate [2, 3], transmit, amplify [4] or phase-shift [5] a focused laser beam. Furthermore, I will report on the first direct long-distance communication of two optical emitters via single photons [6]. I will then discuss strategies for the optimization of the interaction between single photons and single emitters via, e.g. ultra-high collection efficiency [7, 8] or enhancement of spontaneous emission [9] by using plasmonic and dielectric antennas.

References

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