Strong interaction of a single molecule with (single) photons

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Abstract: A single molecule is used to attenuate, phase shift and amplify a laser beam at will. Single photons emitted by a molecule are then used to excite a second molecule at a distance.

Progress in three decades has allowed carrying out optical experiments on single emitters such as atoms, ions, quantum dots, and molecules. These developments have almost exclusively relied on fluorescence measurements or on the usage of high finesse cavities. A few years ago, we showed that a single emitter could also be detected directly via extinction of the excitation light. We argued that the key to imprinting a strong effect on an optical beam is its strong confinement to an area comparable with the absorption cross section of the emitter. Our experimental [1-4] and theoretical [5] investigations have since clearly demonstrated that a single emitter can not only attenuate a laser beam, but it can also amplify it or apply a phase shift to it. The graphs show examples of attenuation above 17% and a phase shift of ±3°. Recently, we have also performed, for the first time, spectroscopy of a single emitter with a single-photon stream generated by another single emitter [6].