Towards scalable sources of entangled photons based on strain-engineered quantum dots

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The prospect of using the quantum nature of light for secure long-distance communication keeps spurring the search and investigation of suitable sources of entangled photons. A single semiconductor quantum dot (QD) is arguably one of the most attractive, as it can generate triggered entangled photons with high efficiency and it is compatible with current photonic-integration technologies. However, the possibility of using QDs in advanced quantum optics experiments is hampered by the presence of structural asymmetries and by decoherence mechanisms that degrade the level of entanglement and the indistinguishability of the emitted photons.

In this talk, I will first introduce a novel class of semiconductor-piezoelectric devices [1] in which different external perturbations are combined to reshape the electronic structure of any arbitrary InGaAs QD so that polarization-entangled photons can be generated with high quality and speed [2-4]. Moreover, I will discuss how full control over the QD in-plane strain tensor allows the energy of the entangled photons emitted by QDs to be precisely controlled [5] in the spectral range in which a cloud of natural atoms behaves as a slow-light medium [6]. Then, I will present our recent results on GaAs QDs fabricated via the droplet-etching method [7,8]. I will show that under resonant two-photon excitation, these novel QDs can generate photon-pairs with high purity, high indistinguishability, and with an unprecedented degree of entanglement that – in contrast to InGaAs QDs – can even reach near-unity values [7]. Finally, I will discuss our first attempts to build up a QD-based quantum network in which photons from QDs located in different cryostats are let interfere at a beam splitter [8].

References

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