Towards the ideal entangled-photon source: how far can we push quantum dots?

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The development of quantum networks for secure communication requires many outstanding challenges to be overcome. One challenge is to fabricate quantum light sources that deliver photon-pairs with ultra-high brightness and with near-unity level of entanglement. Quantum dots can in principle fulfil these desiderata, but new roadblocks and open questions appear whenever their performances are pushed to the levels required by the envisioned applications.

In this talk, I will first discuss how entangled photons from GaAs quantum dots can be used for the construction of a quantum network for secure communication [1,2]. The desiderata set on the photon source – in particular for what concerns brightness and degree of entanglement – will be reviewed. Then, I will illustrate our efforts to fabricate a device based on strain-tunable quantum dots in photonic cavities that aims at optimizing both figures of merit [3]. Finally, I will discuss the different physical mechanisms [4, 5, 6] that potentially prevent quantum dots from emitting photons with entanglement fidelities larger than 99% and I will highlight the role of so-far neglected degrees of freedom [7]. More specifically, I will show how the photon momentum and polarization can be correlated, especially in optical microcavities, switching on which-path information that decreases polarization entanglement. A discussion on future challenges and perspectives will conclude the talk.

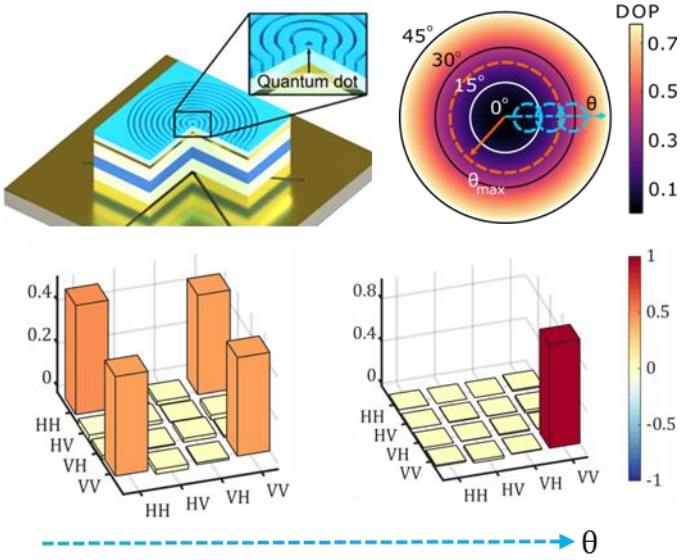

Figure 1: Top panels: Simple sketch of the quantum dot device (left) and degree of light polarization as a function of the emission angle (right). Bottom panels: Examples of the two-photon density matrix collected for different emission angles.

References

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