Spin-photon entanglement from a telecom wavelength quantum-dot

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The ever-evolving demands for computational power and for a securely connected world dictate the development of quantum networks where entanglement is distributed between connected parties [1]. Using single photons as flying qubits, the existing fibre optics infrastructure can be transformed into a global quantum network. "On-demand" generation of entangled photons, using semiconductor quantum dots (QDs), with telecom wavelength emission is imperative for long-distance transmission. However, the crucial ingredient, namely entanglement between a single spin and a photon at C-band wavelengths, has been elusive so far. Despite the progress achieved in the 900 nm region in recent works [2-4], comparable performance at telecom wavelengths has not been demonstrated yet. Additionally, approximations relying on downconversion sources are inherently lossy and significantly increase experimental complexity [5]. Our recent results show that quantum dot-based entanglement sources can fill this gap [6]. In this work, we use an InAs/InP QD, with direct emission in the telecom C-band, to implement an optically active spin-qubit. We demonstrate a full range of optical manipulation techniques such as high-fidelity spin initialisation and full coherent spin control of the resident electron. Using our telecom wavelength device, we further verify the true single photon nature of our source and measure the coherence of a single undisturbed electron spin in our system. Lastly, for the first time we demonstrate high-fidelity spin-photon entanglement in a solid-state system with direct emission into the telecom C-band and obtain a lower bound on the entanglement fidelity of 80.07 %. Our results highlight the potential of our system for the development of future quantum networking applications.

References

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