# Spin-photon entanglement with direct photon emission in the telecom C-band

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Sophisticated quantum networking schemes such as blind quantum computing, clock synchronisation, and entanglement distribution between any points on the globe, are currently in development [1], primarily using photons at telecom wavelengths for long-distance transmission of quantum information. Solid-state based spin-photon interfaces [2] are a practical and integrable resource for such schemes with impressive recent progress towards first applications However, their practical integration is limited because of their emission wavelengths in the visible range of the spectrum up to 900 nm.

Our recent results significantly narrow the performance gap between telecom wavelength quantum dots and the more established solid-state systems with emission at shorter wavelengths [3]. We transfer the established methods for manipulation of a solid-state spin to control the spin in an InAs/InP QD, to demonstrate spin initialisation and coherent spin rotation. We further use these tools to measure the coherence of a single, undisturbed electron spin in our system. Finally, using the level scheme shown in Fig. 1 (a) , we demonstrate entanglement between the electron spin and the frequency of a photon at telecom wavelengths for the first time. To this end, a first laser pulse (entanglement pulse) excites the quantum dot. Relaxation results in the emission of a red or blue photon, with the remaining resident spin in the $|\downarrow\rangle$ or $|\uparrow\rangle$ state, respectively. A second pulse (probe pulse) is used to check whether the spin is in the $|\downarrow\rangle$ state. The resulting correlations between spin orientation and photon frequency, measured in eigenbasis at two different magnetic fields, are shown in Fig. 1 (b). Complemented by measurements in superposition basis, our results demonstrate an entanglement fidelity of 75.2(3.7) % at 9 T, and 80.1(2.4) % at 5 T, respectively.

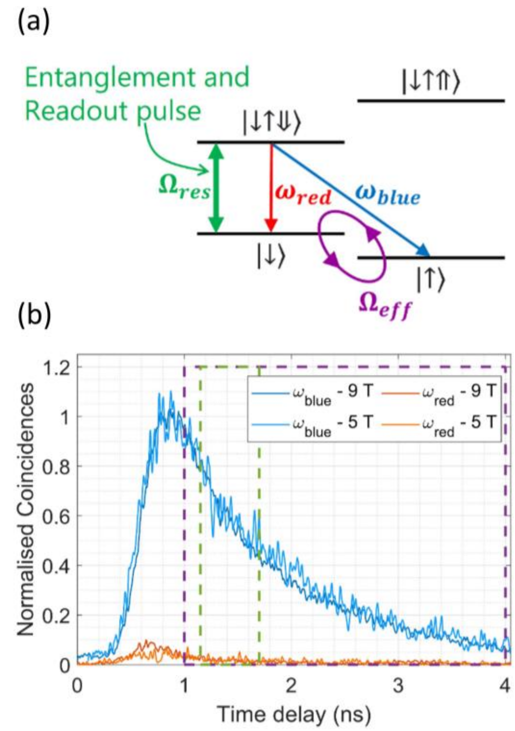


Fig.1. (a) Quantum Dot level scheme used for the entanglement experiment, with filled (empty) arrows denoting electron (hole) spins. $\Omega_{eff}$ and $\Omega_{res}$ are laser-induced excitation and rotation frequencies, respectively, and $\omega_{red}$ ($\omega_{blue}$) denote QD photon emission at the red (blue) frequency. (b) Red and blue photon emission events, conditioned on finding the electron spin in the $|\downarrow\rangle$ state.

References

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