Long-range optical coupling of distant quantum dot spins

Tereza Vakhtel
Maximilian Rimbach-Russ

QuTech and Kavli Institute of Nanoscience, Delft University of Technology, Lorentzweg 1, 2628 CJ Delft, Netherlands

t.i.vakhtel@tudelft.nl

Long-distance interactions are crucial for scaling quantum dot spin qubit devices. Silicon presents a promising platform for these advancements, as it enables the simultaneous integration of photonic circuits [1] and colour centres (such as T-centers), strongly coupled to telecom light [2], as well as gate-defined SiMOS quantum dot spin qubits [3].
In particular, SiMOS qubits have shown high-fidelity gate operations exceeding 99% [4], long coherence times reaching milliseconds [5], and the ability to be fabricated in industrial foundries [6]. We propose a scheme that leverages T-centers to mediate the interaction between quantum dot spin qubits and optical light. This approach can be extended to achieve either ultra-long-distance entanglement between two quantum dot spins or be adapted for fast and all-optical quantum non-demolition measurement. Additionally, we estimate fidelities for prepared Bell states under realistic experimental conditions.

References

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Figures

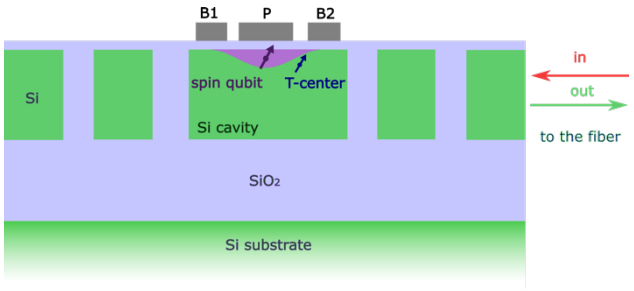

Figure 1: Schematic image of the device: A gate defined quantum dot spin qubit is coupled to a T – centre, placed in Si resonator. One of the cavity's ends is coupled to a telecom fiber.