Plenary Talk PV XIV Fri 9:15 Audimax

Quantum networks based on diamond spins: from long-distance teleportation to a loophole-free Bell test — •Ronald Hanson — Delft University of Technology

The realization of a highly connected network of qubit registers is a central challenge for quantum information processing and long-distance quantum communication. Diamond spins associated with NV centers are promising building blocks for such a network as they combine a coherent optical interface (similar to that of trapped atomic qubits) with a local register of robust nuclear spin qubits [1]. At the same time, the excellent control of NV centers allows for testing and demonstrating fundamental concepts in physics such as qubit steering by adaptive partial measurements [2].

Here we present our latest progress towards scalable quantum networks. We have recently realized deterministic teleportation between long-lived qubits residing in independent setups [3]. The teleportation exploits entanglement between distant NV electronic spins that is generated through spin-photon entanglement and subsequent photon detection [4]. By encoding the source state in a separate qubit (a single nuclear spin) we realize a Bell state measurement that distinguishes between all four outcomes in a single shot. Analysis shows that the obtained fidelities are in principle high enough for a loophole-free violation of Bell's inequalities.

[1] T. H. Taminiau et al., Nature Nanotechnology (in press), see arXiv:1309.5452.
[2] M.S. Blok et al., Nature Physics (in press), see arXiv:1311.2899.
[3] Pfaff et al., in preparation.
[4] H. Bernien et al., Nature 497, 86 (2013).