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A loophole-free Bell test and the route to larger quantum networks ANDREAS REISERER, BAS HENSEN, HANNES BERNIEN, ANAS DRAU, NORBERT KALB, MACHIEL BLOK, TIM TAMINIAU, RONALD HANSON, Qutech and Kavli Insitute of Nanoscience, Delft, The Netherlands — The nitrogen-vacancy (NV) center in diamond gives access to few-qubit nuclear-spin registers with exceptional coherence properties. Entanglement between remote registers can be established via a joint measurement of single photons that are each entangled with the electron spin of one NV center. The entanglement protocol is thus probabilistic but heralded, which has allowed us to perform the first loophole-free test of Bells inequality using two NV centers at a distance of 1.3km. Extending the size of the network requires control over additional qubits at each node. To this end, we use nuclear spins that are controlled via the hyperfine interaction with the electronic spin. I will present our recent experimental results, where we keep a qubit locally in a single nuclear spin or in a decoherence-protected two-spin state while applying a sequence of optical pulses on the electronic spin that generates remote entanglement. Our results open perspectives toward the purification of remote entanglement and toward larger quantum networks.

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