Quantum error correction on a hybrid spin system

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ABSTRACT

Noise and consequential errors are a well-known issue in classical and quantum information processing. However, while in classical systems noise is mitigated by the digital nature of computation and the large number of electrons employed, in quantum systems decoherence caused by the inevitable interaction of qubits with their environment leads to dephasing or even relaxation. Correction of the concomitant errors is therefore a fundamental requirement for scalable quantum computation. After reviewing the basic theory of error correction in both classical and quantum case, outlining the main differences, we show how quantum computation can be implemented using the nitrogen-vacancy defect in diamond. We give an account of how joint initialization, projective readout and fast local and non-local gate operations can all be achieved in solid-state spin systems, even under ambient conditions. In particular, we present the techniques developed by *Waldherr et.al (Nature 2014/01/29/online)* to obtain high-fidelity initialization of a whole spin register (99 per cent) and single-shot readout of multiple individual nuclear spins using the ancillary electron spin of the nitrogen–vacancy defect. Furthermore we show how the implementation of a novel non-local gate generic to the electron–nuclear quantum register allows the preparation of entangled states of three nuclear spins, with fidelities exceeding 85 per cent. With this system we show an experimental demonstration of three-qubit phase-flip error correction.