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Universal control and error correction in multi-qubit spin registers in diamond TIM HUGO TAMINIAU, JULIA CRAMER, TOENO VAN DER SAR, Kavli Institute of Nanoscience, VIATCHESLAV V. DOBROVITSKI, Ames Laboratory and Iowa State University, RONALD HANSON, Kavli Institute of Nanoscience — Quantum registers of nuclear spins coupled to electron spins of individual solid-state defects are a promising platform for quantum information processing. Pioneering experiments selected defects with favourably located nuclear spins having particularly strong hyperfine couplings. For progress towards large-scale applications, larger and deterministically available nuclear registers are highly desirable. Here we present universal control over multi-qubit spin registers by harnessing abundant weakly coupled nuclear spins [1,2]. We use the electron spin of a nitrogen-vacancy centre in diamond to selectively initialize, control and read out carbon-13 spins in the surrounding spin bath and construct high-fidelity single- and two-qubit gates [2]. We exploit these new capabilities to implement a three-qubit quantum-error-correction protocol and demonstrate the robustness of the encoded state against applied errors. These results transform weakly coupled nuclear spins from a source of decoherence into a reliable resource, paving the way towards extended quantum networks and surface-code quantum computing based on multi-qubit nodes.

[1] T. H. Taminiau et al., Phys. Rev. Lett. 109, 137602 (2012)
[2] T. H. Taminiau et al., arXiv:1309.5452 (2013)

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