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Long-range two-qubit gate between nuclear spins in diamond mediated via an optical cavity ADRIAN AUER, GUIDO BURKARD, Department of Physics, University of Konstanz, Germany — Nitrogen-vacancy (NV) centers in diamond represent a promising possibility for a solid-state based realization of a qubit due to their excellent electron- and nuclear-spin coherence properties. Single-qubit gates for the nitrogen nuclear spin have been implemented [1]. Here, we extend an earlier proposal [2] for cavity-mediated coupling between NV electron spins and develop a scheme to implement a universal two-qubit gate between ^{14}N or ^{15}N nuclear spins. By virtually exciting a single NV center with an external laser field, a photon can be scattered into a surrounding cavity; we show that this process depends on the spin state of the nitrogen nucleus. For the two-qubit gate, we consider two NV centers coupled to a common cavity mode and each being excited individually. Virtual cavity excitation can then mediate an effective interaction between the NV nuclear spin qubits, generating a controlled-Z gate. Operation times for the gate implementation are found to be below 100 nanoseconds, which is orders of magnitude faster than the decoherence time of nuclear spin qubits in diamond.

[1] S. Sangtawesin *et al.*, Phys. Rev. Lett. **113**, 020506 (2014).
[2] G. Burkard and D. D. Awschalom, arXiv:1402.6351.

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