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Single-shot readout of multiple nuclear spin qubits in diamond under ambient conditions

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Nuclear spins are attractive candidates for solid-state quantum information storage and processing owing to their extremely long coherence time. However, since this appealing property results from a high level of isolation from the environment, it remains a challenging task to polarize, manipulate and readout with high fidelity individual nuclear spins. A promising approach to overcome this limitation consists in utilizing an ancillary single electronic spin to detect and control remote nuclear spins coupled by hyperfine interaction. In this talk, I will show how the electronic spin of a single Nitrogen-Vacancy (NV) defect in diamond can be used as a robust platform to observe the real-time evolution of surrounding single nuclear spins under ambient conditions. Using a diamond sample with a natural abundance of ^{13}C isotopes, we first demonstrate high fidelity initialization and single-shot readout of an individual ^{13}C nuclear spin. By including the intrinsic ^{14}N nuclear spin of the NV defect in the quantum register, we then report the simultaneous observation of quantum jumps linked to both nuclear spin species, providing an efficient initialization of the two qubits. These results open up new avenues for diamond-based quantum information processing (QIP) including active feedback in quantum error correction protocols and tests of quantum correlations with solid-state single spins at room temperature.