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Probing and engineering nuclear spin ensembles in a central spin system (25+5)

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Central spin systems are ubiquitous, naturally occurring in a variety of physical systems, including rare-earth ions in nuclear spin-rich crystals and atomic-scale defects in two-dimensional materials. Here, we present novel quantum control methods for probing and manipulating a central spin system, where an optically addressable single electron spin is surrounded by an inaccessible dark nuclear spin ensemble. Achieving effective and reliable control over these surrounding spin ensembles enables a wide range of quantum information science applications, including quantum memory for quantum networking, ancilla qubits in quantum computing, and ensemble-based quantum sensing.

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