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Enhancing dark matter search using multi-level system

Quantum sensing with qubits has advanced fundamental physics searches,
but higher dimensional systems offer untapped potential. We present a universal qutrit
framework that yields a sequence-independent fourfold increase in quantum Fisher information and a twofold gain in sensitivity. In ultralight dark matter searches, spin-1 NV-center qutrits can enhance the axion-electron coupling reach by an order of magnitude beyond qubits. Finally, we outline a general formalism for multilevel quantum sensors, providing a systematic pathway toward exploiting higher-dimensional Hilbert spaces for precision measurements.

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Session Classification: parallel session B: Flavor/Baryogenesis