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Maximal adaptive-decision speedups in quantum-state readout¹ BENJAMIN D'ANJOU, LOUTFI KURET, LILIAN CHILDRESS, WILLIAM A. COISH, McGill University — The average time T required for high-fidelity readout of quantum states can be significantly reduced via a real-time adaptive decision rule. An adaptive decision rule stops the readout as soon as a desired level of confidence has been achieved, as opposed to setting a fixed readout time t_f . The performance of the adaptive decision is characterized by the "adaptive-decision speedup", t_f/T . In this work, we reformulate this readout problem in terms of the first-passage time of a particle undergoing stochastic motion. This formalism allows us to theoretically establish the maximum achievable adaptive-decision speedups for several physical two-state readout implementations. We show that for two common readout schemes (the Gaussian latching readout and a readout relying on state-dependent decay), the speedup is bounded by 4 and 2, respectively, in the limit of high single-shot readout fidelity. We experimentally study the achievable speedup in a real-world scenario by applying the adaptive decision rule to a readout of the nitrogen-vacancy-center (NVcenter) charge state. We find a speedup of ≈ 2 with our experimental parameters. Our results should lead to immediate improvements in nano-scale magnetometry based on spin-to-charge conversion of the NV-center spin.

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Benjamin D'Anjou McGill Univ

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