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Single Molecule Magnetic Force Detection with a Carbon Nanotube Resonator[1] KYLE WILLICK, SEAN WALKER, JONATHAN BAUGH, Institute for Quantum Computing, University of Waterloo — Single molecule magnets (SMMs) sit at the boundary between macroscopic magnetic behaviour and quantum phenomena. Detecting the magnetic moment of an individual SMM would allow exploration of this boundary, and could enable technological applications based on SMMs such as quantum information processing. Detection of these magnetic moments remains an experimental challenge, particularly at the time scales of relaxation and decoherence. We present a technique for sensitive magnetic force detection that should permit such measurements. A suspended carbon nanotube (CNT) mechanical resonator is combined with a magnetic field gradient generated by a ferromagnetic gate electrode, which couples the magnetic moment of a nanomagnet to the resonant motion of the CNT. Numerical calculations of the mechanical resonance show that resonant frequency shifts on the order of a few kHz arise due to single Bohr magneton changes in magnetic moment. A signal-to-noise analysis based on thermomechanical noise shows that magnetic switching at the level of a Bohr magneton can be measured in a single shot on timescales as short as 10μs. This sensitivity should enable studies of the spin dynamics of an isolated SMM, within the spin relaxation timescales for many available SMMs.

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