Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Levitated Nano-Magnets as Quantum Transducers JAN GIESELER, ARTHUR SAFIRA, AARON KABCENELL, EMMA ROSENFELD, MARTIN SCHTZ, MIKHAIL LUKIN, Harvard University — Coherent coupling between a single spin and a massive mechanical mode is still an outstanding challenge. Such a system is highly desirable, as it allows preparation of macroscopic quantum states of motion and could be used to mediate long-range spin-spin interactions. One promising approach to engineer a strong spin-mechanical coupling is via magnetic field gradients. Maximizing the coherent coupling requires a compliant, high quality mechanical resonator, strong magnetic field gradients, and spin qubits with very long spin coherence times. In addition, they have to be combined while preserving the excellent properties of the individual components. To address this formidable challenge, we propose a new platform based on levitated magnets. Here, we report on our experimental progress towards integrating a levitated micro-magnet with nitrogen-vacancy (NV) centers in diamond as a new platform for quantum applications. The absence of any support structure yields low mechanical damping and a large magnetic moment to mass ratio, thereby enabling strong coupling. This hybrid setup gives controllable access to the rich, tunable mode spectrum associated with the micro-magnet, consisting of hybridized translational, rotational and internal magnonic modes ranging from kHz to GHz.

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Date submitted: 23 Jan 2018 Electronic form version 1.4