Abstract Submitted
for the DAMOP19 Meeting of
The American Physical Society

Dynamics of a Ferromagnetic Particle Levitated Over a Superconductor[1] DEREK JACKSON KIMBALL, California State University, East Bay, TAO WANG, SEAN LOURETTE, SEAN O'KELLEY, METIN KAYCI, University of California at Berkeley, YEHUDA BAND, Ben-Gurion University, ALEXANDER SUSHKOV, Boston University, DMITRY BUDKER, Helmholtz Institute Mainz, Johannes Gutenberg University, and University of California at Berkeley — Under conditions where the angular momentum of a ferromagnetic needle is dominated by intrinsic spin, an applied torque is predicted to cause gyroscopic precession of the needle [Kimball, Sushkov, and Budker, Phys. Rev. Lett. 116, 190801 (2016)]. If the needle can be sufficiently isolated from the environment, a measurement of the precession can yield sensitivity to torques far beyond that of other systems (such as atomic magnetometers) [Band, Avishai, and Shnirman, Phys. Rev. Lett. 121, 160801 (2018)]. The high sensitivity is a result of rapid averaging of quantum noise. A key enabling technology for a precessing-needle-based torque sensor is a method of near frictionless suspension. One approach is to levitate a ferromagnetic needle above a superconductor. With this goal in mind, we have experimentally investigated the dynamics of a micron-scale ferromagnetic particle levitated above a superconducting niobium surface [Wang et al., arXiv:1810.08748 (2018)]. The phenomenon of ferromagnetic needle precession may be of particular interest for precision measurements testing fundamental physics.

[1]Supported by the Heising Simons Foundation, Simons Foundation, and the NSF

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Date submitted: 29 Jan 2019 Electronic form version 1.4