

Abstract Submitted  
for the DAMOP11 Meeting of  
The American Physical Society

**Sensitive position magnetometry and quantum state control in a hybrid BEC-membrane system**<sup>1</sup> STEVEN STEINKE, SWATI SINGH, MEHMET TASGIN, PIERRE MEYSTRE, B2 Institute, Department of Physics, and College of Optical Sciences, The University of Arizona, KEITH SCHWAB, Applied Physics, California Institute of Technology, MUKUND VENGALATTORE, Laboratory of Atomic and Solid State Physics, Cornell University — The dynamics of a spinor BEC coupled magnetically to a high-Q mechanical membrane are studied theoretically. In particular, we investigate the effects of using phase-contrast imaging to observe the spin of the BEC. In the case of highly dispersive measurements, the Larmor frequency of the BEC can be found to high precision, and the shift in this frequency provides useful information about the motion of the membrane. On the other hand, for projective spin measurements, a large back-action is induced in the membrane, allowing in some cases the production of non-classical states of motion. We investigate the possibilities for cooling and heating, the production of Fock and cat states, and probabilistic state control of the membrane in this latter case.

<sup>1</sup>This work was supported by the DARPA ORCHID program through a grant from AFOSR.

Steven Steinke  
B2 Institute, Department of Physics, and  
College of Optical Sciences, The University of Arizona

Date submitted: 03 Feb 2011

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