Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Superfluid Optomechanics GLEN HARRIS, DAVID MCAUSLAN, EOIN SHERIDAN, WARWICK BOWEN, University of Queensland — The field of quantum optomechanics has seen great progress over the last decade with many exciting theoretical proposals and impressive experimental achievements. Among the most successful optomechanical systems are the collective modes of ultra cold atoms where ponderomotive squeezing and quantization of collective atomic motion have been observed. In this context the collective motion of superfluid helium-4 appears to be a promising candidate given its zero viscosity flow; potentially leading to the simple preparation of macroscopic mechanical oscillators with ultra-high quality factors. Here we present the first observation of Brownian motion in superfluid helium-4 thin films. The superfluid film is formed around an optical whispering gallery mode resonator enabling high sensitivity readout. Furthermore, exceedingly strong dynamical backaction heating and cooling is observed with optomechanical instabilities arising from only 40nW of injected optical power. While there are still many open questions regarding the superfluid hydrodynamics we believe this to be a promising system to study macroscopic non-classical mechanical states.

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Date submitted: 09 Jan 2014 Electronic form version 1.4