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Fiber-Cavity Optomechanics with Superfluid Helium[1] NATHAN E. FLOWERS-JACOBS, ANNA D. KASHKANOVA, ALEXEY B. SHKARIN, SCOTT W. HOCH, Dept of Physics, Yale University, CHRISTIAN DEUTSCH, JAKOB REICHEL, Laboratoire Kastler Brossel, ENS/UPMC, JACK G.E. HARRIS, Dept of Physics and Dept of Applied Physics, Yale University — In a typical optomechanical device, the resonance frequency of a cavity is coupled to mechanical motion through the radiation pressure force. To date, experimental cavities have predominately coupled to a resonant mechanical mode of a solid structure, often a lithographically-defined beam or membrane. We will describe our progress towards realizing an optomechanical device in which an optical fiber-cavity couples to the acoustic modes of superfluid helium. In this system, the optical modes and the acoustic modes of the superfluid are co-located between the mirrored ends of two fiber optic cables. Changes in the density of the superfluid change the effective length of the cavity which results in a standard, linear optomechanical coupling between the 300 MHz acoustic resonances and the 200 THz optical resonances. This type of device is motivated by the self-aligning nature of the acoustic and optical modes (which eases the difficulties of operating at cryogenic temperatures) and by the low optical and mechanical losses of superfluid helium. Although we expect the mechanical quality factor to be limited by acoustic radiation into the glass fiber, we will describe a proposal to realize a dual-band Bragg mirror to confine the optical and acoustic modes more efficiently.

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