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Ultrahigh Q Bulk Acoustic Wave Cavities at the Quantum Limit[1]

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A Fabry-Perot cavity is an optical resonator, which can store photons for milliseconds and enhance interaction between light and matter. The acoustics analogue (phonon trapping), is the Bulk Acoustic Wave device (in thin film or crystal lattice). Measurements provide the ultimate material loss regimes, minimizing clamping losses and achieving record high Q.f products [1], allowing observation of various loss mechanisms such as Landau-Rumer, phonon-phonon dissipation and Rayleigh phonon scattering, as well as previously non-observed non-linear effects [2]. This presentation will summarize our recent work towards cooling such modes to the ground state and operating the device at the Quantum Limit [3]. This includes the first measurements of the Nyquist noise near at 4K [4], as well as details on using such devices to test fundamental physics [5]. [1] M Goryachev etal, Observation of rayleigh phonon scattering through excitation of extremely high overtones in low-loss cryogenic acoustic cavities for hybrid quantum systems, PRL, 111 085502 2013 [2] M. Goryachev etal Jump chaotic behaviour of ultra low loss bulk acoustic wave cavities, APL 105 063501 2014 [3] M Goryachev, M Tobar, Effects of geometry on quantum fluctuations of phonon-trapping acoustic cavities, NJP 16 083007 2014 [4] M Goryachev etal, Observation of the Fundamental Nyquist Noise Limit in an Ultra-High Q-Factor Cryogenic Bulk Acoustic Wave Cavity, APL 105 153505 2014 [5] M Goryachev, M Tobar, Gravitational wave detection with high frequency phonon trapping acoustic cavities, PRD 2014

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