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What's that Sound?
Acoustic Cavities in 2D Layered Materials

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High frequency elastic waves (10-300 GHz) in 2D materials feature low attenuation and can potentially offer a mechanism for storing quantum information and/or for coupling to strain-sensitive nanoscale quantum systems (e.g., embedded quantum emitters). Control over the mechanisms for generating coherent longitudinal acoustic phonons (CLAP), and implementations of acoustic cavities that provide phonon confinement, are viewed as essential for developing novel optomechanical signal processing.

In this talk, we discuss CLAP generation in 2D materials and will describe high frequency, high quality factor (Q) 2D acoustic cavities operating in the 50-600 GHz frequency (f) range with f x Q products up to 1□1014. We show how cavity functionality can be engineered through the introduction of heterogeneities (e.g., steps and interfaces), and we demonstrate implementations of strongly coupled cavities in MoS2/hBN/MoS2 heterostructures, as well as frequency-comb generation in MoS2/hBN bilayer. Our theoretical and experimental results highlight that around 100 GHz, the acoustic phonon lifetimes approach their theoretical limit defined by the lattice anharmonicity.

References:

M. K. Zalalutdinov et al., Nature Communications 12, 3267 (2021)