Master Thesis – Exploring Hypersound Manipulation via Microfabrication and Brillouin Interferometry Measurements

Description – Phonons are the quasi particles representing the mechanical vibrations responsible for sound and heat transport in materials.[1] Analogous to electrons and photons, phonons also exhibit particle wave-duality and the phononic spectrum spans over a wide range of frequencies. Manipulation of phonons of different frequencies offer us control over different effects ranging from low frequency acoustics to high frequency (GHz-THz) hypersound and heat transport. Advancements in Nano and micro-fabrication techniques allows us to design and create phononic crystals. Phononic crystals are periodic materials that takes advantage of the wave like nature of phonons and control their propagation in materials. By manipulating the structure of phononic crystals, it is possible to create specific band gaps for different frequency ranges, including hypersound and heat frequencies.[2] This makes phononic crystals a promising candidate for manipulating hypersound and heat, which can be used for various applications such as signal processing, sensing, thermoelectricity and heat management. Recently, phononic crystals have gained a renewed research interest for their potential in manipulating topologically protected elastic waves.[3]

In this project, we will design and fabricate phononic crystals to manipulate phonons with hypersonic frequencies and characterize them using Brillouin light scattering interferometry. We will utilize optical and scanning electron microscopy techniques to characterize the phononic crystals. We will also perform complimentary measurement techniques such as Raman spectroscopy to fully characterize the phononic crystals.

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References:

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(2) Graczykowski, B.; Sledzinska, M.; Alzina, F.; Gomis-Bresco, J.; Reparaz, J. S.; Wagner, M. R.; Sotomayor Torres, C. M. Phonon Dispersion in Hypersonic Two-Dimensional Phononic Crystal Membranes. *Phys. Rev. B* **2015**, *91* (7), 075414. https://doi.org/10.1103/PhysRevB.91.075414.
(3) Mousavi, S. H.; Khanikaev, A. B.; Wang, Z. Topologically Protected Elastic Waves in Phononic Metamaterials. *Nat Commun* **2015**, *6* (1), 8682. https://doi.org/10.1038/ncomms9682.