Universality of the Frequency Spectrum of Laminates

Monday, August 14th @ 3 PM Room: BB W210

Dr. Gal Shmuel received his Ph.D. in mechanical engineering from Ben-Gurion University, Israel, in 2012. Thereafter, he was a Postdoctoral associate at the California Institute of Technology. Since 2014, he is an Assistant Professor at the Faculty of Mechanical Engineering, Technion, Israel. His research is concerned with the mechanics of active materials, which deform and change their properties by application of external stimuli; soft materials, capable of undergoing large deformations; and heterogeneous media, such as composites and polycrystals.

Abstract:

Waves in periodic media undergo multiple scattering and interference. As a result, their frequency spectrum is divided into bands in which waves pass freely, and gaps in which waves cannot propagate. This band diagram depends on the physical and geometrical properties of the periodic cell, through a dispersion relation.

Using a new representation of the dispersion relation of laminates, we show that their frequency spectrum admits a universal structure, independent of the thickness of each constituent and its particular physical properties. This structure allows deriving the maximal and average width, and the density of the gaps in the spectrum—the latter found to be universal. Rules for tailoring laminates according to desired spectrum properties thereby follow. We also show that various soft laminates—whose diagram is tunable—are also endowed with the same structure. Our representation facilitates characterizing this tunability, as we demonstrate via examples.

This talk is based on a joint work with Ram Band

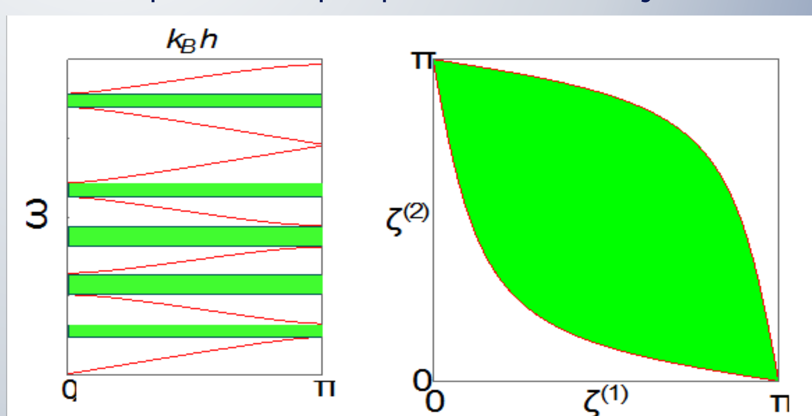

Figure: (Left) Representative band diagram. (Right) The universal band structure over a torus. The gap density (green region), calculated analytically over the torus, is universal.

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