PHYSICAL MATHEMATICS SEMINAR

Steelpans and singing saws: Localized vibrational modes in inhomogeneously curved shells

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ABSTRACT:

A thin elastic shell with spatially varying curvature may support localized vibrational modes, i.e. stationary waves which are confined to a small subregion. This phenomenon underlies the sustained tones of two shell-like musical instruments, the singing saw and the steelpan. Inspired by these instruments, we explore how geometry can be used to confine acoustic modes in thin elastic media and insulate them from boundary losses. By combining experiments, theory and numerical simulations, we show how spatial variations in curvature govern the localization strength of these trapped states.

We present two mathematical tools to infer the existence of localized modes in singly and doubly curved shells. The first is a generalization of the localization landscape theory, introduced by Mayboroda and Filoche in the scalar setting, to elastic shell theory. The landscape allows us to predict the location of confined eigenmodes by solving a Poisson problem instead of the full eigenvalue problem. Secondly, we show that certain geometries possess topologically protected modes which are localized near inflection lines, analogous to edge states in topological insulators. Our work suggests a geometric route to designing high-quality resonators across scales, from macroscopic instruments to nanoscale devices.

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2:30 PM – 3:30 PM
Building 2, Room 449

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