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Mechanical Meta-Materials as lattices of quadrupolar elastic charges

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Abstract:
Soft Mechanical Metamaterials (SMM) are elastic bodies that inherit their properties from their structure. Famous examples are simple elastomers that contain lattices of holes, presenting properties like negative elastic moduli, geometrically frustrated states, and nonlinear responses.

Theoretical analysis of SMM mechanics requires solving the non-linear equilibrium equations of elasticity theory accompanied by multiple boundary conditions on all holes edges, a daunting task from an analytical theoretical perspective. In contrast, finite-element numerical methods produce solutions that agree very well with experimental measurements.

In this talk I will introduce a new geometric formalism that reduces the continuum mechanical description into a discrete interacting elastic charges located at the holes' lattice, very similar to classical spin models. This effective formalism produces intuitive and quantitative predictions in agreement with previous experimental and numerical results. A direct advantage of this formalism is its natural extension to study disordered Soft Mechanical Metamaterials, a task that challenges current approaches, and immediately calls for the arsenal of statistical physics in and out of equilibrium. I will conclude by discussing the continuum limit of interacting quadrupolar field and its relevance for describing related systems such as wrinkles in thin elastomeric sheets and cellular tissue.

Date & Location:

Tuesday, November 24, 2020, 11:00
Zoom meeting