Feb 13, 2026

Powered by Symmetry. Protected by Topology:

A Journey Through the Special Mechanics of Kagome Metamaterials

Beyer Distinguished Lecture
ASCE Elasticity Committee Distinguished Lecture

Dr. Stefano Gonella

James L. Record Professor
Department of Civil, Environmental, and Geo-Engineering
University of Minnesota

Seminar Details

2:30-4:00pm

UH Campus
Classroom & Business Building
Room CBB 110

Online via Teams
https://teams.microsoft.com/meet/28672503493418?p=0CX16bX3BZZ6J5ss6O

ABSTRACT

Elastic metamaterials are structural materials that owe their unique wave manipulation capabilities to their complex internal architecture. Topological metamaterials are a special subclass of metamaterials whose behavior is controlled by the topology of their phonon bands. In this talk, I will explore some exceptional regimes exhibited by lattice metamaterials that can be traced to their symmetries and to the topological character of their phonon spectra. I will illustrate the problem through the lens of the kagome lattice family, whose geometry endows them with unique, often non-intuitive mechanical and acoustic properties. The discussion will encompass statics, dynamics, and some special static phenomena to understand which – paradoxically – one must look at the problem through the lens of wave mechanics. I will first invoke the notion of lattice duality. Applied to kagome lattices, duality offers a way to map a 2D periodic lattice with local elasticity to a 1D aperiodic chain endowed with long-range interactions. With the aid of a prototype, I will show that the emergent behavior of this chain features a series of non-intuitive deformation patterns, including the activation of non-local floppy twist sequences characterized by sharp sensitivity to the direction of loading. I will then shift the attention to structural kagome metamaterials. Through a deep dive into symmetry and group theory considerations, I will show the emergence of so-called fragile topological bands. Fragile topology is a weaker form of topology, elusive to detect in elastic systems, which manifests in the appearance of isolated pass bands with special morphological characteristics. I will demonstrate this phenomenon through carefully designed laser vibrometer tests carried out on physical prototypes. I will conclude by framing a pathway for the automatic design of elastic metamaterials with desired topological characteristics prescribed on demand.

BIOGRAPHY

Stefano Gonella is the James L. Record Professor in the Department of Civil, Environmental and Geo- Engineering at the University of Minnesota. He received Ph.D. and M.S. in Aerospace Engineering from Georgia Tech in 2007 and 2005, respectively, following a Laurea, also in Aerospace engineering, from Politecnico di Torino in 2003. Before joining the University of Minnesota, he was a post-doctoral associate at Northwestern University. During the 2023-2024 academic year, he was the William R. Kenan Visiting Professor for Distinguished Teaching at Princeton University. He is an elected Fellow of the American Society of Mechanical Engineers (ASME). Other distinctions include the NSF CAREER award in 2015 and several teaching awards at the University of Minnesota. His research interests revolve around the modeling, simulation and experimental characterization of dynamical phenomena in architected materials, phononic crystals and metamaterials. His latest efforts have been directed towards understanding the role of topological states of matter in the design of mechanical metamaterials.