Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Topological design of torsional metamaterials VINCENZO VITELLI, JAYSON PAULOSE, ANNE MEEUSSEN, Institute Lorentz for Theoretical Physics, Leiden, TOPOLOGICAL MECHANICS LAB TEAM — Frameworks – stiff elements with freely hinged joints – model the mechanics of a wide range of natural and artificial structures, including mechanical metamaterials with auxetic and topological properties. The unusual properties of the structure depend crucially on the balance between degrees of freedom associated with the nodes, and the constraints imposed upon them by the connecting elements. Whereas networks of featureless nodes connected by central-force springs have been well-studied, many real-world systems such as frictional granular packings, gear assemblies, and flexible beam meshes incorporate torsional degrees of freedom on the nodes, coupled together with transverse shear forces exerted by the connecting elements. We study the consequences of such torsional constraints on the mechanics of periodic isostatic networks as a foundation for mechanical metamaterials. We demonstrate the existence of soft modes of topological origin, that are protected against disorder or small perturbations of the structure analogously to their counterparts in electronic topological insulators. We have built a lattice of gears connected by rigid beams that provides a real-world demonstration of a torsional metamaterial with topological edge modes and mechanical Weyl modes.

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Date submitted: 06 Nov 2015 Electronic form version 1.4