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A Design Method for Topologically Insulating Metamaterials¹ KATHRYN MATLACK, ETH Zurich, University of Illinois Urbana-Champaign, MARC SERRA-GARCIA, ETH Zurich, ANTONIO PALERMO, University of Bologna, SEBASTIAN HUBER, ETH Zurich, CHIARA DARAIO, ETH Zurich, California Institute of Technology — Topological insulators are a unique class of electronic materials that exhibit protected edge states that are insulating in the bulk, and immune to back-scattering and defects. Discrete models, such as massspring systems, provide a means to translate these properties, based on the quantum hall spin effect, to the mechanical domain. This talk will present how to engineer a 2D mechanical metamaterial that supports topologically-protected and defectimmune edge states, directly from the mass-spring model of a topological insulator. The design method uses combinatorial searches plus gradient-based optimizations to determine the configuration of the metamaterials building blocks that leads to the global behavior specified by the target mass-spring model. We use metamaterials with weakly coupled unit cells to isolate the dynamics within our frequency range of interest and to enable a systematic design process. This approach can generally be applied to implement behaviors of a discrete model directly in mechanical, acoustic, or photonic metamaterials within the weak-coupling regime.

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