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Topological mechanical metamaterials have perfectly directional bulk response[1] D. ZEB ROCKLIN, Cornell University, Georgia Institute of Technology — The elastic response of typical materials to a local load is stress and strain in all directions. Here, we show contrariwise that mechanical frames with balanced numbers of constraints and degrees of freedom (the "Maxwell" condition) can experience stress and/or strain on only one side of a load. Kane and Lubensky showed, in a recent, seminal work, that such systems possess a topologically nontrivial phonon band structure corresponding to the electronic modes of topological insulators. Applying bulk-boundary correspondence, they demonstrated a signature physical consequence: the shifting of zero modes resultant from missing bonds from one edge to another. We now show that the same topological invariant governs such a system's bulk response: when bonds are swollen at one point the lattice does not distort evenly around it but instead only on one side dictated by the topological polarization. Similarly, when general forces are applied to a polarized lattice tension is induced in bonds only on one side of the applied force. Hence, topological polarization represents a sharp and robust way to direct force and motion and the response (Green's) function is a fundamental bulk signature of topological polarization.

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