Topological soft matter: from linkages to kinks

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Networks of rigid bars connected by joints, termed linkages, provide a minimal framework to design robotic arms and mechanical metamaterials built out of folding components. These linkages may admit motions that perform useful functions. Can these motions be made to be topologically robust? I will explain this question and illustrate our answer with a chain-like linkage that, according to linear elasticity, behaves like a topological mechanical insulator whose zero-energy modes are localized at the edge. Simple experiments we performed using prototypes of the chain vividly illustrate how this edge mode can in fact propagate unobstructed all the way to the opposite end. Indeed, the chain is a mechanical conductor, whose carriers are nonlinear solitary waves, not captured within linear elasticity. This chain can be regarded as the simplest example of a topological mechanical metamaterial whose protected excitations are solitons, moving domain walls between distinct topological mechanical phases. Live demonstrations on real toys will be performed.