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Overcoming dissipation with structure: Stable propagation of mechanical signals in soft mechanical metamaterials KATIA BERTOLDI, JORDAN RANEY, Harvard University, NEEL NADKARNI, California Institute of Technology, CHIARA DARAIO, ETH, DENNIS KOCHMANN, California Institute of Technology, JENNIFER LEWIS, Harvard University — Soft structures with rationally designed architectures capable of large, nonlinear deformation present opportunities for the design of unprecedented, highly-tunable devices and machines. However, the highly-dissipative nature of soft materials has inherently limited the way in which such systems can be used. Here we present an architected soft system comprised of elastomeric, bistable beam elements connected by elastomeric linear springs. The dissipative nature of the polymer readily damps linear waves, preventing propagation of any mechanical signal beyond a short distance, as expected. However, the unique architecture of the system enables propagation of stable, nonlinear solitary transition waves with constant velocity and pulse geometry over arbitrary distances. Since the high damping of the material removes all other linear, small amplitude excitations, the desired pulse propagates with high fidelity and controllability. This phenomenon can be used for control signals as we demonstrate through the design of soft diodes and soft mechanical logic gates.

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