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Controlling large deformations of marginal disordered structures
MENACHEM STERN, MATTHEW PINSON, University of Chicago, ALEXANDRA CARRUTHERS, University of Puerto Rico, San Juan, ELIZABETH CHEN, Harvard University, ARVIND MURUGAN, University of Chicago — Metamaterials are typically sought to demonstrate specific responses in the non-linear deformation regime. However, analytic methods for these systems are often based on linear approximations. We find that practical questions of actuation in origami have counter-intuitive answers due to a strong mismatch between linear and non-linear theory near the special flat state, where all modes meet. Linear-non-linear mismatch generically leads to an exponential number of 'dead end' folding modes, resulting in an emergent glassy energy landscape around the flat state. This landscape makes refolding of a pre-folded creased sheet much more difficult than one would expect. Conversely, borrowing results from associative memory in neuroscience, we show that structures with multiple programmed folding motions can be much easier to control than expected, as long as the flat state is avoided.

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