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A general theory of mechanical instabilities in soft solids EVAN HOHLFELD, Department of Physics, Harvard University and Chemical Sciences Division, LBNL, L. MAHADEVAN, Engineering and Applied Sciences, Kavli Institute for Nanobio Science and Technology, Harvard University — Some instabilities in soft solids, e.g. buckling and wrinkling, can be detected in linearized analysis. Surprisingly, linearly stable configurations can still have nonlinear instabilities with strictly zero energy barrier. Two examples are cavitation (formation of voids) and sulcification (formation of sharply creased free surface folds), wherein singularities nucleate and grow when a critical strain is achieved. Here we present the first general theory of stability in nonlinearly elastic materials. The theory predicts when singularities spontaneously form, irrespective of linearized analysis, and how these can be controlled with geometry. Such "hidden" instabilities arise from the scale-free geometric and constitutive nonlinearities common in soft materials, and can be understood as scale symmetry breaking processes in simple cases. More deeply, even buckling and wrinkling can be traced back to scale-free linear instabilities (loss of ellipticity at an interface) as was first explained by M. A. Biot. We illustrate the theory with simulations and experiments on sulcification. Time allowing we will also discuss fracture and delamination.

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