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Marginal Matter

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All around us, things are falling apart. The foam on our cappuccinos appears solid, but gentle stirring irreversibly changes its shape. Skin, a biological fiber network, is firm when you pinch it, but soft under light touch. Sand mimics a solid when we walk on the beach but a liquid when we pour it out of our shoes. Crucially, a marginal point separates the rigid or jammed state from the mechanical vacuum (freely flowing) state - at their marginal points, soft materials are neither solid nor liquid. Here I will show how the marginal point gives birth to a third sector of soft matter physics: intrinsically nonlinear mechanics. I will illustrate this with shock waves in weakly compressed granular media, the nonlinear rheology of foams, and the nonlinear mechanics of weakly connected elastic networks.