Elasticity on the Edge of Stability: Soft Matter Inspired by the Cell

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Much like the bones in our bodies, the cytoskeleton consisting of stiff protein biopolymers determines the mechanical stability and response of cells. Unlike passive materials, however, living cells are kept far out of equilibrium by metabolic processes and energy-consuming molecular motors that generate forces to drive the machinery behind various cellular processes. Inspired by such networks, we describe recent theoretical and experimental advances in our understanding of fiber networks in vitro and in vivo. We show that these exhibit a unique state of highly responsive matter near the isostatic point first studied by Maxwell [1,2]. For fiber networks, this represents a marginal state of matter with exceptional mechanical properties, including a strongly nonlinear elastic response and zero-temperature critical behavior [3]. Moreover, the introduction of molecular motor activity can dramatically affect the stability of such systems [4,5].

References:

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