Mechanosensing via inhibition of dissipation in a thermodynamically consistent active solid

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Active solids provide a framework for understanding the mechanics and thermodynamics of dense living matter, while also offering design principles for synthetic metamaterials with embedded actuation and chemistry. A central challenge in describing these nonequilibrium systems is to derive macroscopic mechanochemical couplings from well-defined microscopic sources of activity, rather than imposing them phenomenologically. Adopting a bottom-up theoretical approach, we formulate a thermodynamically consistent model of an active solid and identify one such emergent coupling between mechanical response and dissipation. In particular, we show that dissipation is maximised at finite stress and suppressed at large stress, effectively driving a transition toward passive behaviour. This mechanism provides a generic explanation for the nonmonotonic enzymatic activity observed in crowded biocondensates, and suggests a route to distributed mechanosensing that can be exploited to functionalise active materials.