Abstract Submitted
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Extending two-phase theories of soft composite solids to the non-dilute regime[1] FRANCESCO MANCARELLA, Nordic Institute of Theoretical Physics (NORDITA), ROBERT STYLE, University of Oxford, JOHN WETTLAUFER, Yale University and Nordic Institute of Theoretical Physics (NORDITA) — Composite materials are ubiquitous in the natural environment and in engineered materials and hence capture the interest of a wide audience. Eshelby's 1957 theory treats the interaction of macroscopic stress fields with isolated inclusions within an elastic solid, and it has been widely used to treat the mechanics of composite materials. However, due to its neglect of interface stress, which is a particularly key effect in soft materials, the theory breaks down whenever the typical inclusion size R is of order or less than the elastocapillary lengthscale L. In this regime, under external stress, the effect of inclusion shape becomes strongly size-dependent. Here, we develop two new non-dilute theories, estimate the elastic moduli of composites comprised of an isotropic, compressible, linear-elastic compliant solid hosting a non-dilute spatially-random distribution of identical liquid droplets. The composite stiffness depends on a single dimensionless parameter L/R, and we find significant elastic moduli corrections for inclusions sizes R as large as 100 L. By generalizing the exact theory recently developed for the corresponding dilute case, we find that when $R < 3L/2$ ($R = 3L/2$) liquid inclusions stiffen (cloak the far-field signature of) of the host solid.

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