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A numerical modeling capability for the interplay between surface energy and elasticity in soft materials DAVID HENANN, YUHAO WANG, Brown University — Surface energy is an important factor in the deformation of fluids but is typically a minimal or negligible effect in solids. However, when a solid is soft and its characteristic dimension is small, forces due to surface energy can become important and induce significant elastic deformation. The interplay between surface energy and elasticity can lead to interesting elasto-capillary phenomena. We have developed a finite-element formulation for problems involving these effects in both 2D and 3D settings and will demonstrate the simulation capability by examining two elasto-capillary problems. (1) The Rayleigh-Plateau instability in an elastic material – In a fluid, this instability causes fluid jets to break up into droplets; however, as shown in recent experiments (Mora et al., PRL, 2010), break-up is prohibited in an elastic material, resulting in a stable undulatory configuration. (2) The effect of fluid-filled droplet inclusions on a soft solid – When the matrix material is stiff, the presence of fluid-filled inclusions leads to a more compliant composite material; however, recent experiments (Style, et al., Nature Physics, 2014) have shown that when the matrix material is more compliant, the presence of droplets leads to stiffening. In this talk, we will show that our simulation capability predicts all experimentally observed phenomena and provides a straightforward route for describing nonlinear aspects of elasto-capillarity, which are difficult to address via analytics.

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