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Elastohydrodynamic relaxation of porous films and slender fibers

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he deformation of soft and flexible objects is a common elastohydrodynamic scenario. In this presentation, we consider deformable surfaces and flexible fibers subjected to hydrodynamic and capillary stresses, and the resulting dynamical approaches to equilibrium. First, we consider a rigid object approaching a poroelastic material in a viscous fluid, for which hydrodynamic stresses arise in the lubricated contact region and deform the soft material. The elastic deformation modifies in turn the flow, hence generating a soft-lubrication coupling. As revealed by our analytic model making use of linear poroelastic theory, the effect of porosity in this scenario is essentially to divide the response into compressible and incompressible parts, with a diffusive temporal crossover separating the two purely elastic responses. Second, we consider a slender fiber prepared in a microfluidic chip, subject to capillary stresses at the surface of a confined and driven droplet. In general, the equilibria for these types of liquid-fiber systems depend on surface tension and the bending modulus of the deformable object. Indeed, a plethora of self-assembled structures including coiled droplets, bundled hair and capillary origami have been observed elsewhere. If these equilibria are well described in the literature, the dynamic equilibration path in surrounding hydrodynamic flow has been less reported. Our system provides a model visco-elasto-capillary relaxation context, starting from a model non-equilibrium state. We thus observe and describe theoretically the dynamic retraction of a slender fiber into a moving droplet.

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