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Soft Lubrication, Lift and Optimality JAN M. SKOTHEIM, Center for Studies in Physics and Biology, The Rockefeller University, L. MAHADEVAN, Division of Engineering and Applied Sciences, Harvard University — We consider some basic principles of fluid-induced lubrication at soft interfaces. In particular, we quantify how a soft substrate changes the geometry of and the forces between surfaces sliding past each other. By considering the model problem of a symmetric nonconforming contact moving tangentially to a soft surface, we determine the normal force in the small and large deflection limit, and show that elastic deformation couples tangential and normal forces and thus generates lift. Furthermore, there is an optimal combination of material and geometric properties that maximizes the normal force. We investigate a variety of geometries and constitutive equations for the soft material, but always find the same generic behavior which suggests that our theory may be broadly applicable to the elastohydrodynamic lubrication of soft elastic and poroelastic gels and shells, and perhaps even cartilaginous joints.

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