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Pressure-dependent surface viscosity and its surprising consequences in interfacial flows HARISHANKAR MANIKANTAN, TODD SQUIRES, University of California, Santa Barbara — The surface shear viscosity of a surfactant monolayer almost always depends strongly on surface pressure, and this oft-ignored rheological feature significantly alters fluid flow and dynamics of particles on the interface. In order to illustrate the qualitatively new phenomena that arise out of pressure-dependent rheology, we focus here on a series of analytically tractable yet paradigmatic examples of lubrication geometries. Thin-gap flows naturally amplify pressure changes, and thus exemplify the effects of pressure-dependent viscosity. We show that much of the mathematical machinery from Newtonian lubrication analyses can be modified in a relatively straightforward manner in such systems. Our analysis reveals novel features such as a self-limiting flux when a surfactant is pumped through a narrow channel, a maximum approach velocity in squeeze flows due to divergent inter-particle forces, and forces perpendicular to the direction of motion that breaks symmetries associated with Newtonian analogs. We discuss the broader implications of these phenomena, especially with regard to interfacial suspension mechanics for which these lubrication geometries provide a convenient limit.

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