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Weak Nonlinear Analysis of the Rayleigh-Taylor Instability in Linear Viscoelastic Fluids[1] DINESH BHAGAVATULA, RANGA NARAYANAN, University of Florida — Pattern formation at the free surface of compliant media when subject to gravity is of relevance in the design of soft devices with tuneable shapes and in the dynamics of mucus films in pulmonary capillaries. These interfacial patterns owe their origin to an instability arising from the interplay between elasticity, viscosity, surface tension and gravity. In this work, we focus on the stability of a linear viscoelastic fluid layer attached to a rigid surface in the presence of gravity. The stability of this system is investigated by carrying out a linear stability and nonlinear analysis. From this analysis, we identify the critical parameter space for the onset of the instability. The weakly nonlinear analysis indicates that the elasticity of the soft-gel layer plays a key role in the supercritical to subcritical transition. To glean the physics of this transition, we focus on a soft-gel layer whose thickness in infinite. This infinite layer configuration reveals that the elastic component of normal force balance alters the nature of the bifurcation from subcritical rupture to supercritical saturation of the free surface. The subcritical rupture of the interface is attributed to the elastic shear stresses and surface tension.

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