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Effects of elasticity and surface tension on the spreading dynamics of a thin film under the influence of intermolecular forces[1] YUAN-NAN YOUNG, Dept. of Math. Sci., New Jersey Institute of Technology, HOWARD STONE, Dept. of Mechanical and Aerospace Engineering, Princeton University — The spreading dynamics of a thin layer of viscous Newtonian fluid between an elastic sheet and a wetting solid substrate is examined using lubrication theory. On the wetting substrate an ultra thin film (precursor film) develops as a result of an intermolecular force between the fluid and the solid substrate. Such a precursor film prevents the stress singularity associated with a moving contact line in the lubrication framework. Following the methodology by Glasner (2013, Phys. Fluids), the elasticity effects on the macroscopic contact line in the quasistatic limit are elucidated by an ordinary differential equation derived from an energetic analysis. Similar to the case of a fluid interface with surface tension (capillary spreading), the elasto-capillary thin film profile also consists of a core at the center, an ultra thin film in the far field, and a contact line region where the core film profile connects smoothly to the precursor film. For capillarity-dominated spreading, the precursor film transitions monotonically to the core film. For elasticity-dominated spreading, a spatial oscillation of film height in the contact line region is found instead. In addition, elasticity causes a sliding motion of the thin film: the contact angle is close to zero due to elasticity.

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