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Surfactant-Induced Fingering Phenomena in Thin Liquid Films

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The Marangoni-driven spreading of a surfactant droplet on a thin liquid film is accompanied by an instability, which manifests itself via the formation of fingering patterns. These patterns localise near the foot of the droplet behind an advancing front that forms at the surfactant leading edge. We have developed a theory based on the lubrication approximation to explain the physical mechanism responsible for this fingering instability. This theory elucidates the dependence of the pattern wavelength on system parameters such as the ratio of the thickness of the underlying film to that of the droplet, surfactant solubility and the form of the surfactant equation of state. The patterns obtained from our numerical simulations bear a striking resemblance to those observed experimentally.

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