Mobile soap film drainage shows self-similarity

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Liquid foams are widely used in industry because of their remarkable thermal and mechanical properties. Although, predicting their stability remains a challenge as it results from diverse mechanisms. One of which is liquid film thinning under the effect of drainage, that is still lacking today full understanding.

We study a unique soap film in a rectangular frame draining under the effect of gravity. Our study focuses on "mobile" soap films that exhibit a smooth thickness profile at their center along with the presence of an instability near the borders of the frame, next to the meniscii, called marginal regeneration [2]. This instability creates locally thinner film elements surrounded by thicker film. Subject to gravity, in vertical films, these thinner elements rise due to buoyancy force. This phenomenon generates an upward flux along the borders inside the frame, contrasting with the overall downward motion of the colored interference fringes in the center of the films [3]. We aim to address how to characterize these two opposite flows and understand how they are coupled, dictating the time scale of the thinning process.

In our work, we precisely study the spatio-temporal features of the thinning process thanks to color interferometry. We show that there is an equivalence between looking at the descent dynamics of the interference fringes and looking at the thinning dynamics at given positions. We also show that the drainage dynamics is self-similar gathering all data onto a single curve regardless of the solution properties and frame dimensions. Finally, data from literature also align with ours, suggesting a universal soap film shape during the drainage. To conclude, draining films all have the same shape with a thinning rate that is a function of the experimental parameters [4]. These results pave the way towards a better understanding on how marginal regeneration governs soap film drainage.

Références

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