On the Landau-Levich transition.

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A solid surface can be coated by a thin film when the solid is withdrawn out of a bath of liquid. This dip coating process was first analyzed by Landau and Levich, who computed the thickness of the entrained film as a function of plate velocity. In the case of partial wetting, where the liquid does not naturally wet the plate, there is a threshold velocity below which the meniscus is steady and the solid remains dry. Liquid entrainment only occurs above this threshold value, and we investigate the dynamic wetting transition between from a stable meniscus to an entrained film.It has recently been predicted that a receding contact line becomes unstable when the capillary number exceeds a critical value $Ca_c^{\#}$ and that at this critical point perturbations of the contact line would relax with an infinite time.

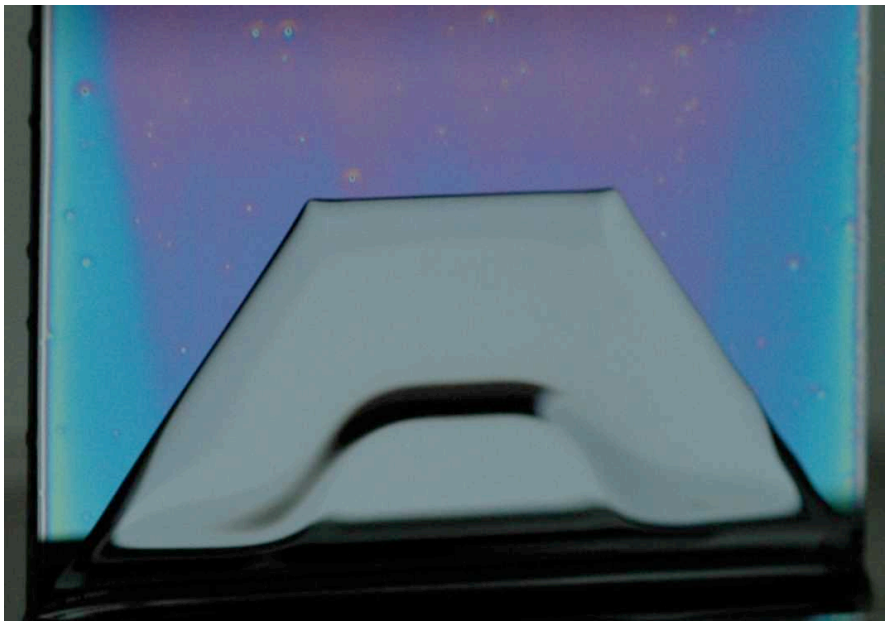

figure : liquid film entrained by a vertical plate pulled out of a bath of silicone oil

In our experiments, however, liquid entrainment occurs at a capillary number Ca* which is significantly lower than Ca_c. The critical behavior expected at Ca_c is thus avoided, and we observe that contact line perturbations decay with a finite relaxation time. The threshold velocity coincides precisely with the contact line velocity above the transition, and we attribute the early transition to the nucleation of a capillary ridge (see fig.) which moves ahead of the thin film. Hence, the characteristics of this ridge determine the threshold velocity for liquid entrainment. Observations are compared with a full-scale hydrodynamic model.

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