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Singularities at contact: mechanics of a liquid drop on a solid film

BENNY DAVIDOVITCH, UMass Amherst, DOMINIC VELLA, Oxford University — Partial wetting of solid surfaces is a classical phenomenon, which underlies many elasto-capillary problems. It is thus surprising that some key aspects of partial wetting create much confusion among workers in this field. At the heart of this confusion is the interplay of two kinds of singular processes: First- matching three continuum phases at the contact line; Second —doing so with vanishing strain for an “inextensible” solid phase. In this talk I will address the contact of a liquid drop on a thin, stiff solid film, suspended between fasteners or subjected to fixed tensile loads. In such a set-up, the mechanics is doubly singular, reflecting high bendability together with near inextensibility of the film. Several groups suggested recently that the deformation of the film induced by the drop allows measuring the solid-liquid and solid-vapor surface energies, or a “pre-tension” in the suspended film. I will explain the fundamental error that underlies such proposals, and will describe a solution to this problem. Our solution employs singular perturbation theory, and takes into full consideration solid elasticity and surface energy.

Benny Davidovitch
UMass Amherst

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