Interaction between a descending cube and a soap film

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ABSTRACT

The interaction that occurs between liquid foams and solid objects is important in industrial processes such as froth flotation for mineral separation and has many potential applications in microfluidics. To better understand this interaction, we study how a light cube is reoriented by a horizontal soap film (e.g. of a bamboo foam) that it descends onto under its own weight. We present results from quasi-static (Surface Evolver [1]) simulations in which we vary the initial orientation of the cube, as well as the Bond number, which we validate by comparing with experimental results. Previously, we showed that a bamboo foam reorients a cube towards a particular stable orientation as it descends through and detaches from the soap film, so that it presents a horizontal surface to the next film of the foam [2]. In this work, we reduce the Bond number so that surface tension effects become even more important compared to gravitational effects, and as a result the cube sometimes becomes entrapped in the soap film. For smaller Bond numbers, we show that the stable orientation for the cube is as shown in Figure 1, where the soap film has a hexapolar deformation with three rises and three depressions. We show how the final orientation varies with the Bond number, and find the critical Bond number where the soap film can no longer support the weight of the cube.

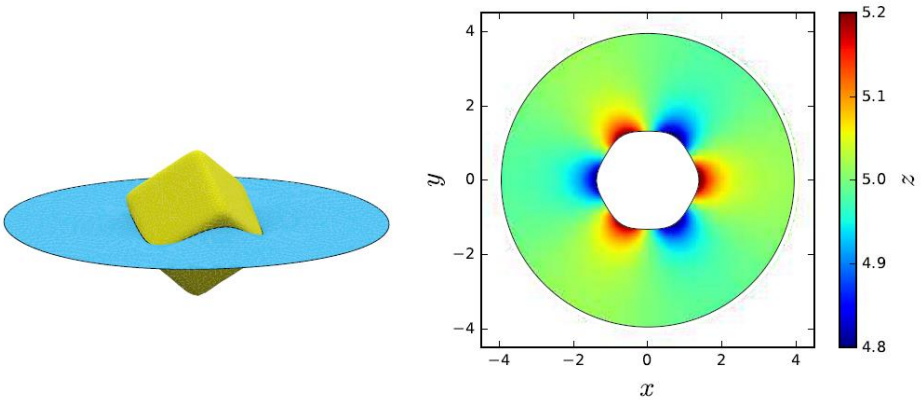

Figure 1: A (superquadric) cube suspended at equilibrium in a soap film.

[1] K. Brakke. The Surface Evolver, Exp. Math., 1:141-152. 1992.

[2] I.T. Davies. Simulating the interaction between a descending super-quadric solid object and a soap film. P Roy Soc A-Math Phy, 474(2218), p.20180533