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A close-up view of a pancake droplet in the microfluidic chips[1]

LAILAI ZHU, FRANCOIS GALLAIRE, Laboratory of Fluid Mechanics and Instabilities (LFMI), EPFL — We develop a boundary integral method to study the droplet dynamics in confined geometries in the low-capillary-number regime, where the the lubrication film between the droplet and solid boundaries becomes important. We investigate a translating droplet tightly squeezed in a Hele-Shaw cell. The cell gap width is around $0.5 \sim 0.85$ the radius of a relaxed droplet and the capillary number is in the range $[0.007, 0.16]$. We highlight the three-dimensional feature of the droplet interface and flow filed. The interface develops an arc-shaped ridge near the rear-half rim with a protrusion in the rear and a laterally symmetric pair of higher peaks; this pair of protrusions has been identified by recent experiments [2] and predicted asymptotically [3]. The mean film thickness is well predicted by the extended Bretherton model with fitting parameters. Flow fields with recirculation patterns are presented. On the horizontal plane, a dipolar disturbance flow field is identified and its $1/r^2$ spatial decay is confirmed numerically.

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[2]Huerre et al., Phys. Rev. Lett., vol. 115 (6), 2015, 064501
[3]Burgess Foster, Phys. Fluids A, vol. 2 (7), 1990, pp. 1105-1117

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