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Creeping three-dimensional flow around a immobile penny-shaped cylindrical droplet FRANCOIS GALLAIRE, LFMI, EPFL, Lausanne, Switzerland — The flow in a shallow microchannel around a stationary flattened cylindrical viscous droplet at low Reynolds number is considered, using matched asymptotic expansions, with the aspect ratio as small parameter. At leading order, the flow is at rest in the center region of the droplet and it is governed by the two-dimensional Hele-Shaw potential flow equations in the exterior. However, close to the interface, a boundary layer has to be introduced in each fluid, in order to fulfill the kinematic and dynamic boundary conditions. As anticipated from simple scaling arguments, the boundary layer thicknesses scale with the channel height. The next order in the boundary-layer expansion shows the appearance of both radial and cross-plane velocity components. The results are compared to numerical solutions of the full 3-D Stokes equations. Marangoni driving along the interface can be included and yields surprising 3-D recirculation patterns.

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