The evolution of viscous flow on a cylinder
DAISUKE TAKAGI, HERBERT E. HUPPERT, Institute of Theoretical Geophysics, DAMTP, University of Cambridge — The temporal development of a thin viscous layer on a stationary cylinder is investigated both theoretically and experimentally. A constant volume of fluid is released instantaneously at the top of a cylinder, whose axis is horizontal. The resultant flow is confined laterally by vertical plates and propagates down a channel whose slope varies continuously along the flow. The structure of the current is shown using lubrication theory to initially have a uniform thickness. This thickness is independent of the fluid volume per cross-stream width. The thickness and length of the current after time \( t \) from initiation are given by \((3\nu R/2g)^{1/2}t^{-1/2}\) and \(A(2g/3\nu R)^{1/2}t^{1/2}\) respectively, where \( g \) is gravity, \( A \) the cross sectional area of fluid, \( \nu \) its kinematic viscosity and \( R \) the radius of the cylinder. These results are in good agreement with experimental data taken on a cylinder of radius 15 cm and width 11 cm. The front of the current, which can produce a series of rivulets after it has propagated a distance proportional to \( A^{1/2} \), ultimately detaches from the underside of the cylinder. Video clips of the laboratory experiments highlight some remarkable features at the contact line due to capillary action.

Herbert E. Huppert
Institute of Theoretical Geophysics, DAMTP, University of Cambridge

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