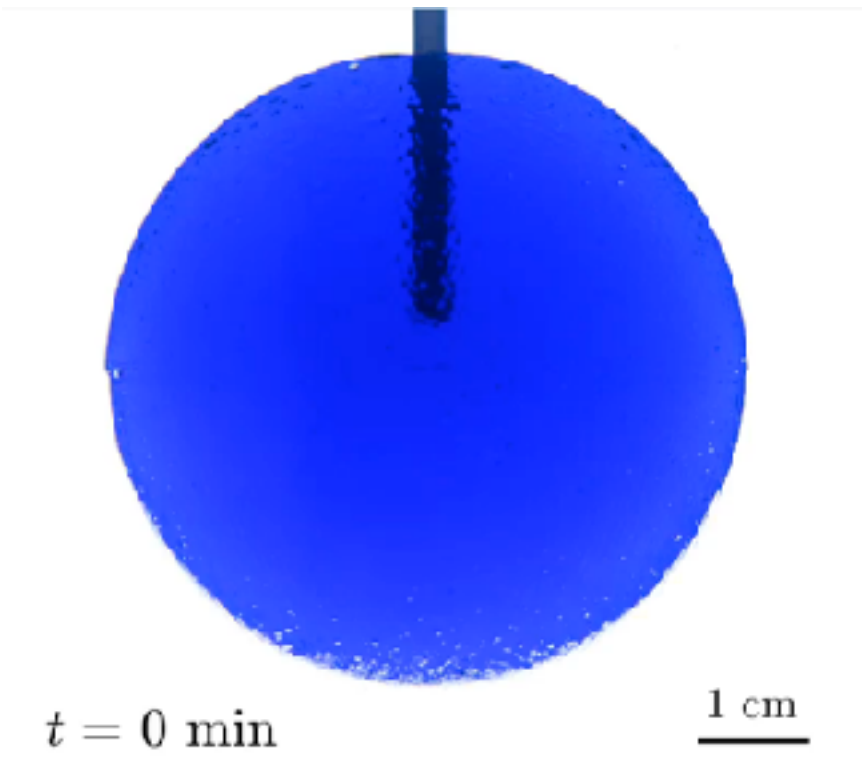
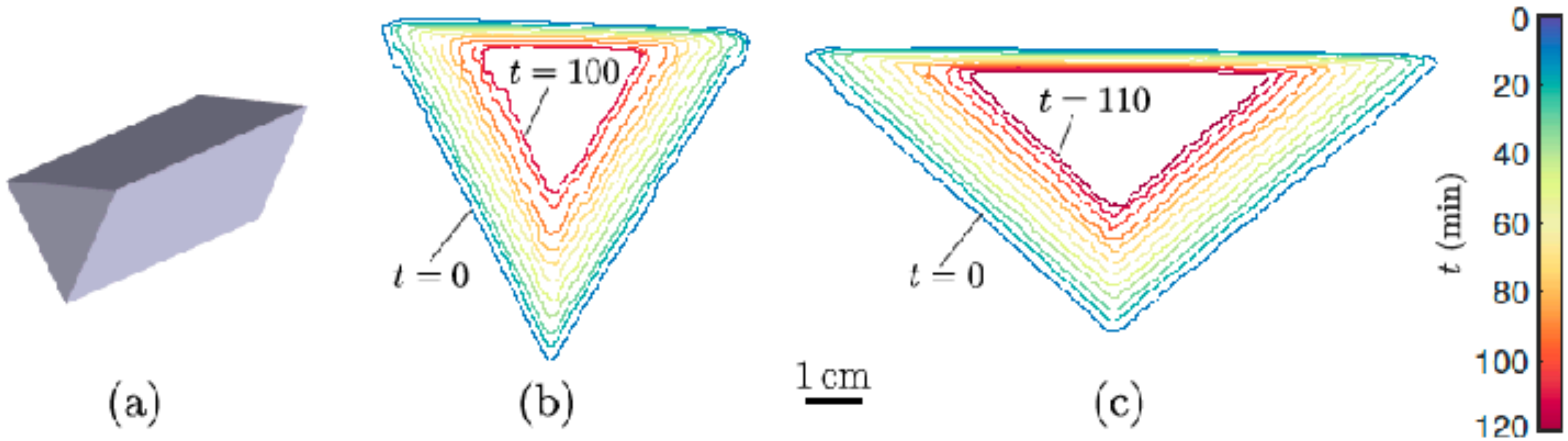
The Chupa Chup® problem



Self-sculpting of a dissolvable body due to gravitational convection, M.S. DaviesWykes et al. *Phys Rev. Fluids* **3**, 043801 (2018)

The Chupa Chup® problem



$V_{Dissolution} \sim 1 cm/h$

FIG. 5. Shape preservation of dissolving wedges. (a) Sketch of initial configuration: cross-sectional shape evolution at 10-min intervals for bodies with initial base angle (b) $\theta_0 = 60^\circ$ and (c) $\theta_0 = 100^\circ$.

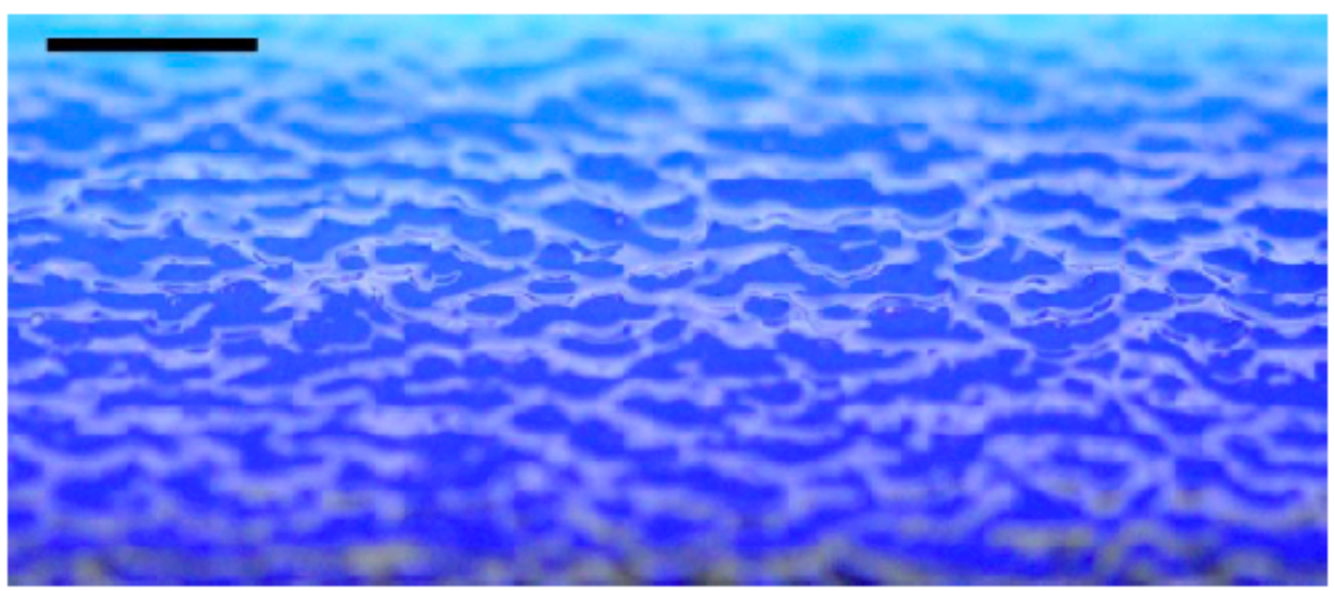


FIG. 6. Small-scale roughness on the underside of a partially dissolved wedge. The wedge has dissolved for 10 min and the scale bar is 1 cm.

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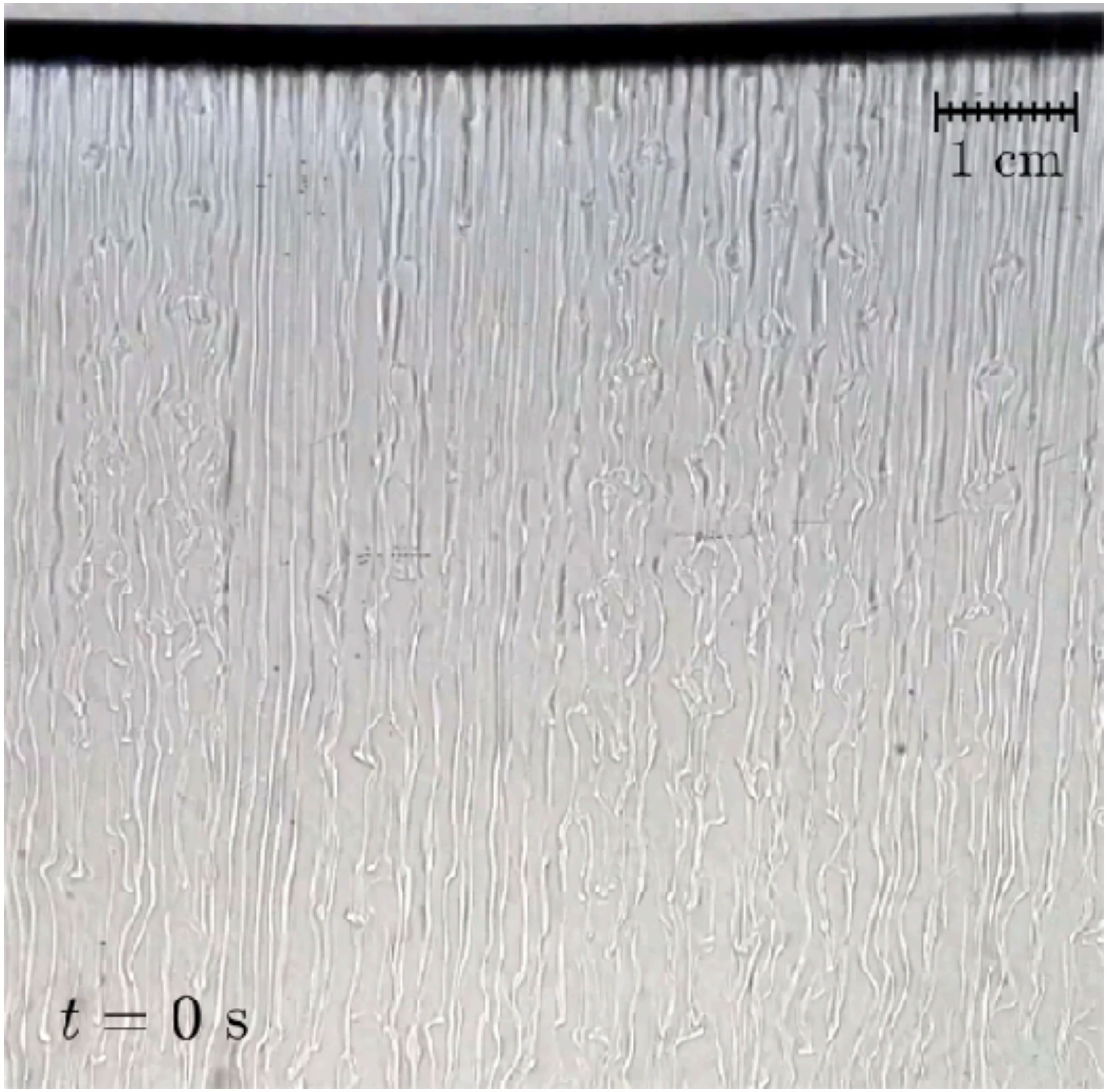
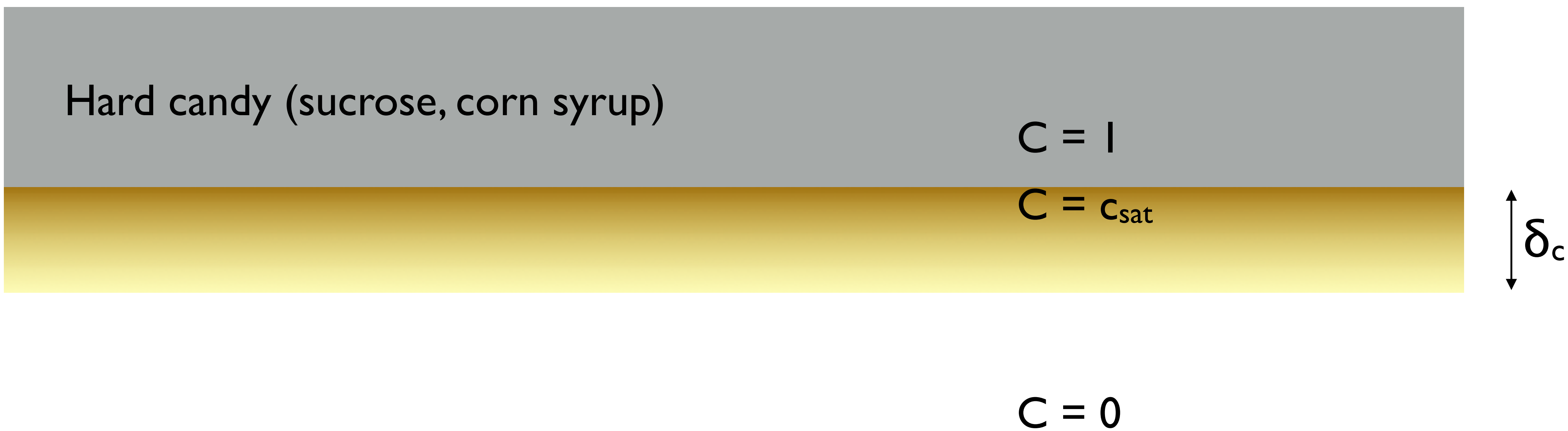


The Chupa Chup® problem

Derive an order of magnitude of the critical thickness δ_c for the instability of the layer of dense sucrose solution
Derive an ordre of magnitude of the dissolution velocity



$\rho_s = 1.4\ g/cm^3$

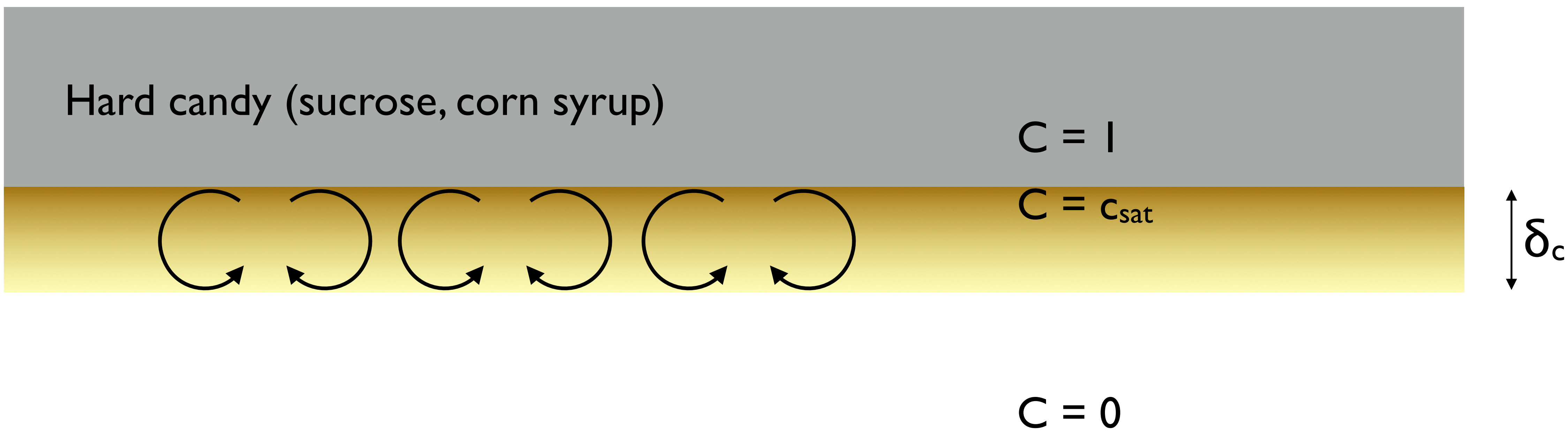
$\rho_f = 1\ g/cm^3$

$c_{sat} = 0.67$

$\nu_{sat} = 770 \times 10^{-6}\ m^2/s$

$D_{sucrose} = 4 \times 10^{-10}\ m^2/s$

$\nu_{water} = 10^{-6}\ m^2/s$



Estimate the velocity V within the convection rolls by balancing the driving buoyancy torque and the viscous torque

Estimate the convection time t_C across the diffusion layer

Compare it to the mass diffusion time t_D