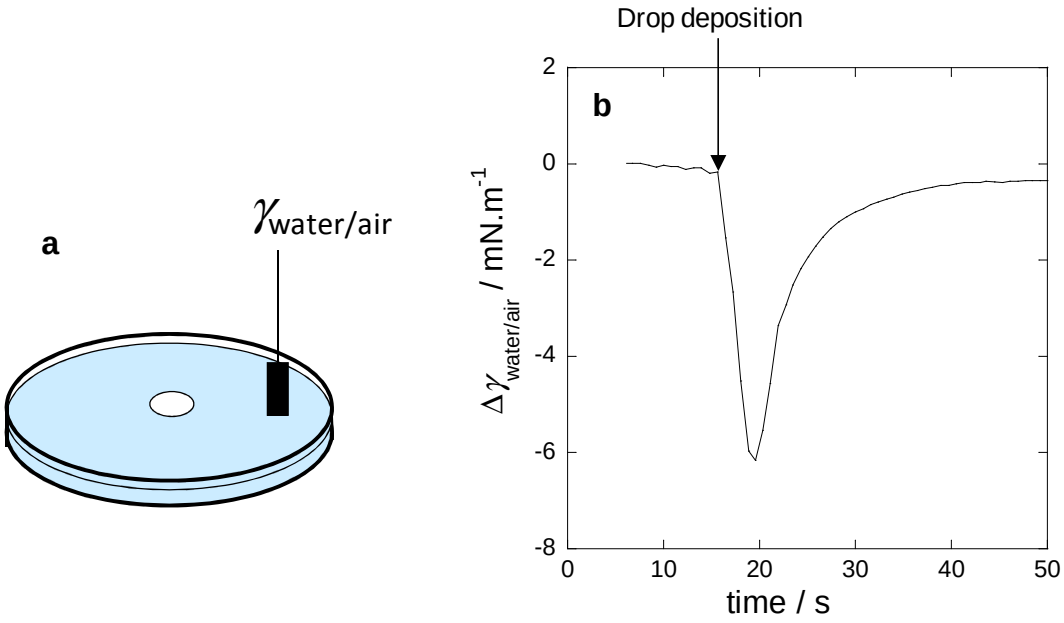
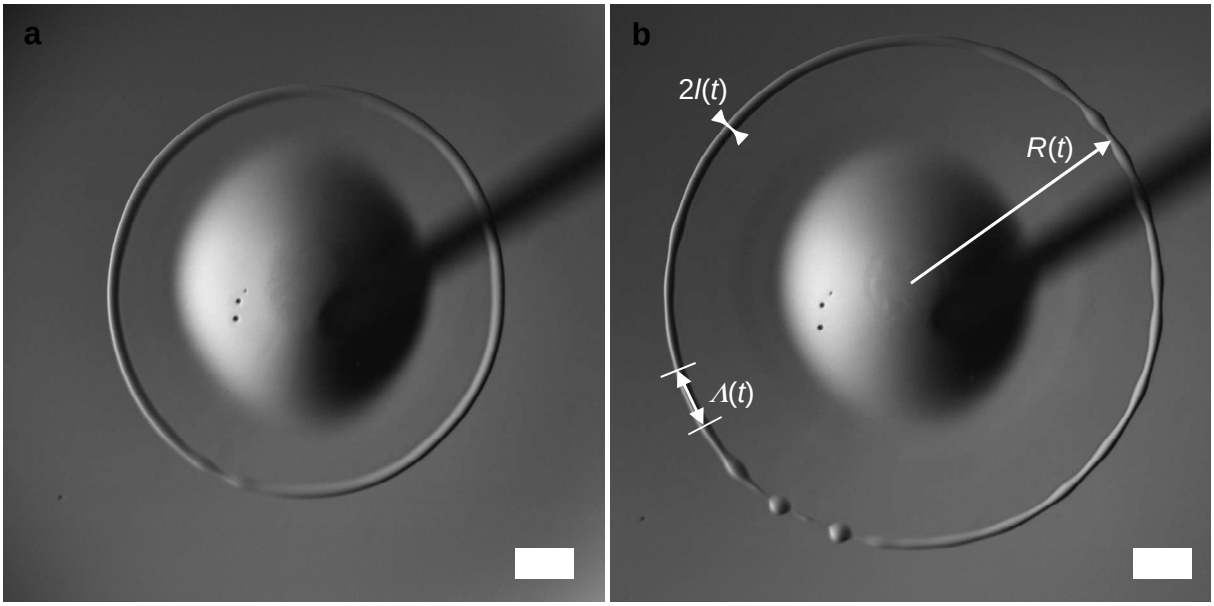


Supplementary Figure 1: **Experiment revealing the surface activity of DCM on water**. **a** sketch of the measurement setup, with the Wilhelmy plate inserted 3cm away from the centre of the Petri dish; **b** evolution of the water/air surface tension after a 25 µL drop has been released, revealing a fast 6 mN.m^{-1} decrease of $\gamma_{water/air}$. Beyond that point, the drop fades away and the surface tension gradually recovers its initial value.



Supplementary Figure 2: Evolution of rim varicosities. **a** rim geometry at time t_1; **b** at time t_2=t_1+14.86 ms. Values of the most amplified wavelength Λ were obtained by determining the distance between the two most pronounced bulges in **a**, and between the two bulges at the left of the two drops in **b**; the (larger) wavelength comprised between the two drops in **b** was excluded because it is already influenced by nonlinear mechanisms, as testified by the presence of a satellite droplet in between the two drops.

	Λ/l ($t=t_0$)	Λ/l ($t=t_1$)
theory, $T_\gamma/T_s \to 0$, $T_{\mu o}/T_s \to 0$	9.01	9.94
theory, $T_\gamma/T_s \to 0$, $T_{\mu o}/T_s = 1$	6.65	7.53
experiments, $T_\gamma/T_s \approx 0.0073$, $T_{\mu o}/T_s = 0.91$	—	7.4

Supplementary Table 1: Theoretical prediction and experimental determination of the most amplified disturbance during pulsation P_1. The most amplified wavelength, Λ, is normalized by the rim half-thickness, l. Experimental values of time ratios T_γ/T_s and $T_{\mu o}/T_s$ refer to time t_1.