Fast and viscous !

Auriane Huyghues Despointes, David Quéré

Physique et Mécanique des Milieux Hétérogènes, UMR 7636 du CNRS, PSL Research University, ESPCI-Paris, 7 Quai Saint-Bernard, 75005 Paris
auriane.huyghues-despointes@espci.fr

Non-wetting viscous drops are known to move unusually fast on inclines compared to wetting ones, due to the combined effects of rotation (which minimizes dissipation within the liquid) and non-wetting behavior (which reduces contact with the substrate) [1][2]. Here, we report the existence of two distinct ultra-fast viscous regimes, in which the speed of the objects increases by a factor of ten to one hundred compared to previous models and experiments. We try to identify and classify these different regimes.

When the slope of the substrate is increased beyond a few degrees, a dynamic reduction of contact occurs, minimizing even more the interactions with the substrate and thereby reducing dissipation. The drop then enters an ultra-fast, non-stationary regime — **the Acrobatic regime** — where it deforms periodically due to centrifugation (Fig. 1).

A viscous drop on a superhydrophobic surface can also detach from the solid and enter an **Aerodynamic regime** : its velocity no longer depends on its viscosity, and rotation is replaced by translation. This second ultra-fast regime leads to the most remarkable speeds (around 3 m/s, nearly one hundred times higher than predictions) without significantly deforming the drop, as it is no longer subject to centrifugal forces.

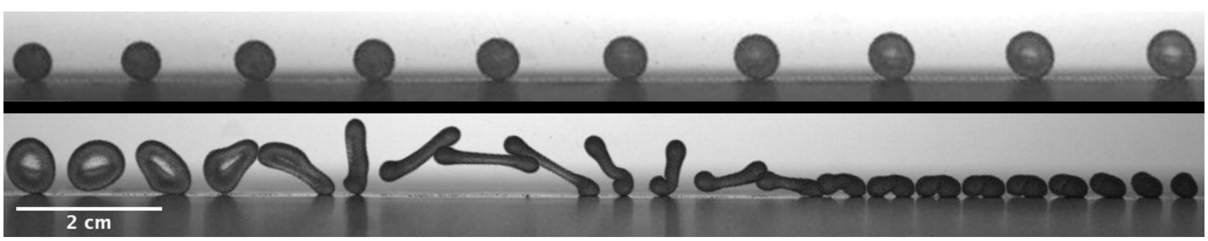

Figure 1. Chronophotograpy of a glycerol non-wetting drop (R = 1.7 mm) as it rolls down a plate tilted by $\alpha = 30°$ (camera tilted by the same angle, images separated by **a.** 20 ms, **b.** 9 ms). **a.** The rolling drop keps on growing and accelerating as its shape changes. **b.** It spontaneously takes-off, transforming into a two-lobed shape. Forced by gravity to land on the substrate, the drop slows down and reassembles in a globular object before repeating the cycle.

Références

1. L. Mahadevan and Y. Pomeau, *Physics of Fluids*, **11**, 2449–2453 (1999).
2. P. Aussillous and D. Quéré, *Nature*, **411**, 924–927 (2001).