Leidenfrost Wheels

Ambre Bouillant[a,b], Christophe Clanet[a,b], and David Quéré[a,b]

Leidenfrost phenomenon, first described in 1756, occurs when a volatile liquid approaches a hot plates. Quasi-instantaneouly, a vapor film forms beneath the drop. The high mobility of Leidenfrost drops is commonly attributed to the lack of contact with the hot substrate, and it makes them sensitive to tiny forces, such as gravity or airflows[1]. However, we discover that drops deposited without initial velocity on strictly horizontal substrates self-propel in random directions. This phenomenon is triggered by evaporation-driven confinement. PIV measurements reveal that, as the drop aspect ratio of the drop becomes of order unity, internal motions symmetry systematically breaks. Large drops flatten by gravity host two convective cells in the enlightened plane whereas droplets, kept quasi spherical by capillarity only host one rotating cell. Internal flows thus switch from symmetric to asymmetric rolling. Such a flow reshapes the vapor thickness and tilts it, as evidenced by interferometric measurement[2]. It is just as if droplets were transporting their own, stationary ratchet. They thus propel[3] in the rolling direction. Droplets are thus found to generate their own dynamics and self-propel isotropically despite the absence of external field[4], which contributes to and even explains their legendary mobility.

a Physique&Mécanique des Milieux Hétérogènes, ESPCI, 75005 Paris, France.
b LadHyX, École polytechnique, 91128 Palaiseau, France.

1 Quéré, D. *Annual Review of Fluid Mechanics*, **45**, 197-215, (2013).
2 Burton, J. C. et al. *Physical review letters*, **109**, 074301 (2012).
3 Dupeux, G. et al. *Physics of Fluids*, **25**, 051704, (2013).
4 Bouillant, A. et al. *Submitted*, (2018).
5 Sobac, B. et al. *Physics of Fluids* **29**, 082101 (2017).