Symposium
“Experiments in Fluid Mechanics 2017”
23-24 OCTOBER 2017

Droplet surfing on a boundary layer

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State of art

A. Duchesne et al., *EPL*, 2013

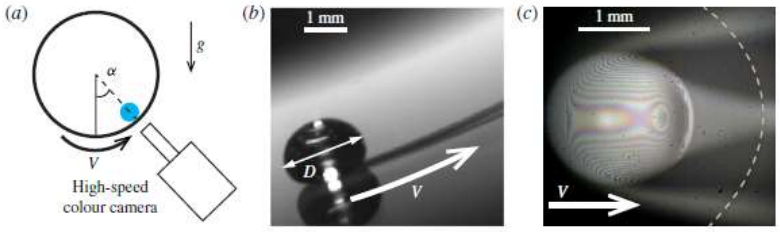
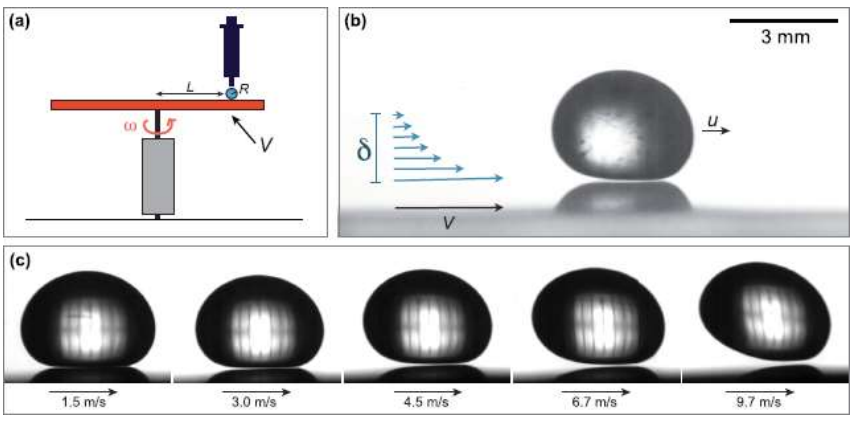


FIGURE 1. (*a*) Schematic (not to scale) of the experimental setup. (*b*) Side view of a levitating droplet. (*c*) Interferometric measurements of the air layer under the droplet.

H. Lhuissier et al. , *Journal of Fluid Mechanics*, 2013



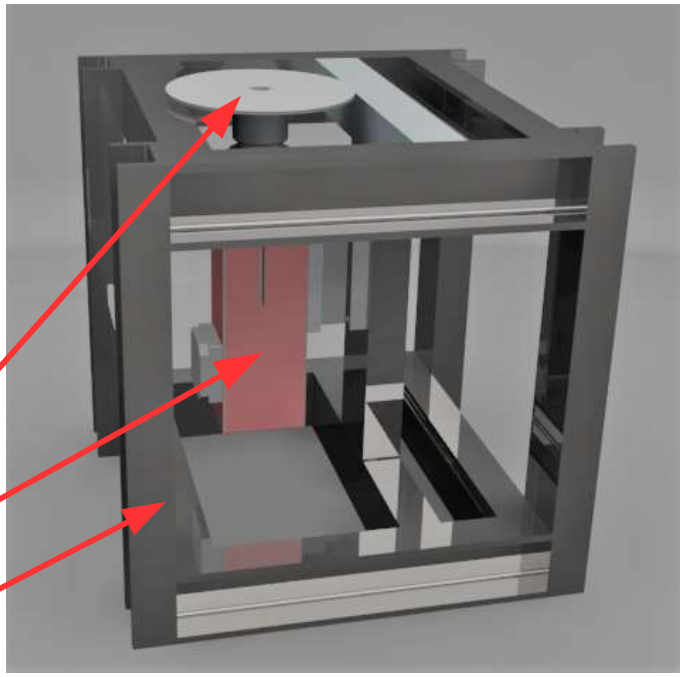
A. Gauthier et al., *Physical Review Fluids*, 2016

Experiment concept

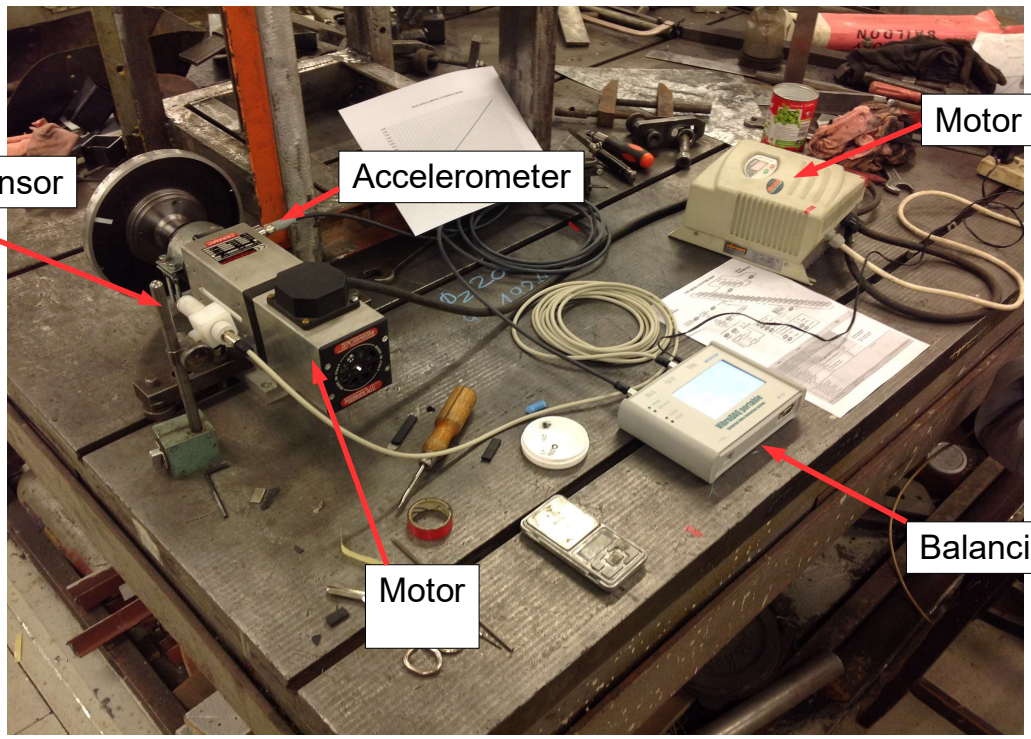
Liquid: Silicone Oil

Surface: Rotating polished steel disk.

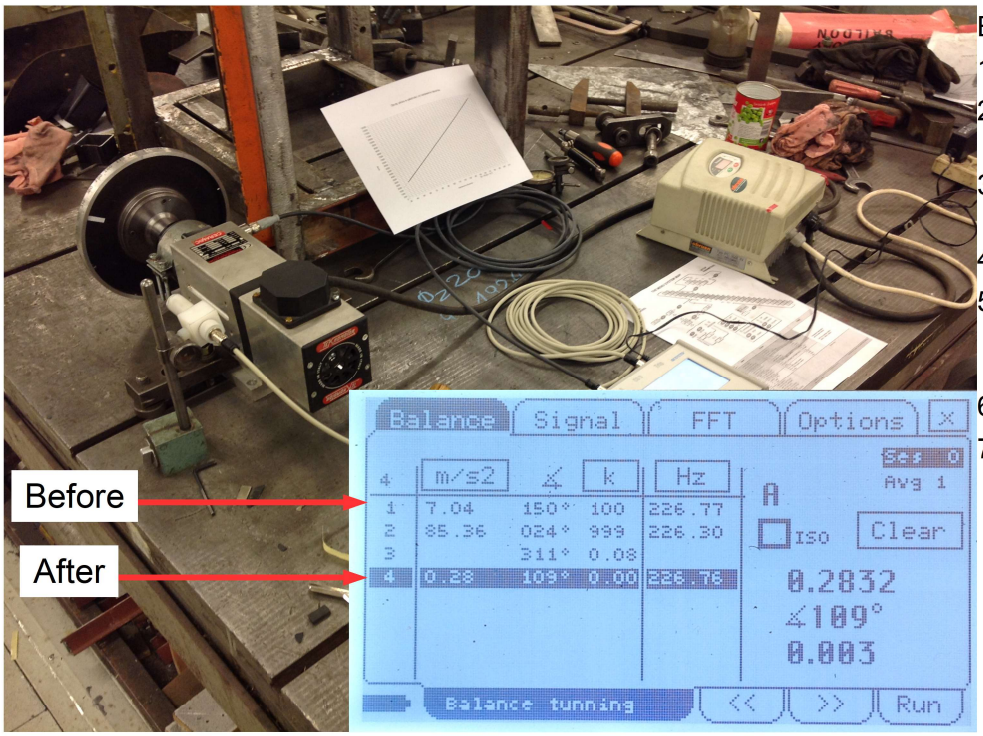
Wide rotational speed range



Preparing the setup



Disk balancing



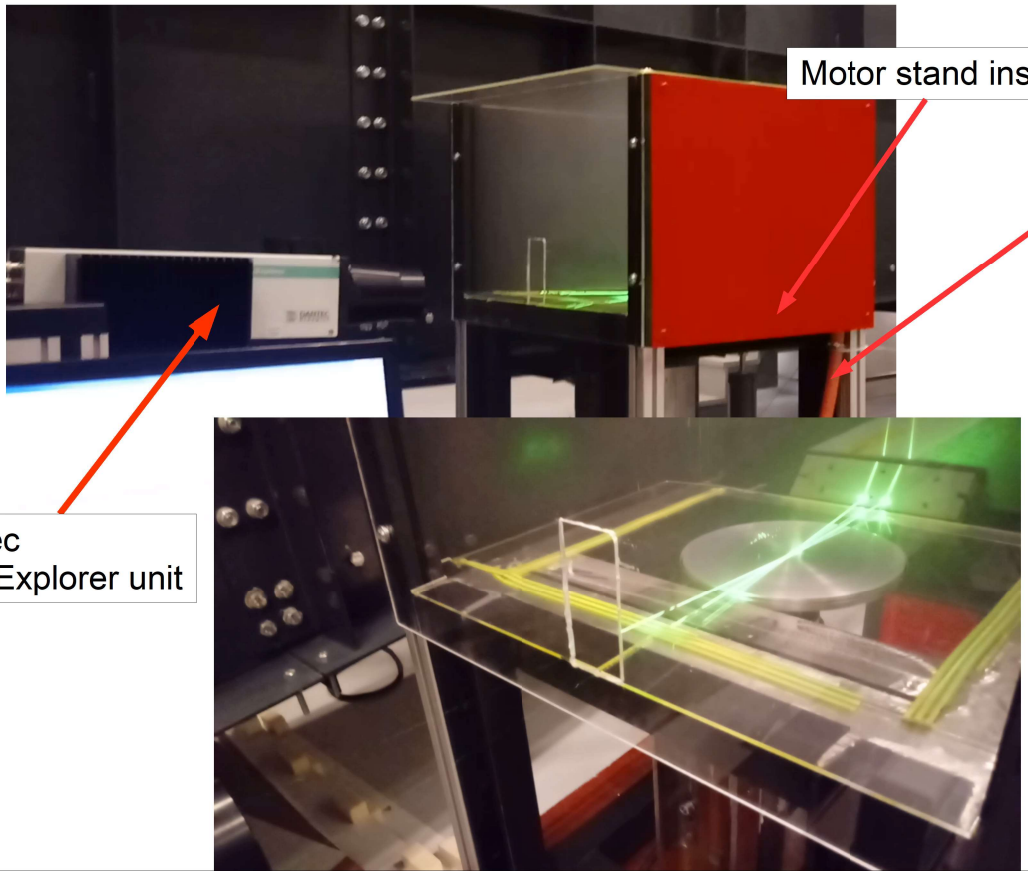
Balancing process order:

1) Run the motor at desired speed
2) Put a known mass at a known radius
3) Enter mass and radius into the control unit
4) Run the motor again
5) Read from the control unit, where to put another balancing mass and how heavy it has to be
6) Run the device yet again
7) Read final balancing result

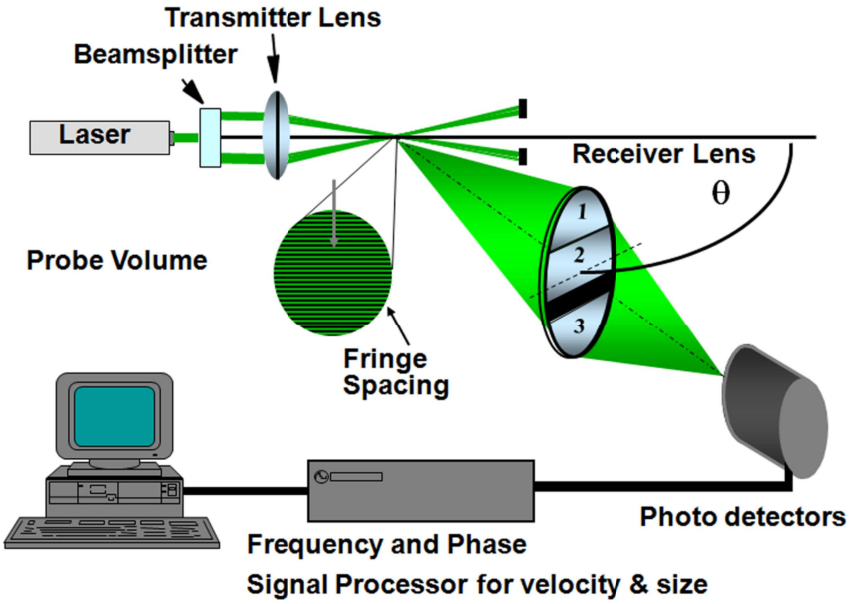
We reduced the imbalance by 96%

Balancing equipment and results

Boundary layer measurements



Laser Doppler Anemometry

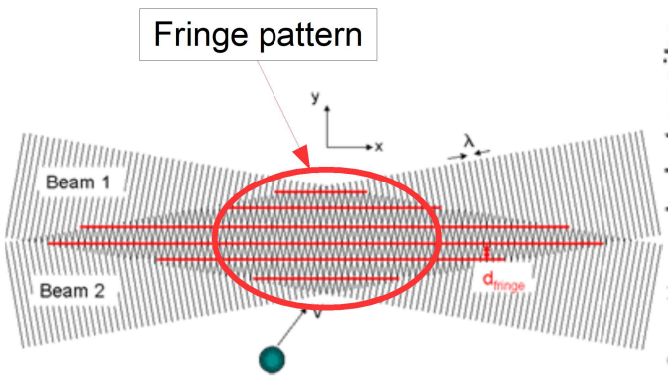


Source: http://www.lavision.de

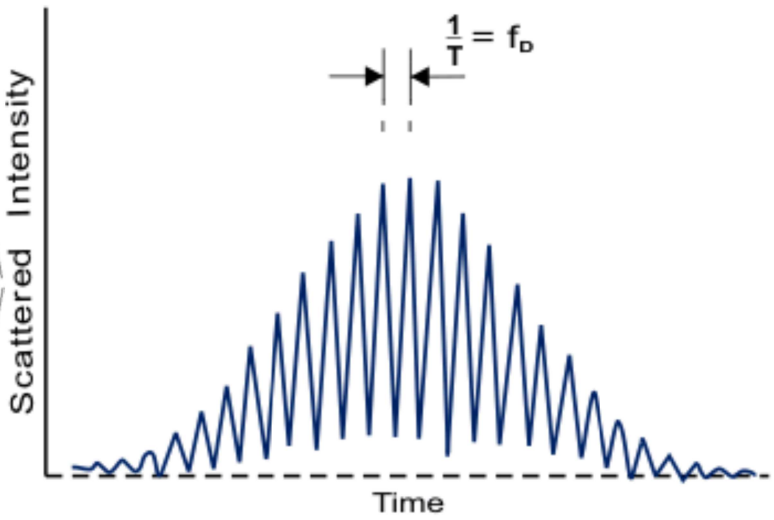
Principles of LDA

1) Laser beam splits in two. One beam has a shifted frequency
2) Beams cross, creating fringe pattern
3) Particle passes through beams crossing volume
4) As particle moves through the volume, it scatters light from the fringes
5) Photo detector receives the scattered light
6) Signal processor determines particle's velocity

LDA principle



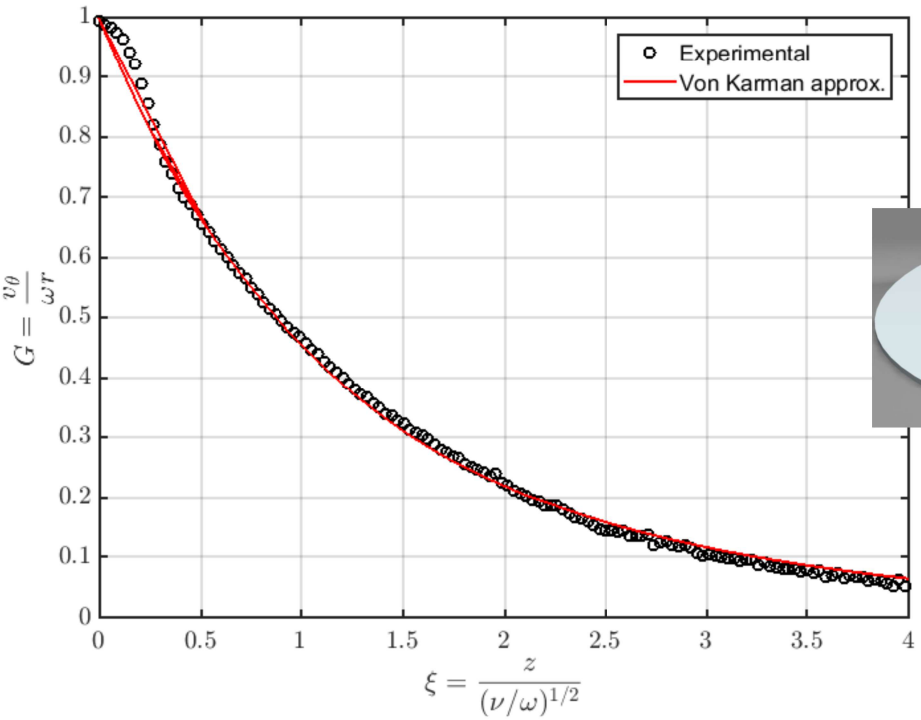
Source: https://www.erc.wisc.edu/

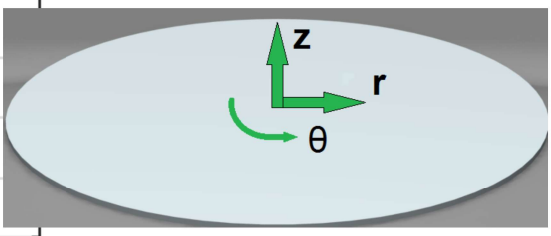


Source: http://thermopedia.com

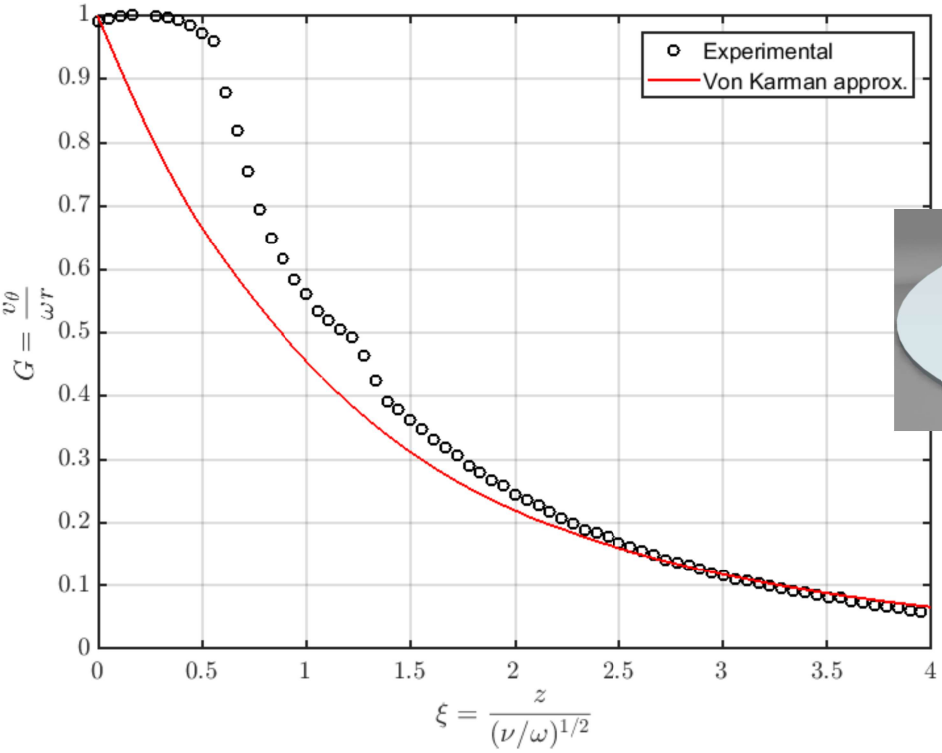
$$f_d = f_s + \frac{2V}{\lambda}\sin\left(\frac{\theta}{2}\right) \longrightarrow V = \frac{\lambda(f_d - f_s)}{2\sin\left(\frac{\theta}{2}\right)}$$

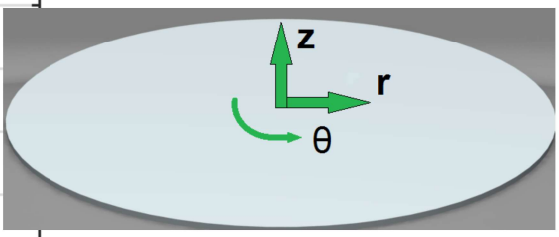
Laminar regime



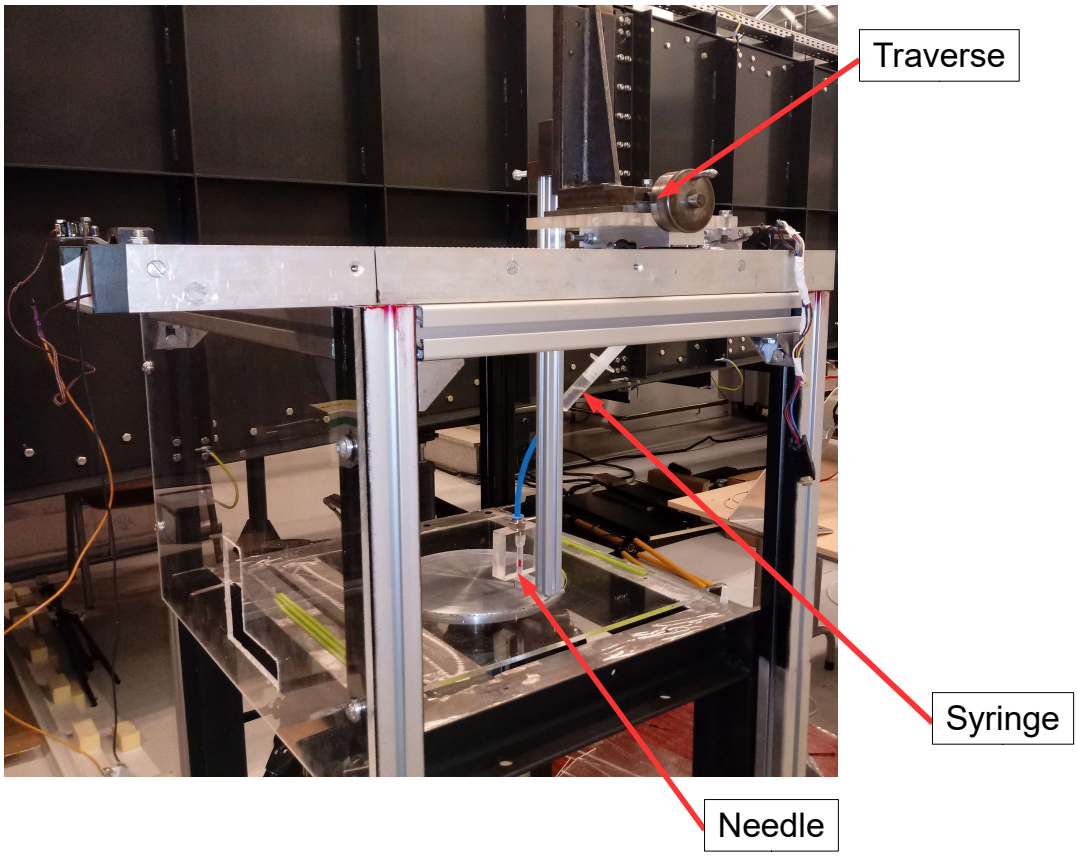


Turbulent regime

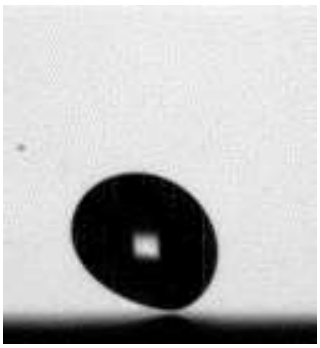




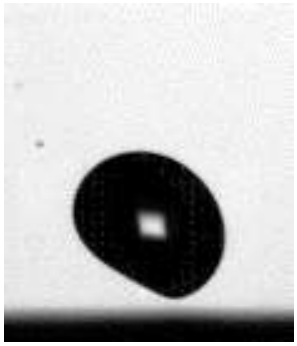
Experiment stand



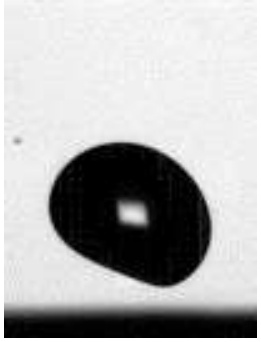
Thickness of air gap



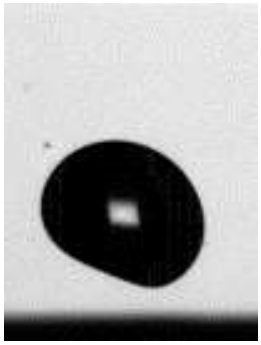
10 m/s



20 m/s



30 m/s

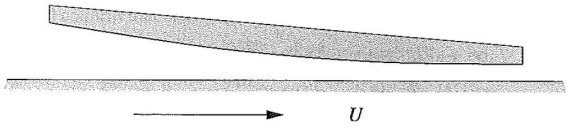


40 m/s

Perspectives

How the shape of the droplet influences levitation phenomenon?

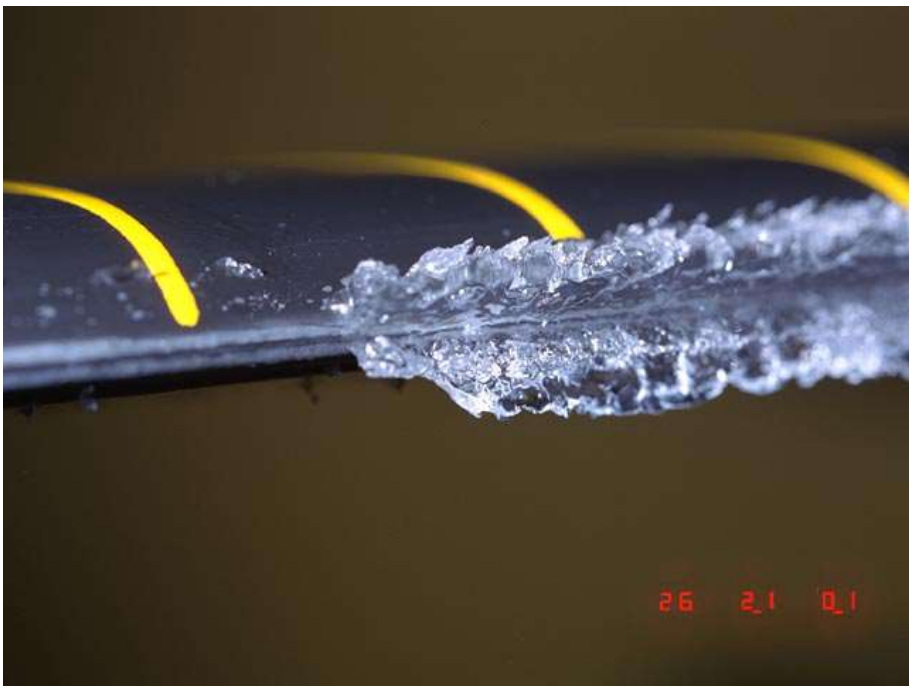
$$\mathbb{B}o = \frac{\rho g D^2}{\sigma}$$



$$\frac{\mathrm{d}}{\mathrm{d}X}\left(H^3\frac{\mathrm{d}p}{\mathrm{d}X}\right) = 6\frac{\mathrm{d}H}{\mathrm{d}X}$$

Levitation of solid object?

Is there any connection?



Source: https://upload.wikimedia.org/wikipedia/commons/3/33/Icing_on_a_rotor.jpg

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Thank you for your attention

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