LIÈGE université
GRASP

Controlling liquid landscape with 3D-printed spines: A tool for micromanipulation

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CONTEXT

GRAVITY wins over **SURFACE TENSION** and keeps the water level flat and horizontal, even when tilting the container

...

Except in the few millimeters of a **CAPILLARY MENISCI**

...

Let's challenge this!

SUPERPOSITION OF MENISCI

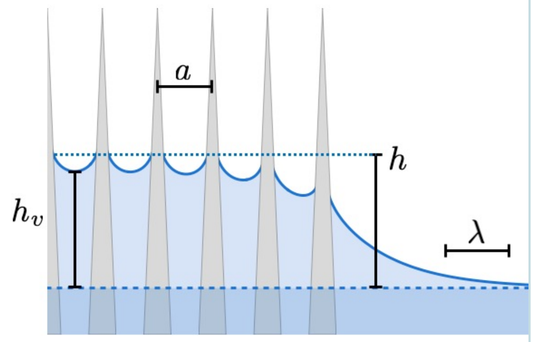
- Liquid elevation around one meniscus: $z(r) = QK_0\left(\frac{r}{\lambda}\right)$

  With the constant integration, also called the **capillary charge** $Q = (R - h\tan\alpha)\cos(\theta + \alpha)$

  And λ, the **capillary length**, the distance over which surface tension overcomes gravity

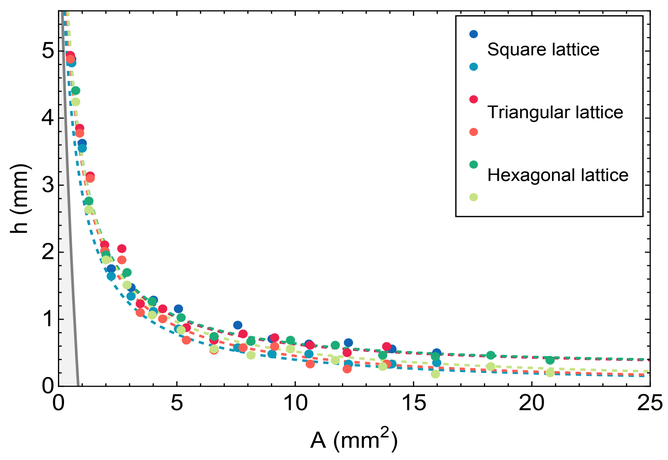
- Menisci can **SUPERIMPOSE** when the distance is smaller or around λ
- Liquid elevation around the **G I A N T** meniscus:

$$z(x,y) = \sum_{k,\ell} Q_{k,\ell} K_0\left(\frac{|\vec{r} - \vec{r}_{k,\ell}|}{\lambda}\right)$$

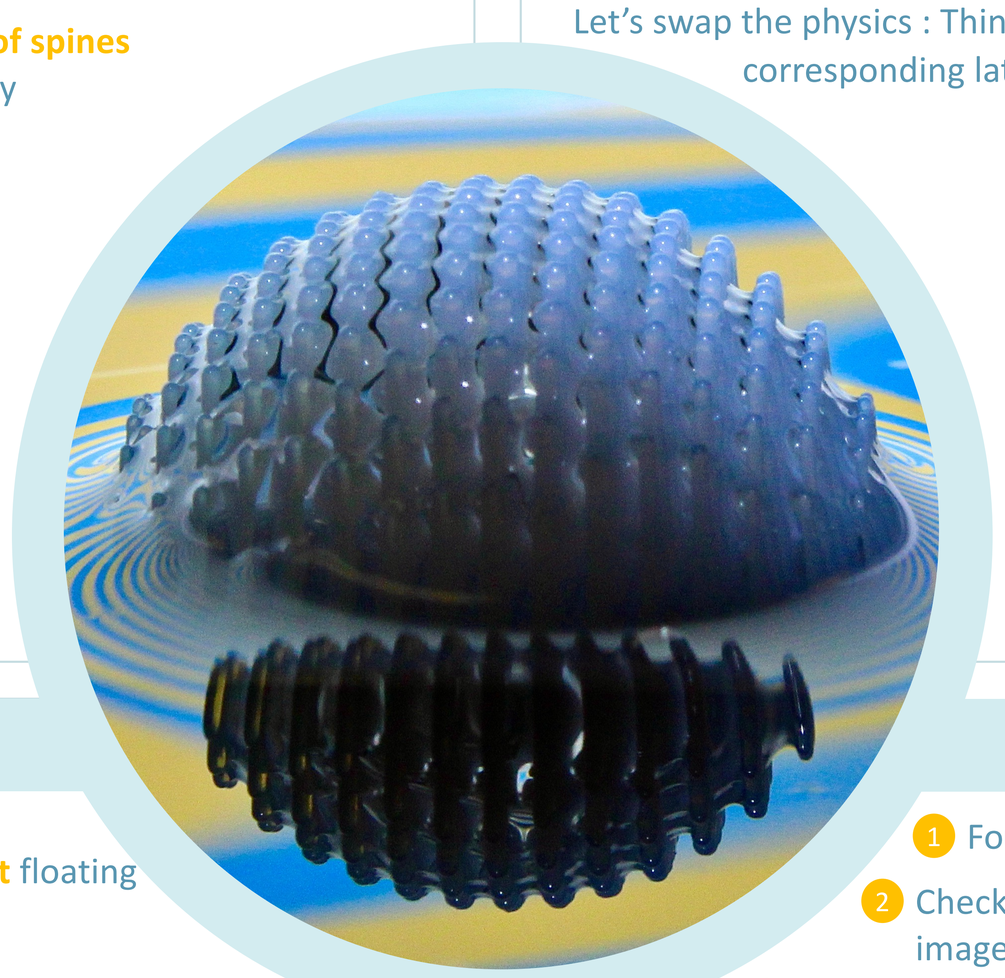


EXPERIMENTAL RESULTS

- Liquid elevation inside **3D-printed arrays of spines** with varying lattice constant and symmetry

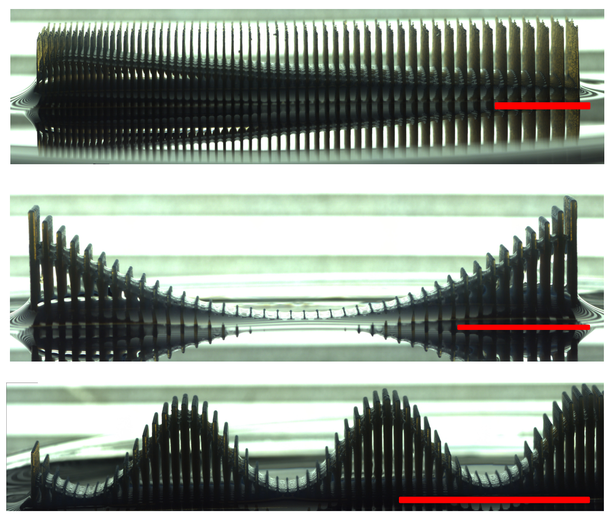


- Model is valid when $a > 4(R - h\tan\alpha)$



LIQUID SLOPES AND SLIDES

Let's swap the physics : Think about a desired interface and find the corresponding lattice

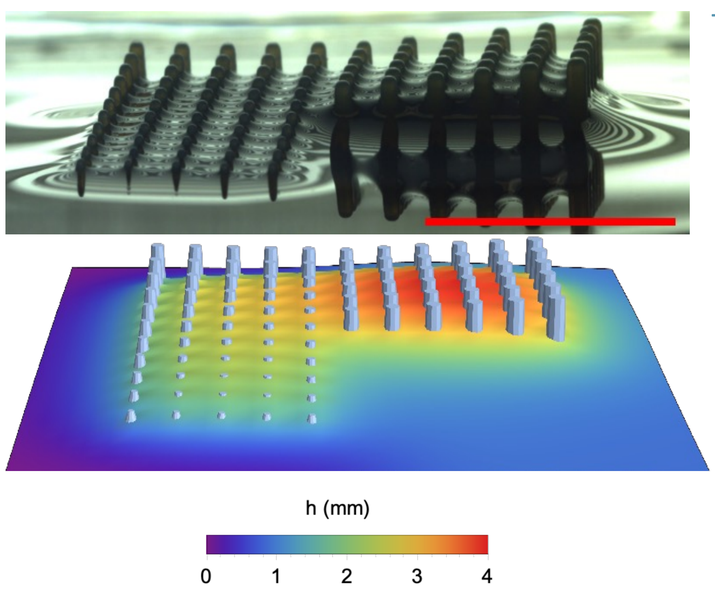


MANIPULATION

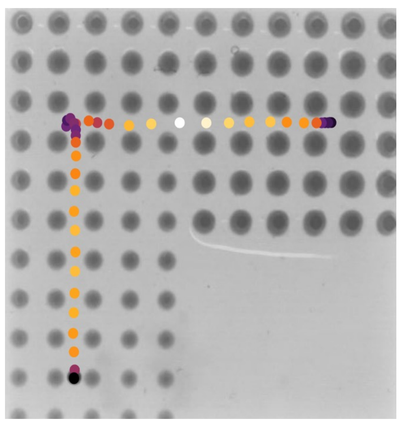
This device serves as a great tool to **transport** floating particles into **programmable paths** !

- Heavy particles: fall down a meniscus (W > B)
- Light particles: rise up along a meniscus (B > W)

→ 3-directional transport

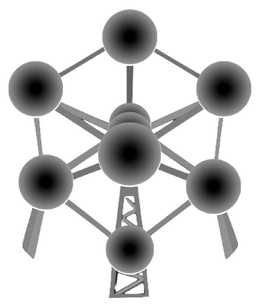


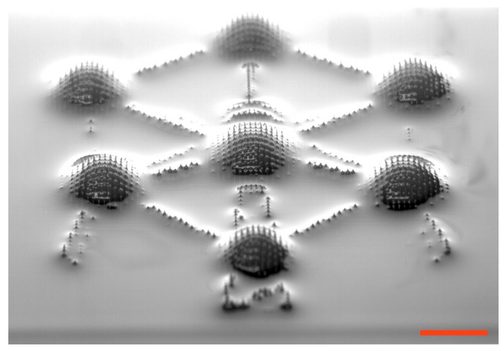
Trajectory of an 800 µm bead:



ART

1. Found a nice image
2. Check our GitHub for the code that transforms your image into a specially engineered array of spines
3. 3D-print the provided STL file
4. Deep it into water and enjoy!





PERSPECTIVES

- Sorting of particles based on their size
- Cleaning interfaces
- Actuate the spines
- Study the particular dynamics of object into our device

« *Controlling liquid landscape with 3D-printed spines: A tool for micromanipulation* », M.Delens, A.Franckart, and N. Vandewalle, In Review
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International meeting in memory of Yves Couder:
Self-Organization in physics and biology, morphogenesis, turbulence, walking droplets and non-linear physics
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