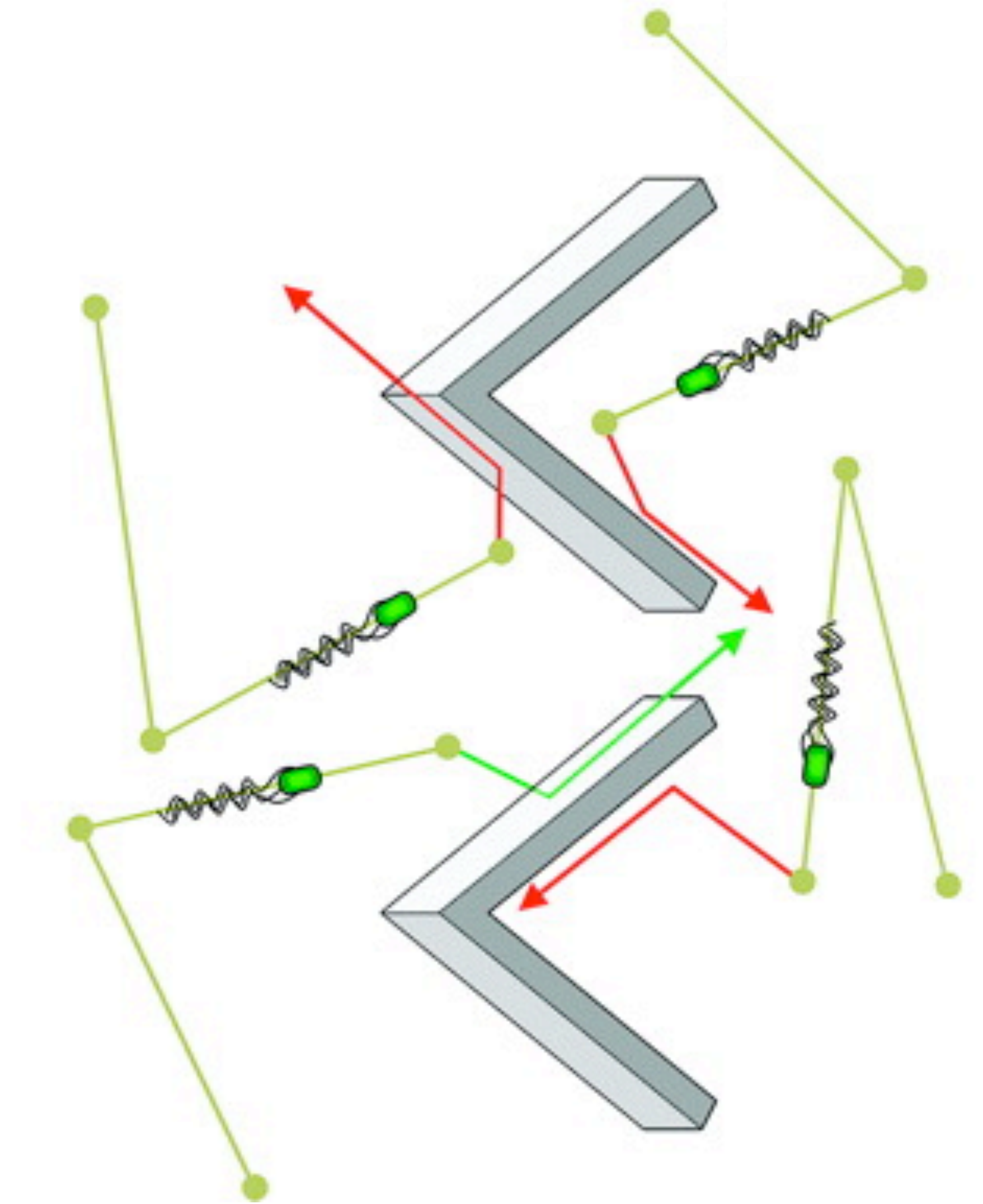


Active matter at the boundary

A group of bacteria meets at the wall

Carlo Giorgetti

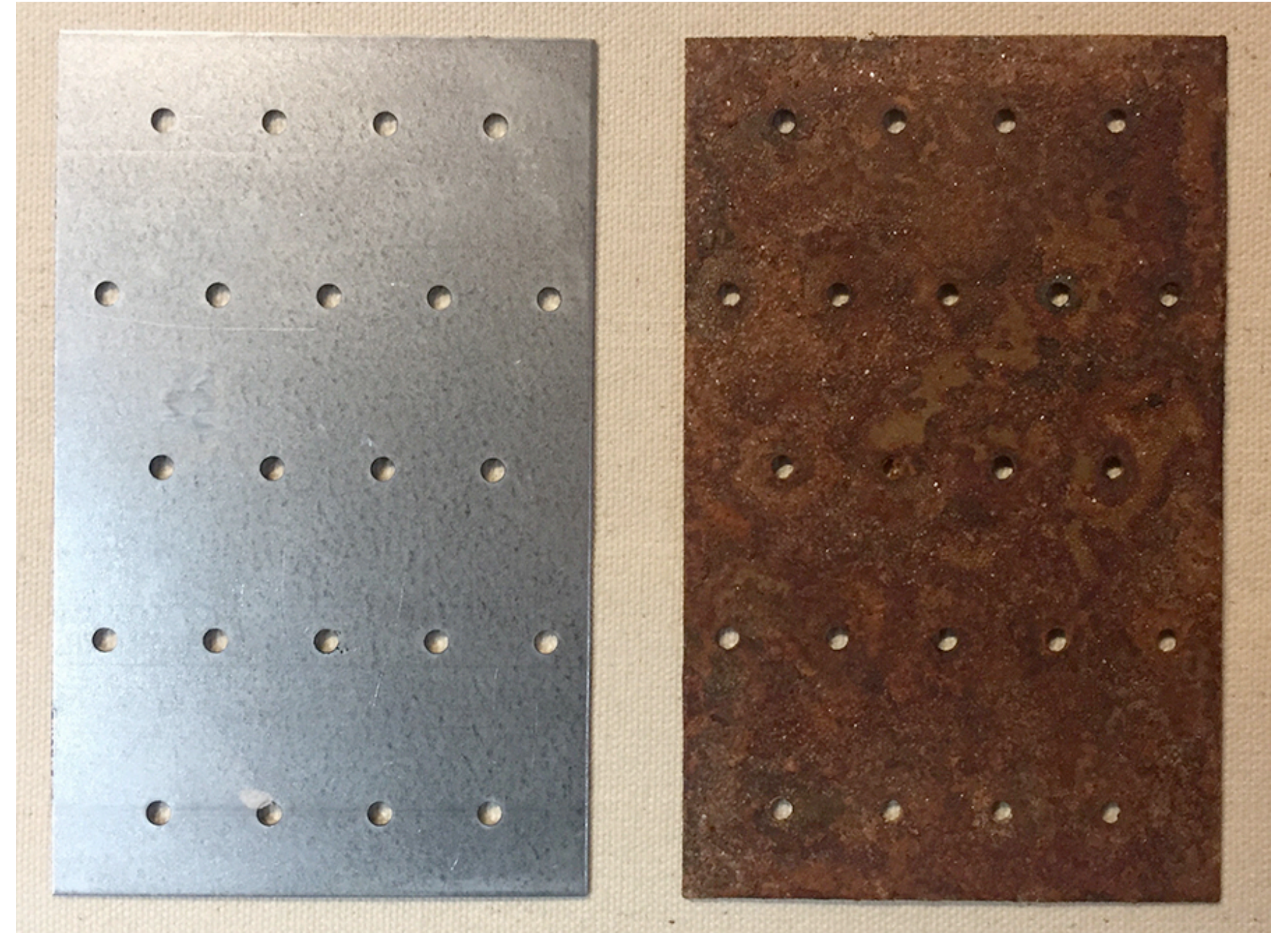


Introduction



**God made solids, but surfaces
were the work of the devil**

Introduction

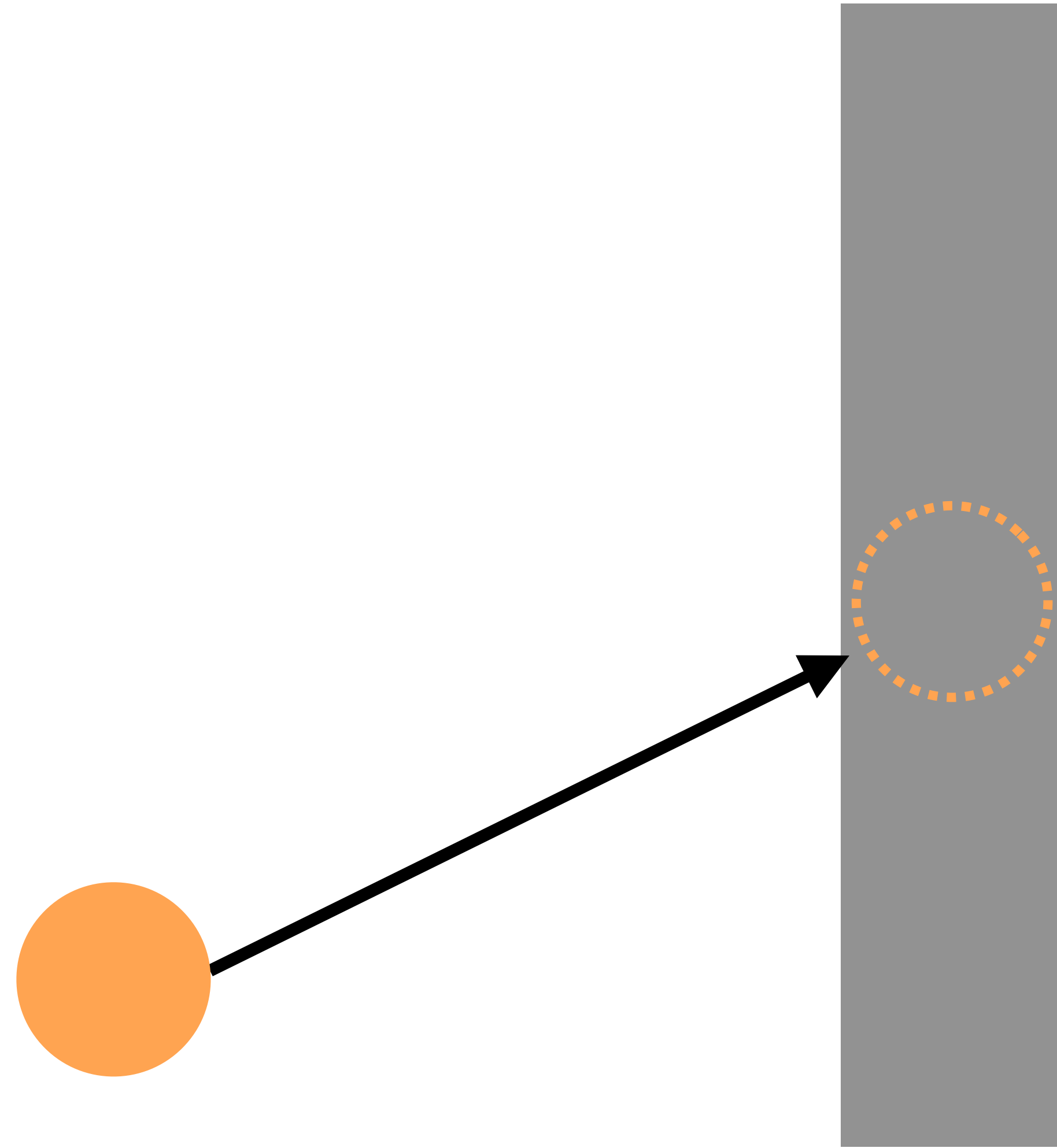


God made solids, but surfaces
were the work of the devil

“Our” boundary

Boundary: the interaction between bodies

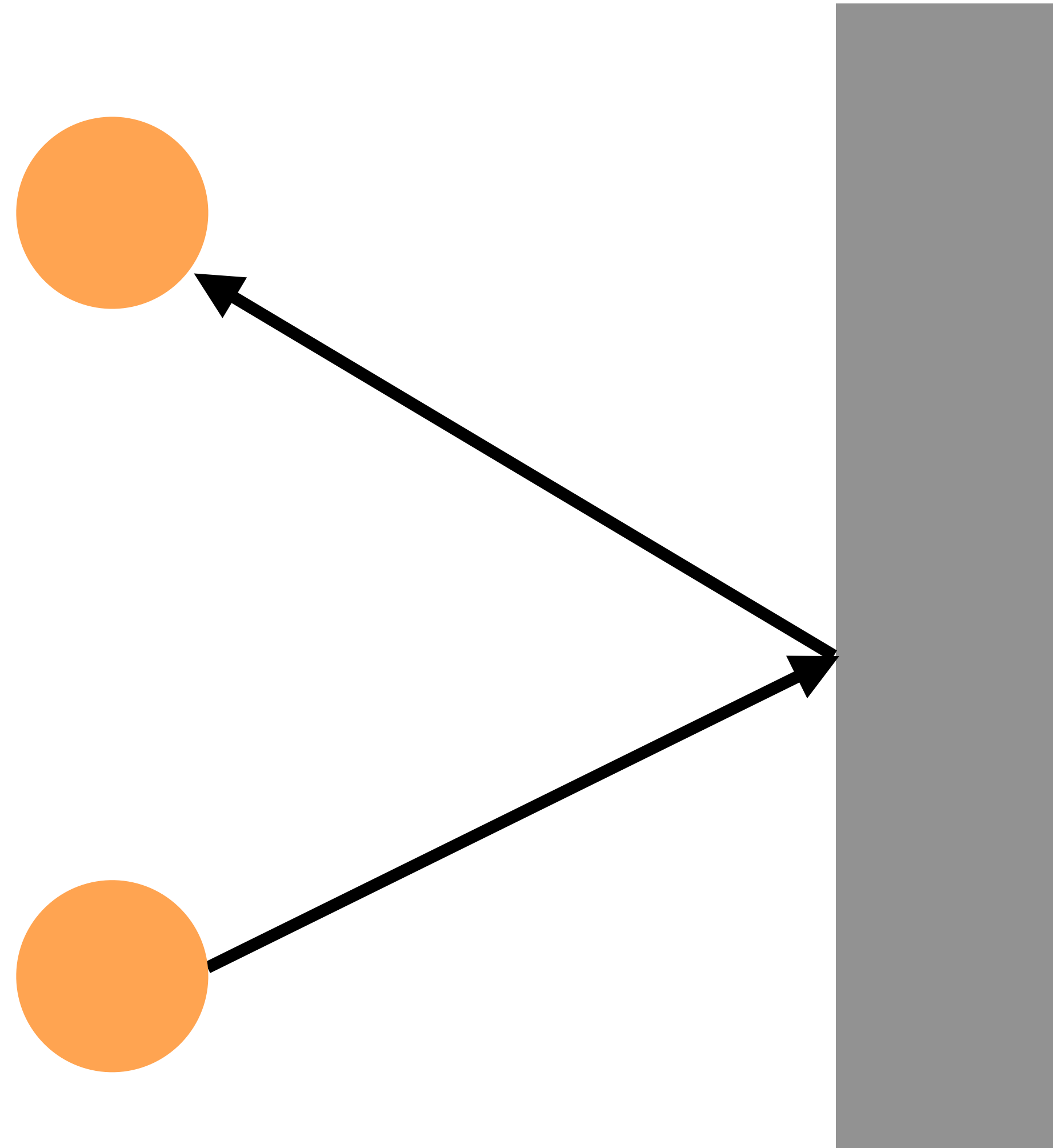
Soft interaction: velocity is consumed



“Our” boundary

Boundary: the interaction between bodies

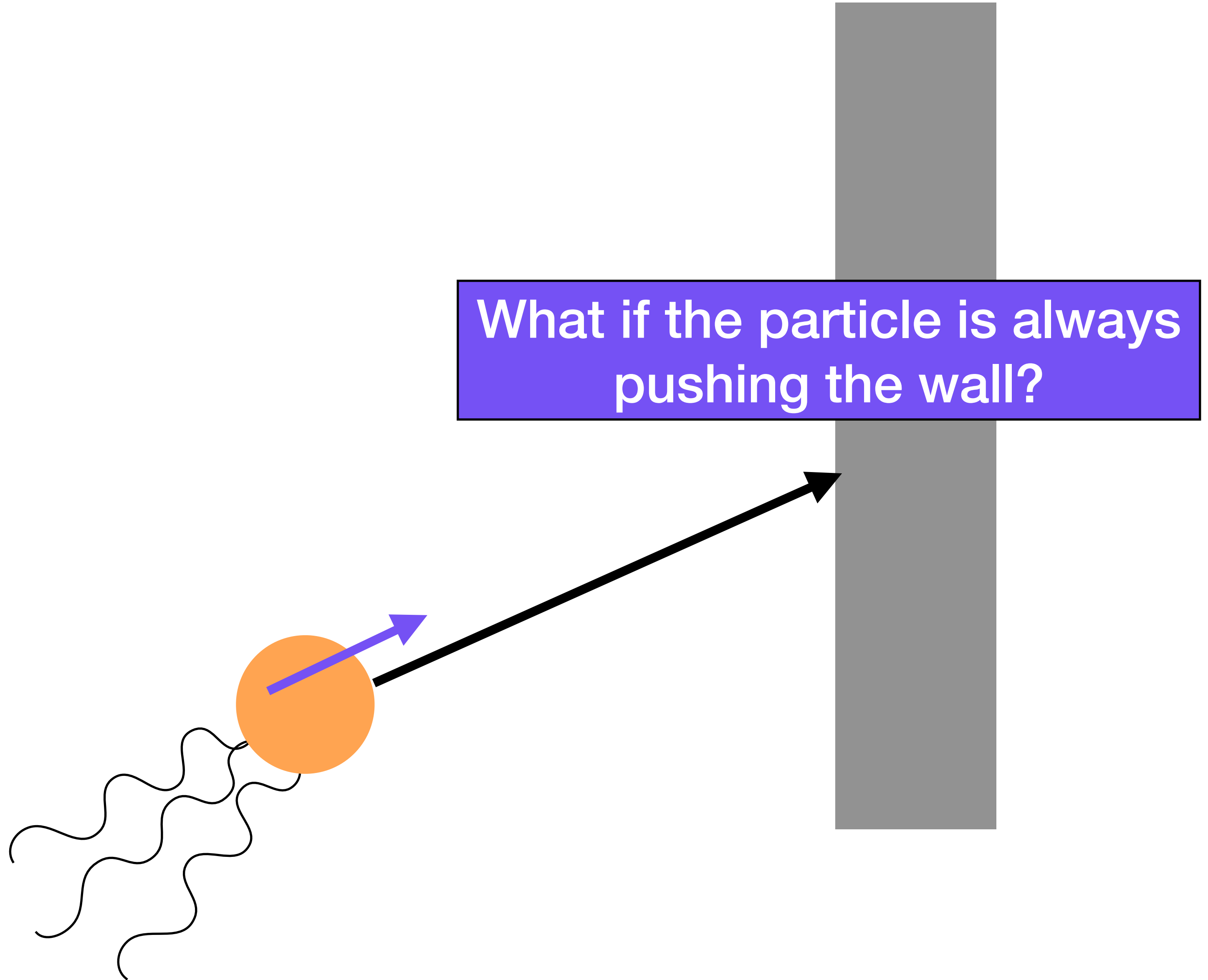
Soft interaction:
Conservation of
“momentum”



“Our” boundary

Boundary: the interaction between bodies

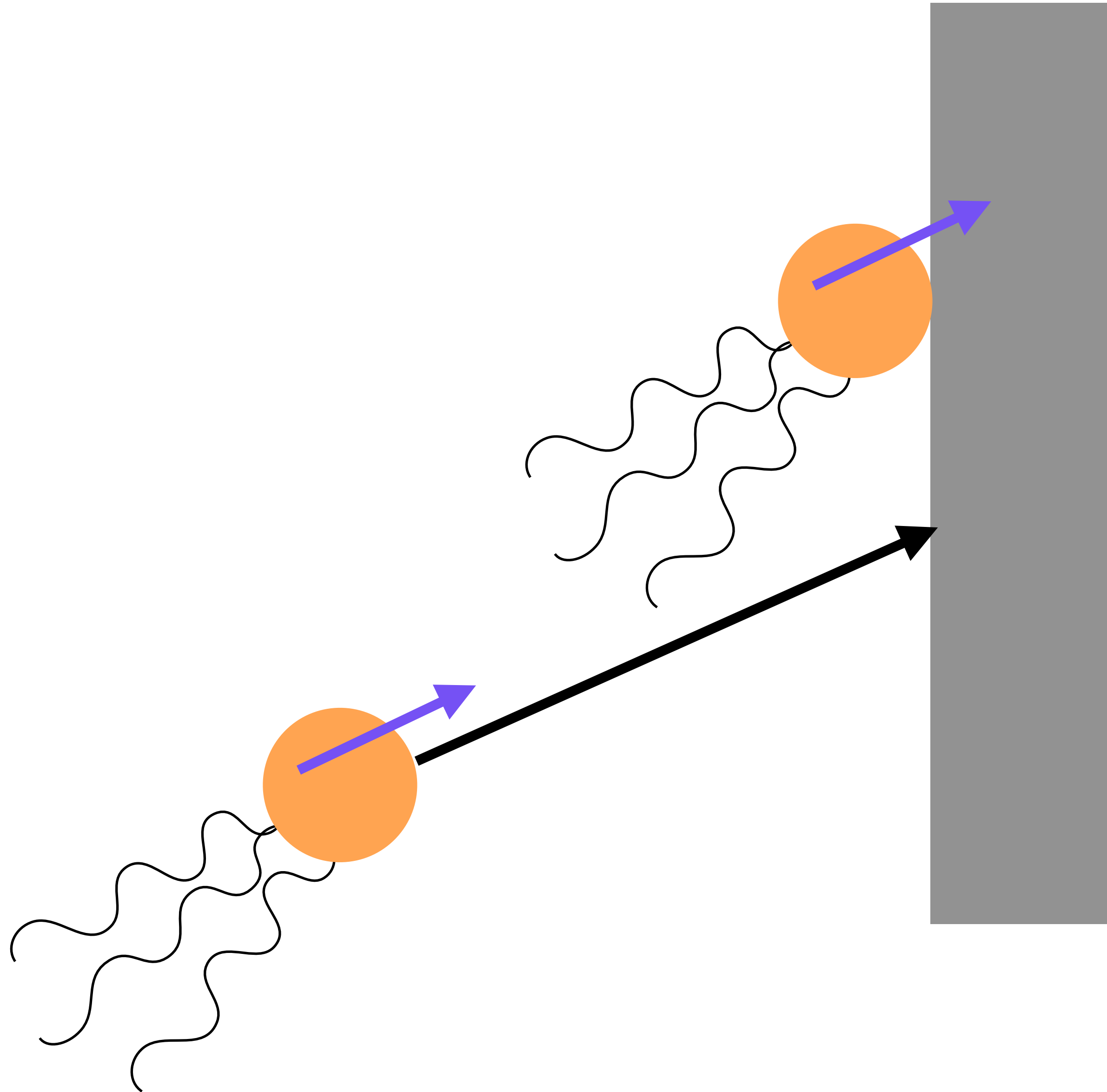
Hard interaction: conservation of momentum



“Our” boundary

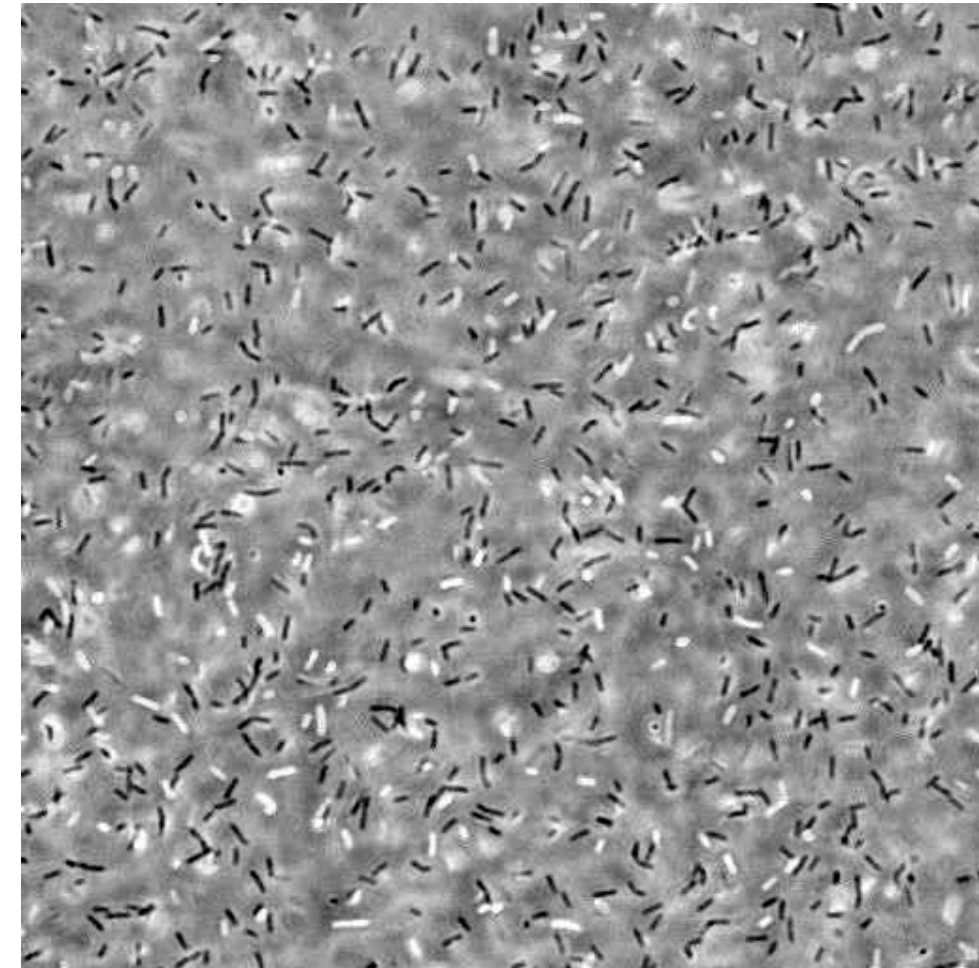
Boundary: the interaction between bodies

Hard interaction: conservation of momentum



Active matter

Biological system



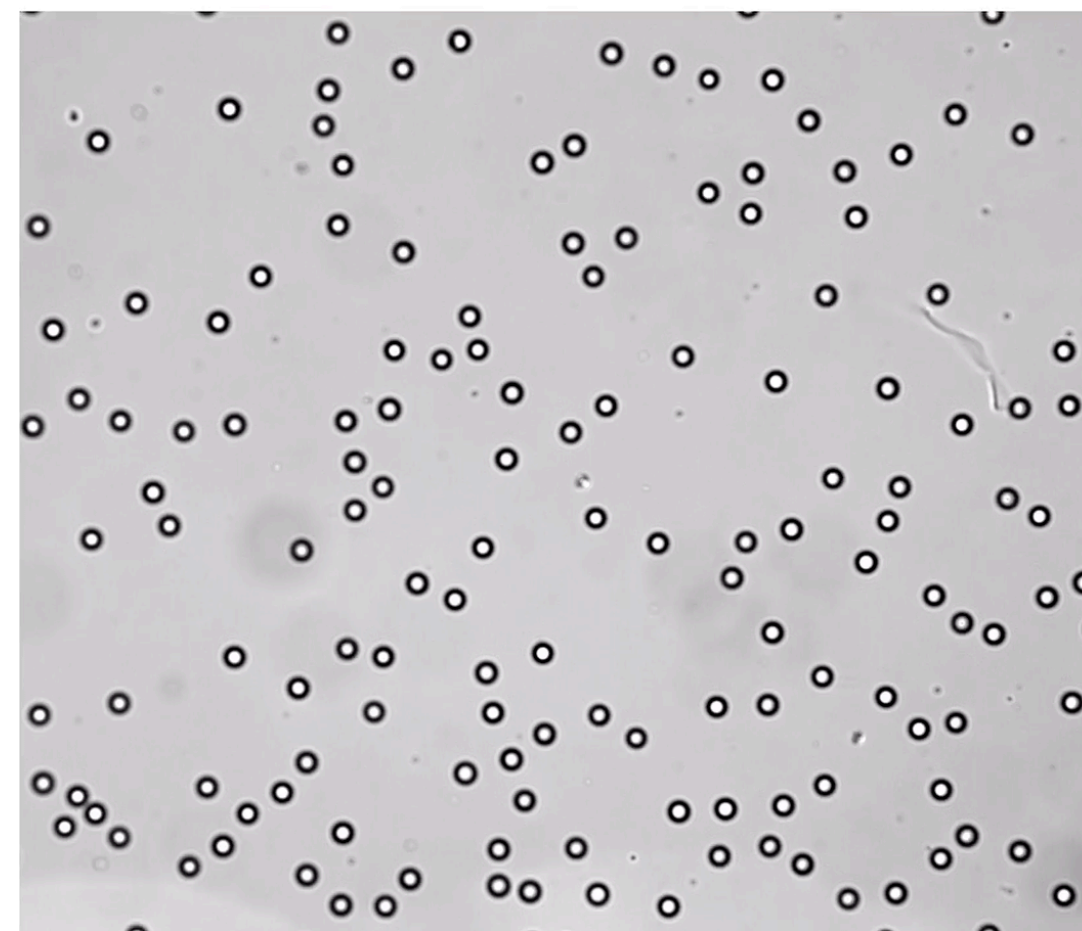
nm

μm

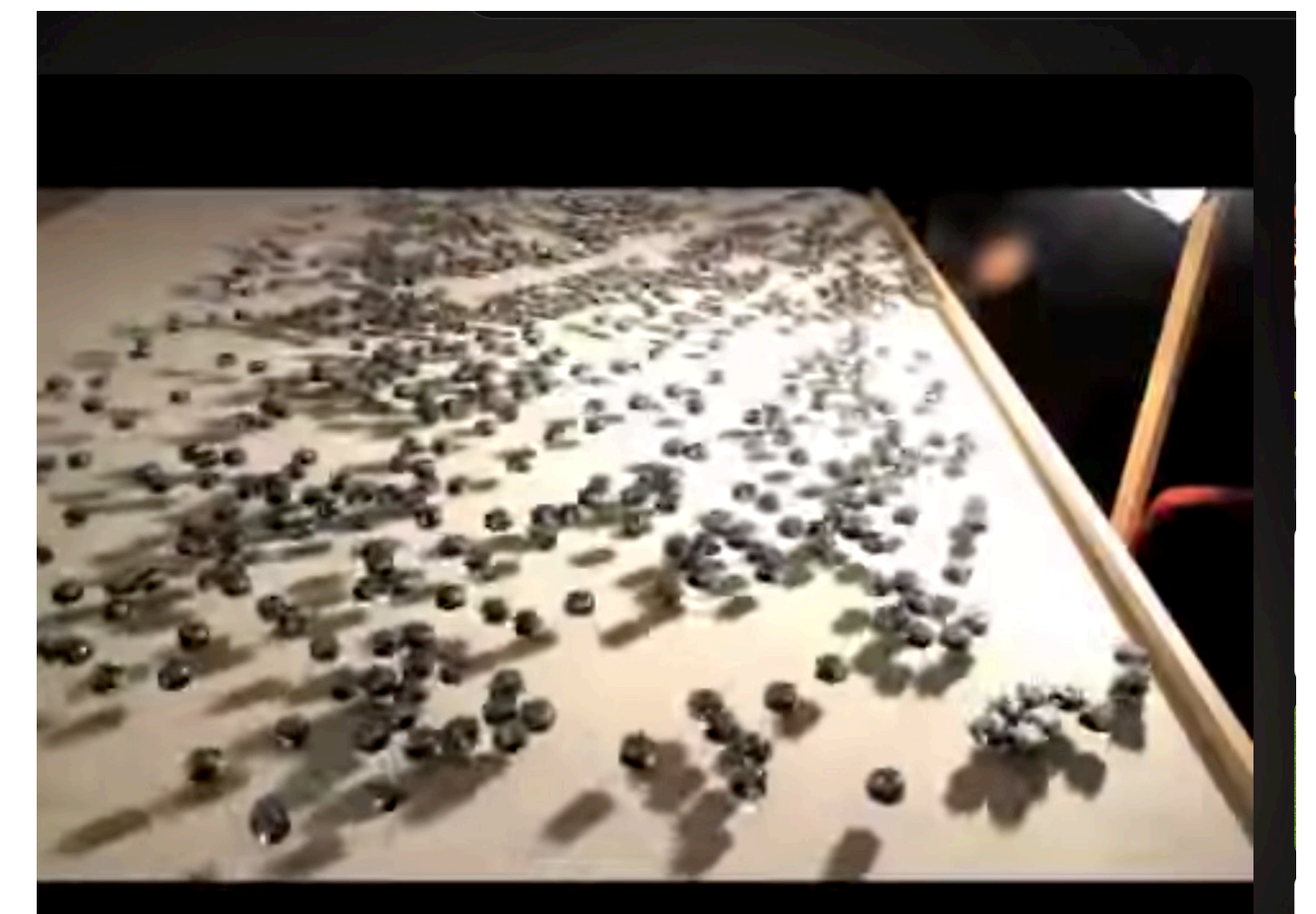
mm

m

Artificial system

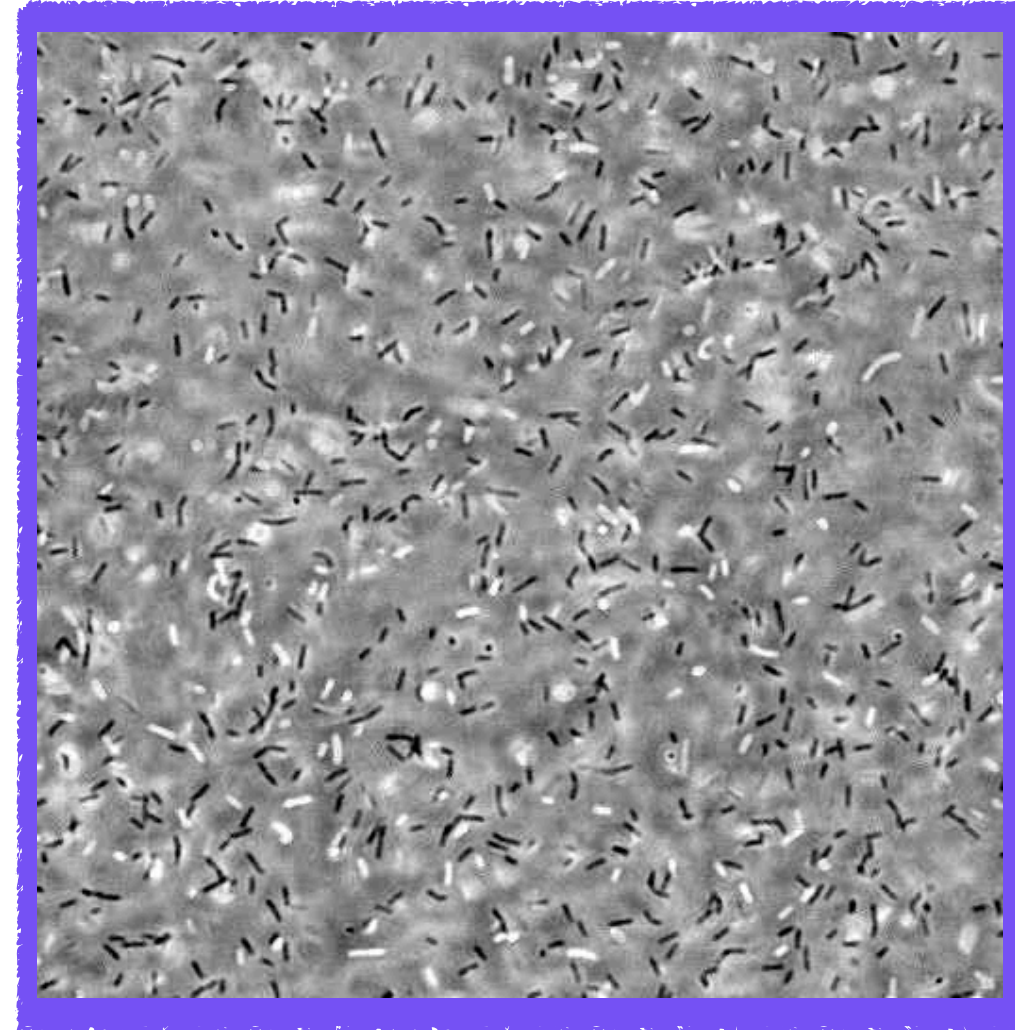


200 μm



Active matter

Biological system



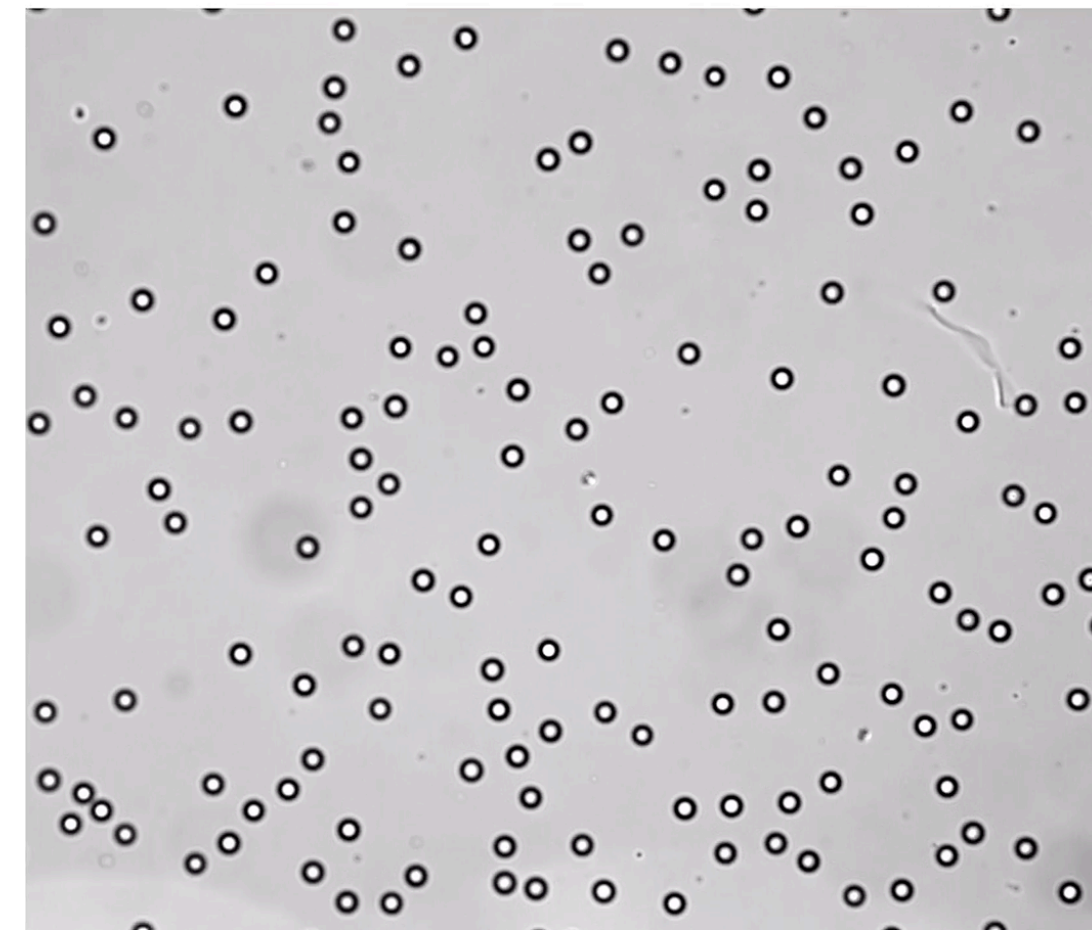
nm

μm

mm

m

Artificial system



200 μm



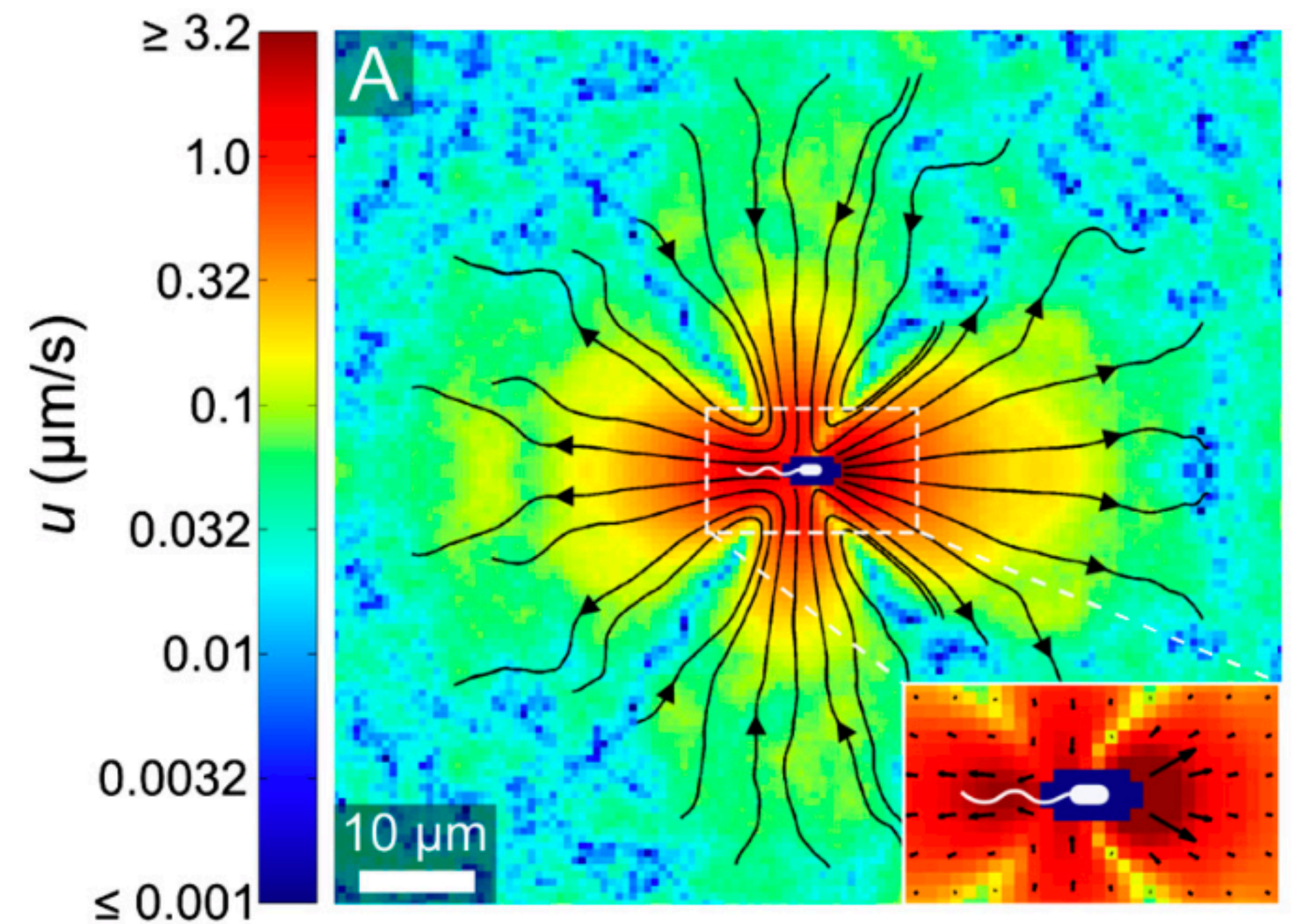
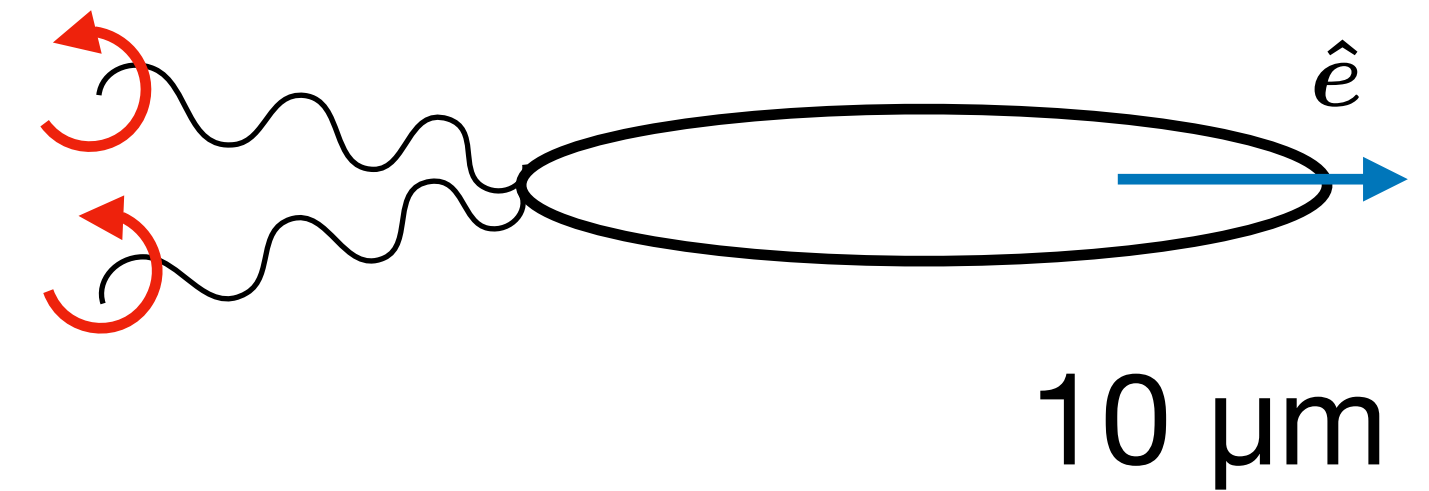
Bacteria 101

Bacillus subtilis

Low Reynolds number swimming

Inertial forces = 0

$$\mathbf{u} = \frac{P}{8\pi\eta r^2} \left(3 (\hat{\mathbf{e}} \cdot \hat{\mathbf{r}})^2 - 1 \right) \hat{\mathbf{r}}$$

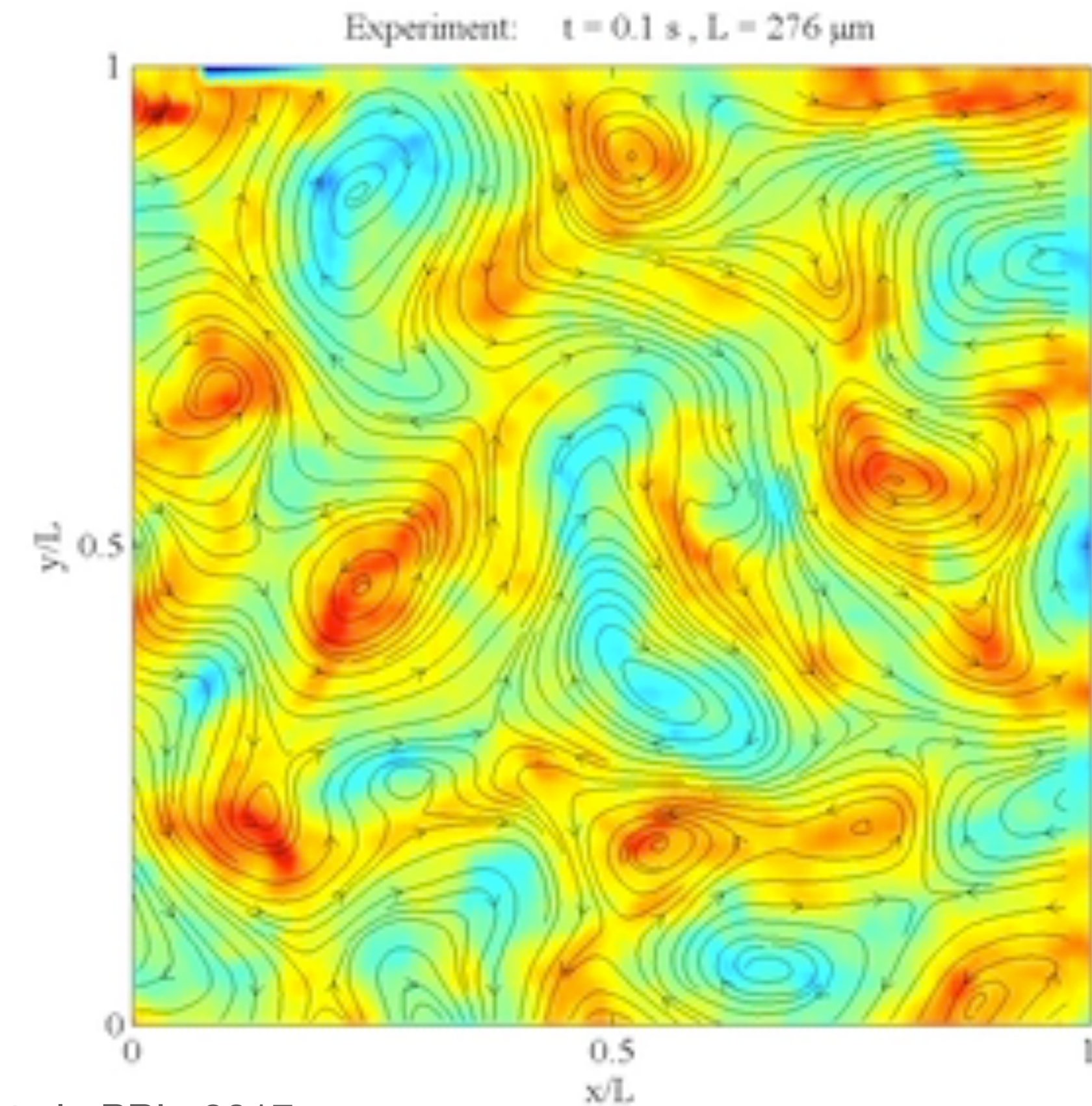
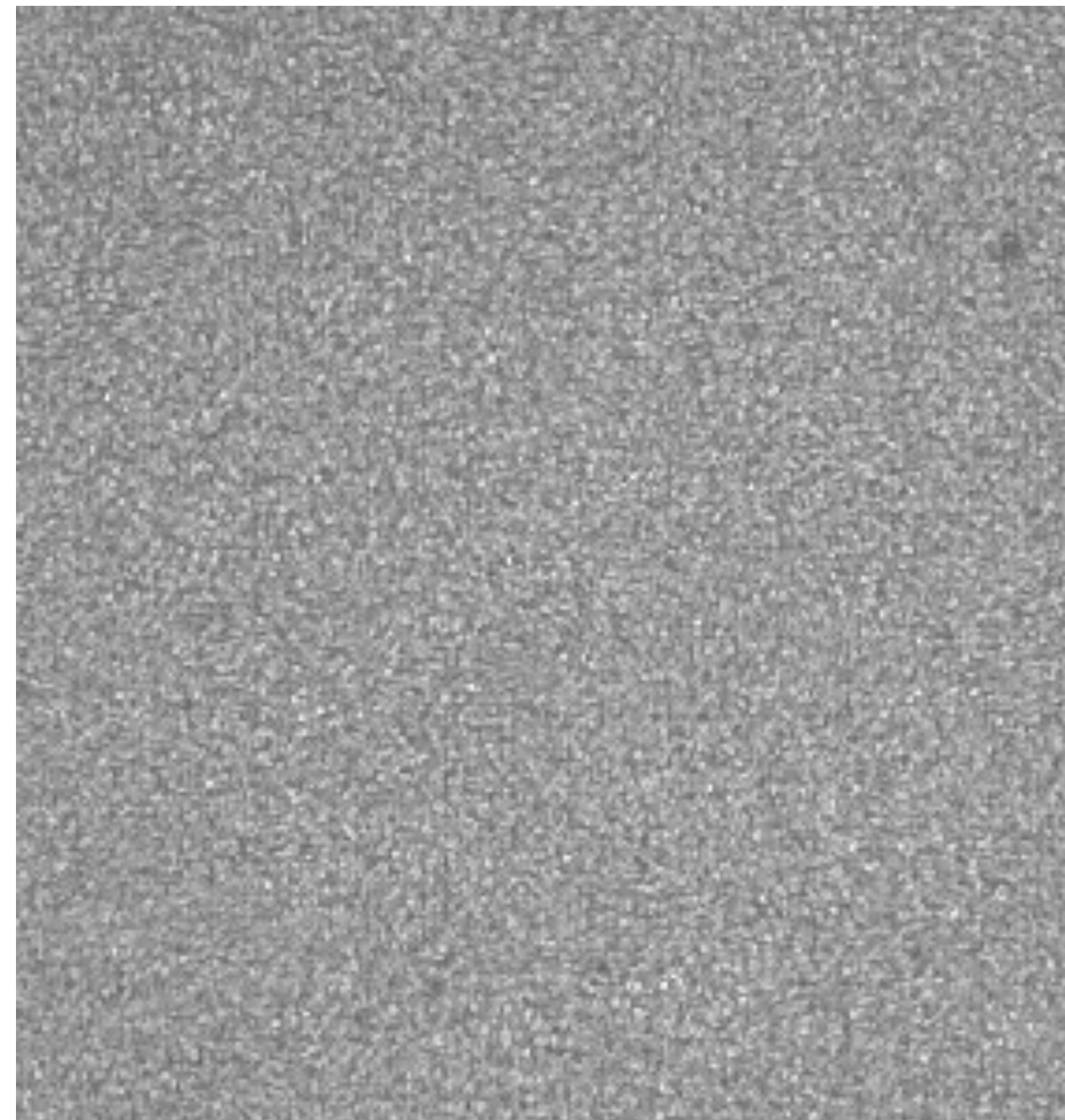


Drescher et al., PNAS, 2011

Active turbulence

Collective motion after a certain density threshold

- Swirls, jets, vortices
- Finite vortex size

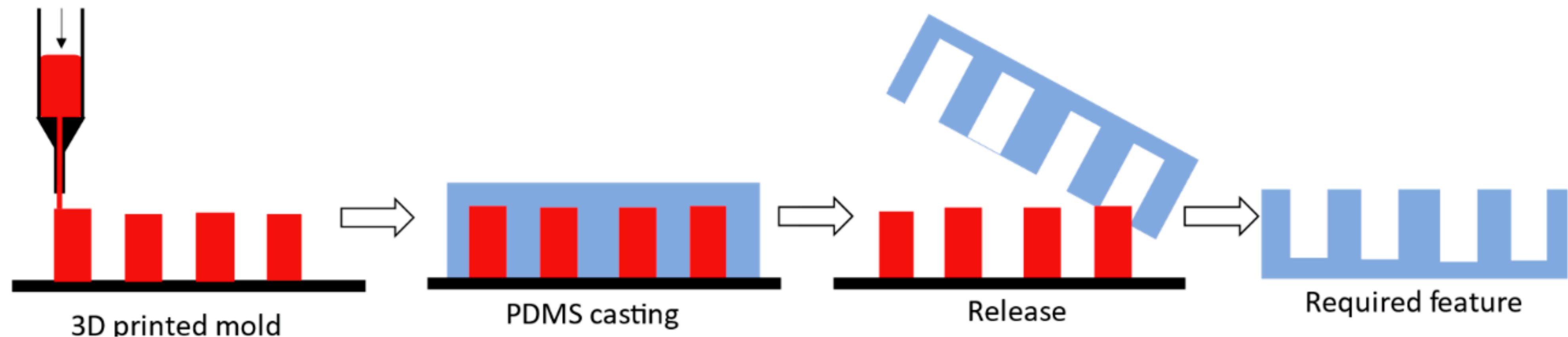
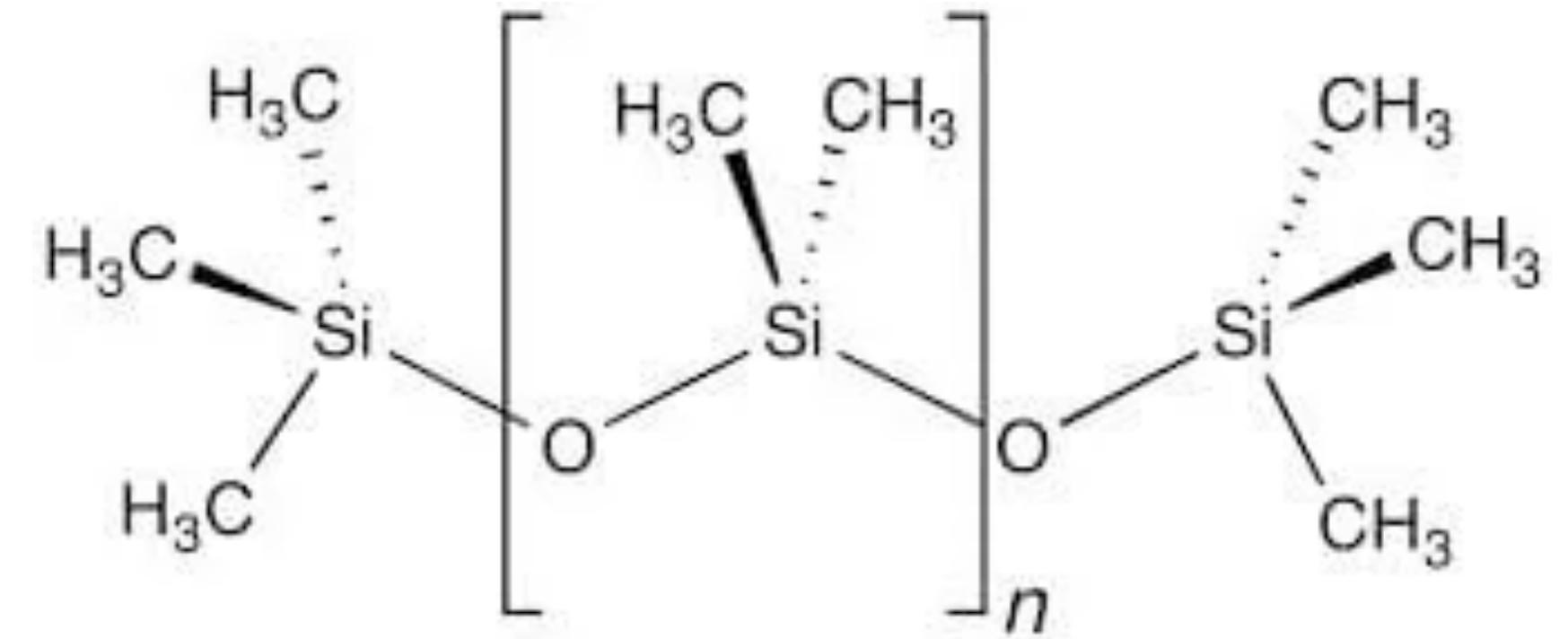


Wioland et al., PRL; 2017

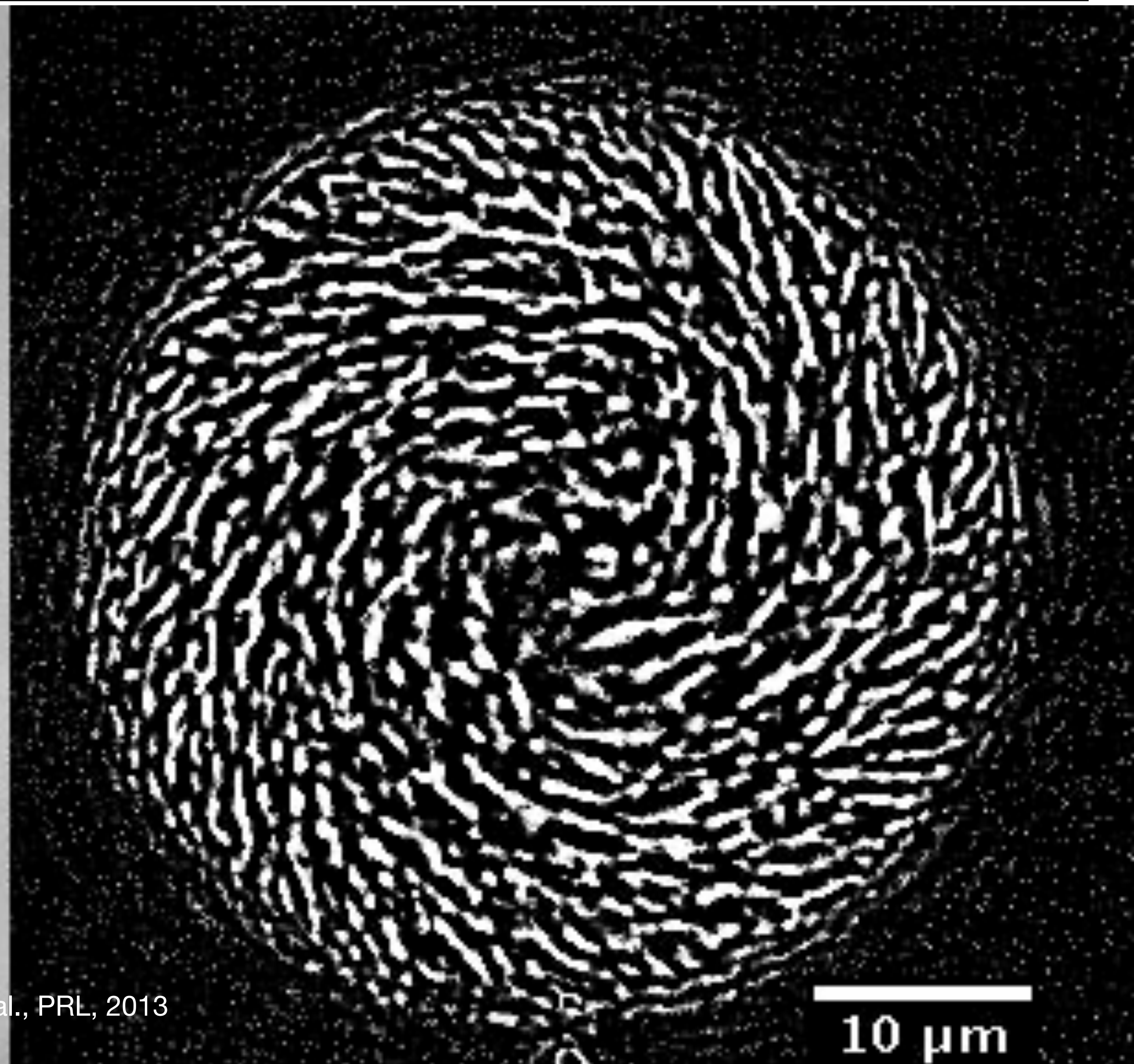
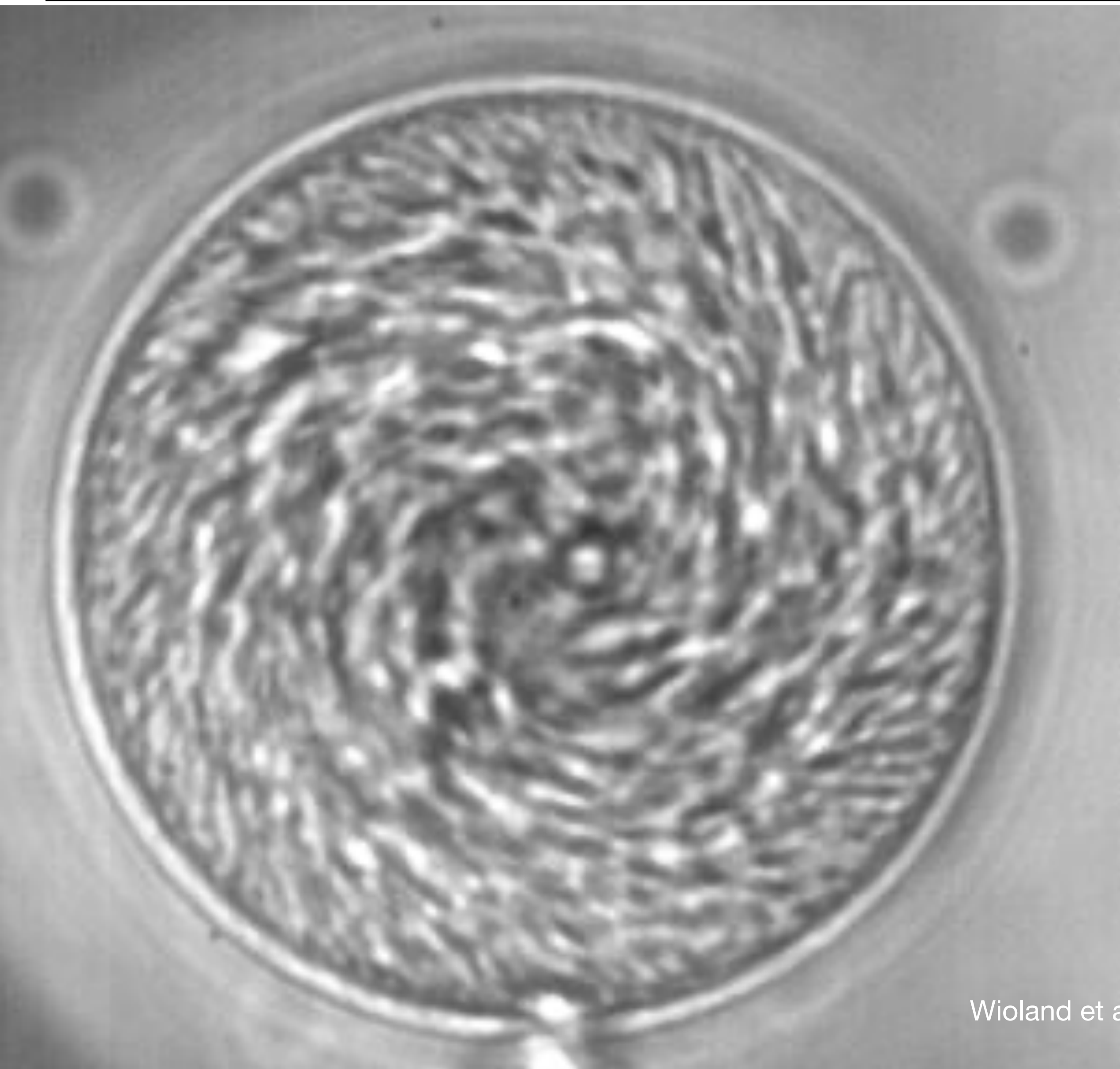
Soft lithography

Polydimethylsiloxane

- Optical transparency
- Thermal stability
- High permeability to gases
- Hydrophobicity

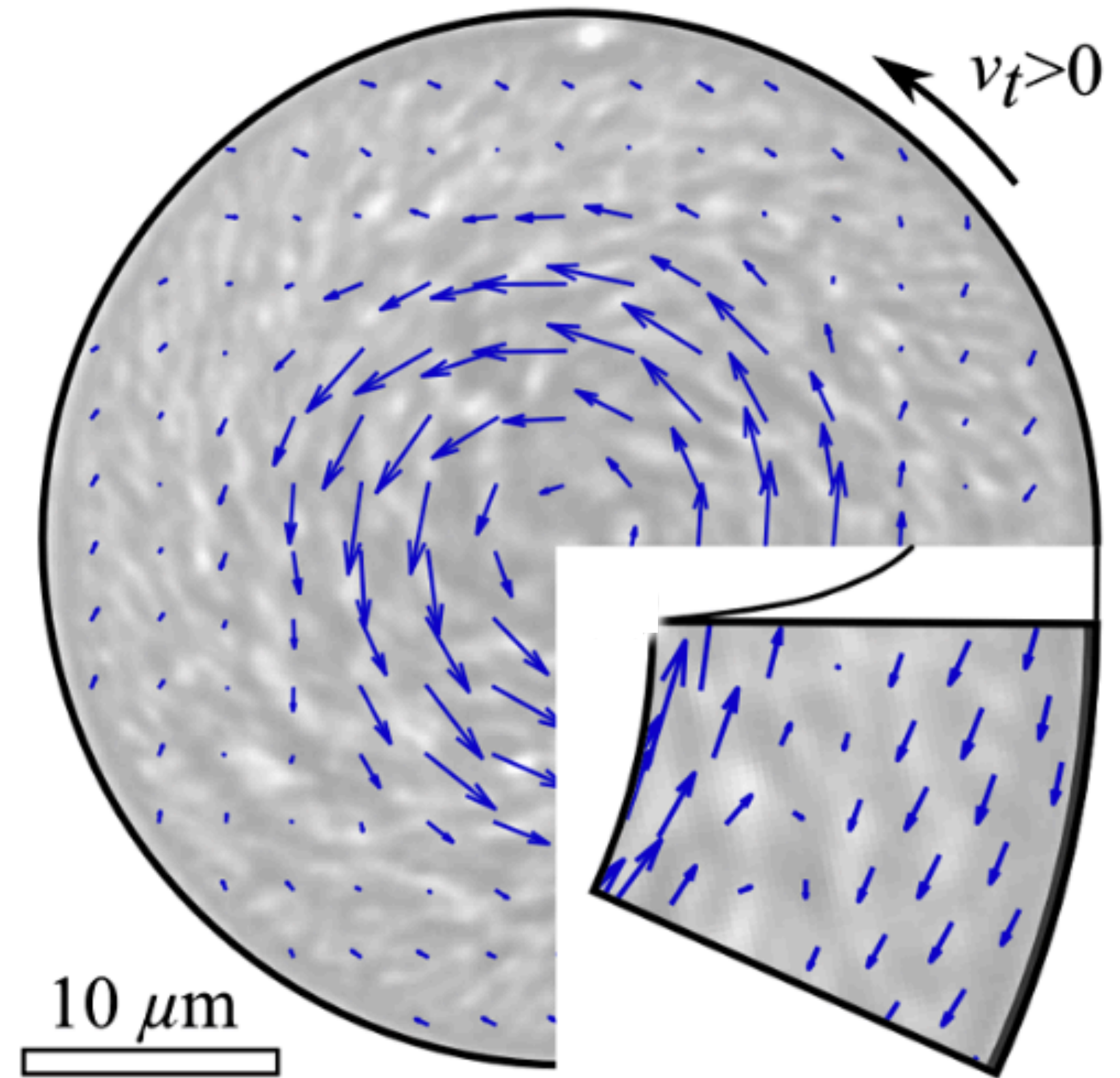
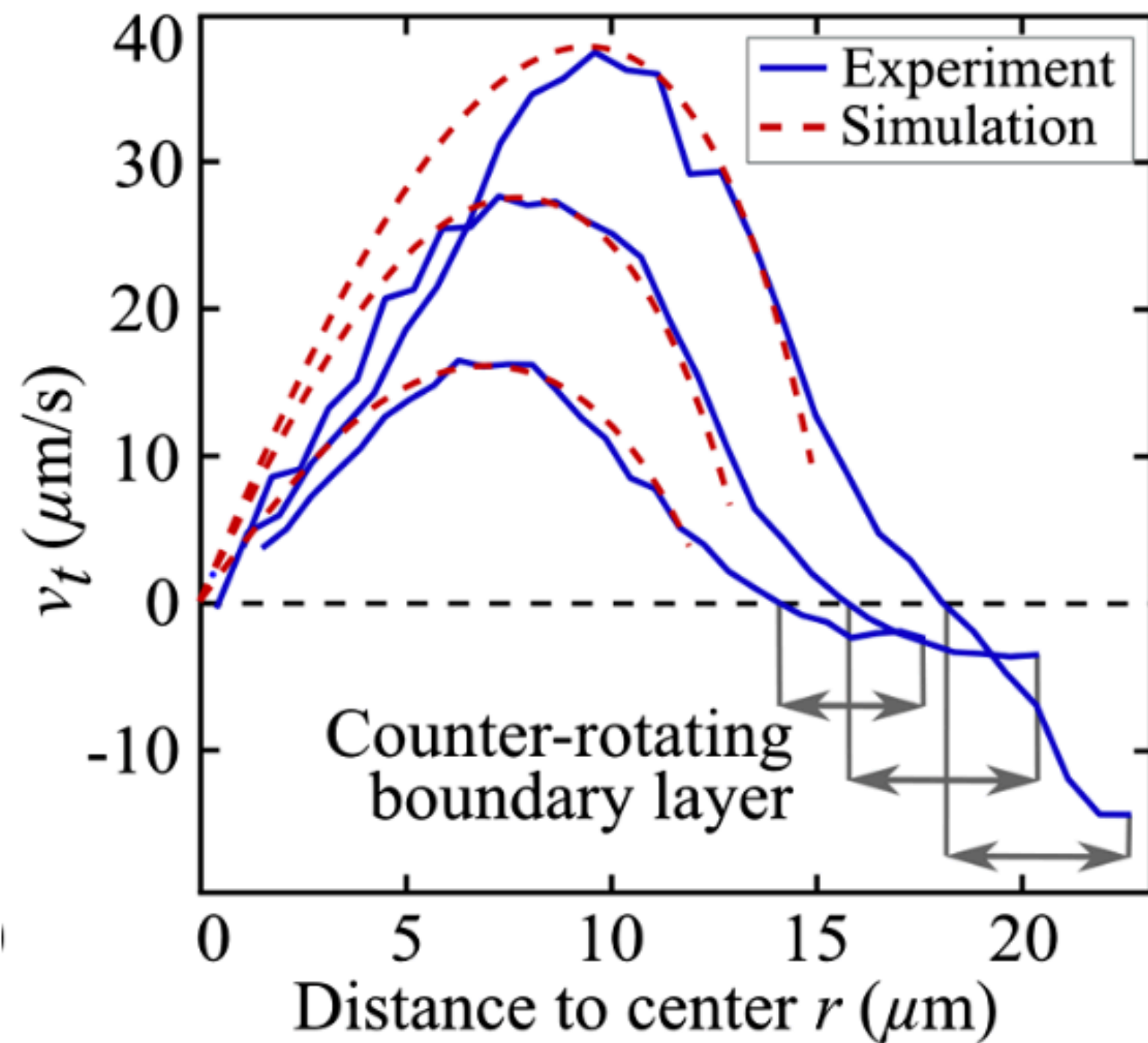
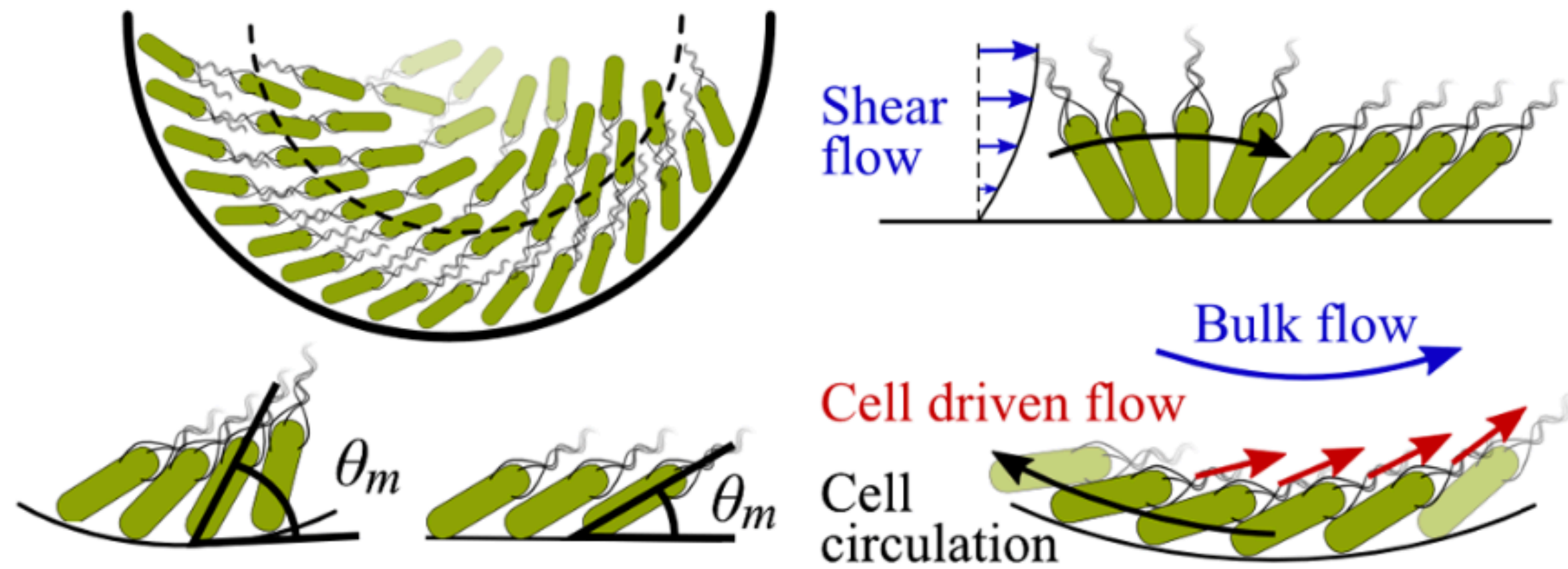


Spiral confinement

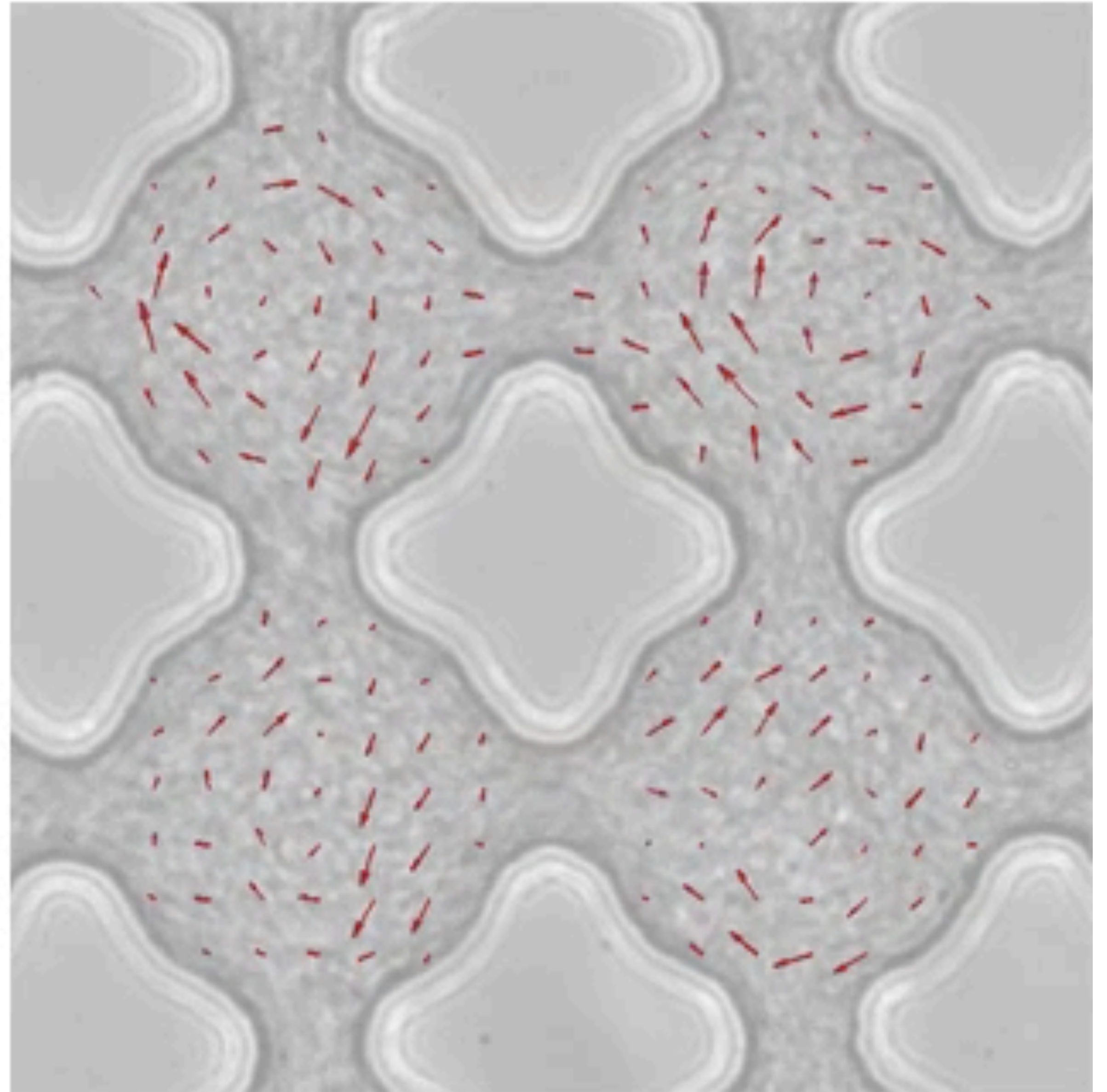
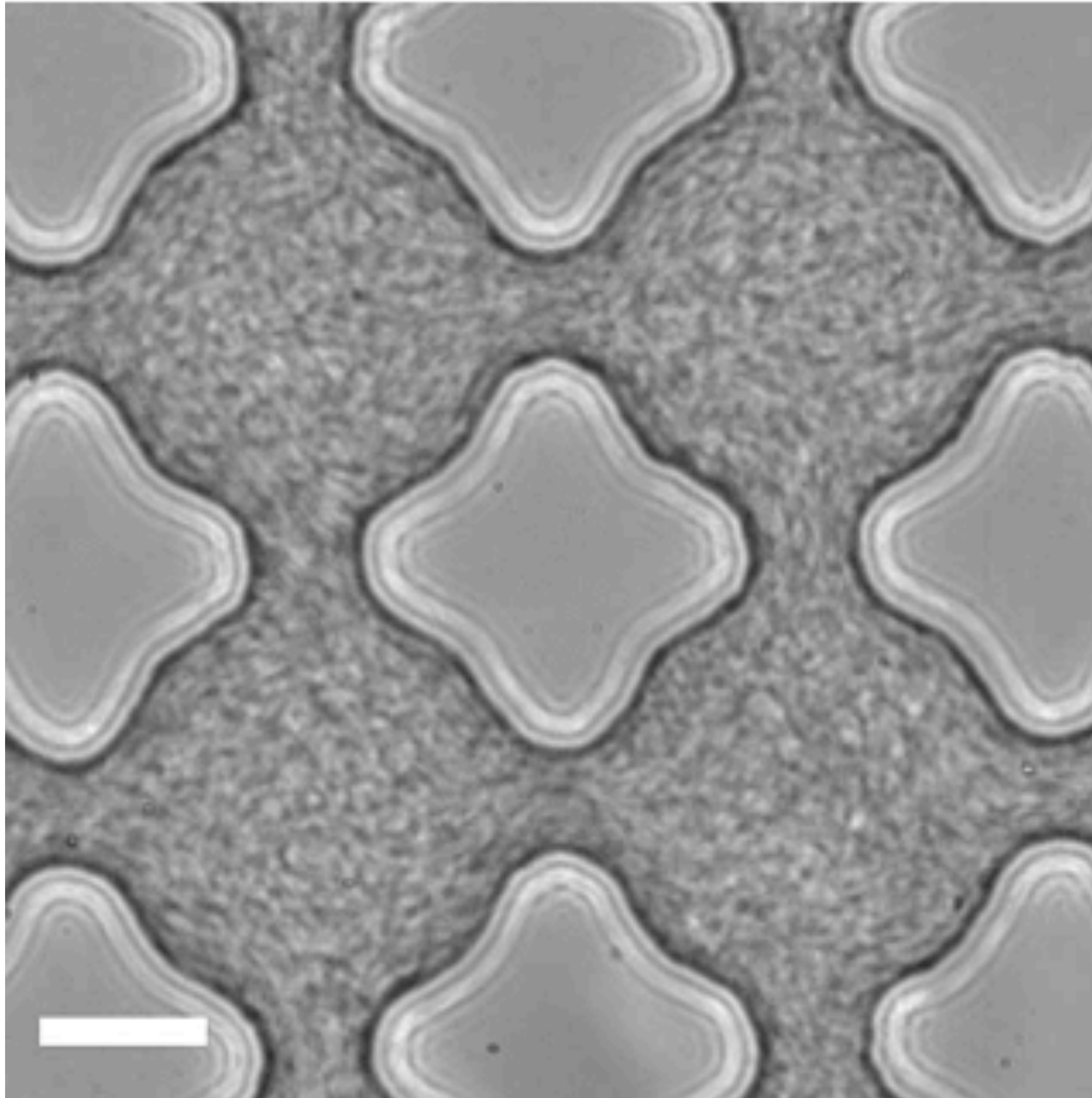


Wioland et al., PRL, 2013

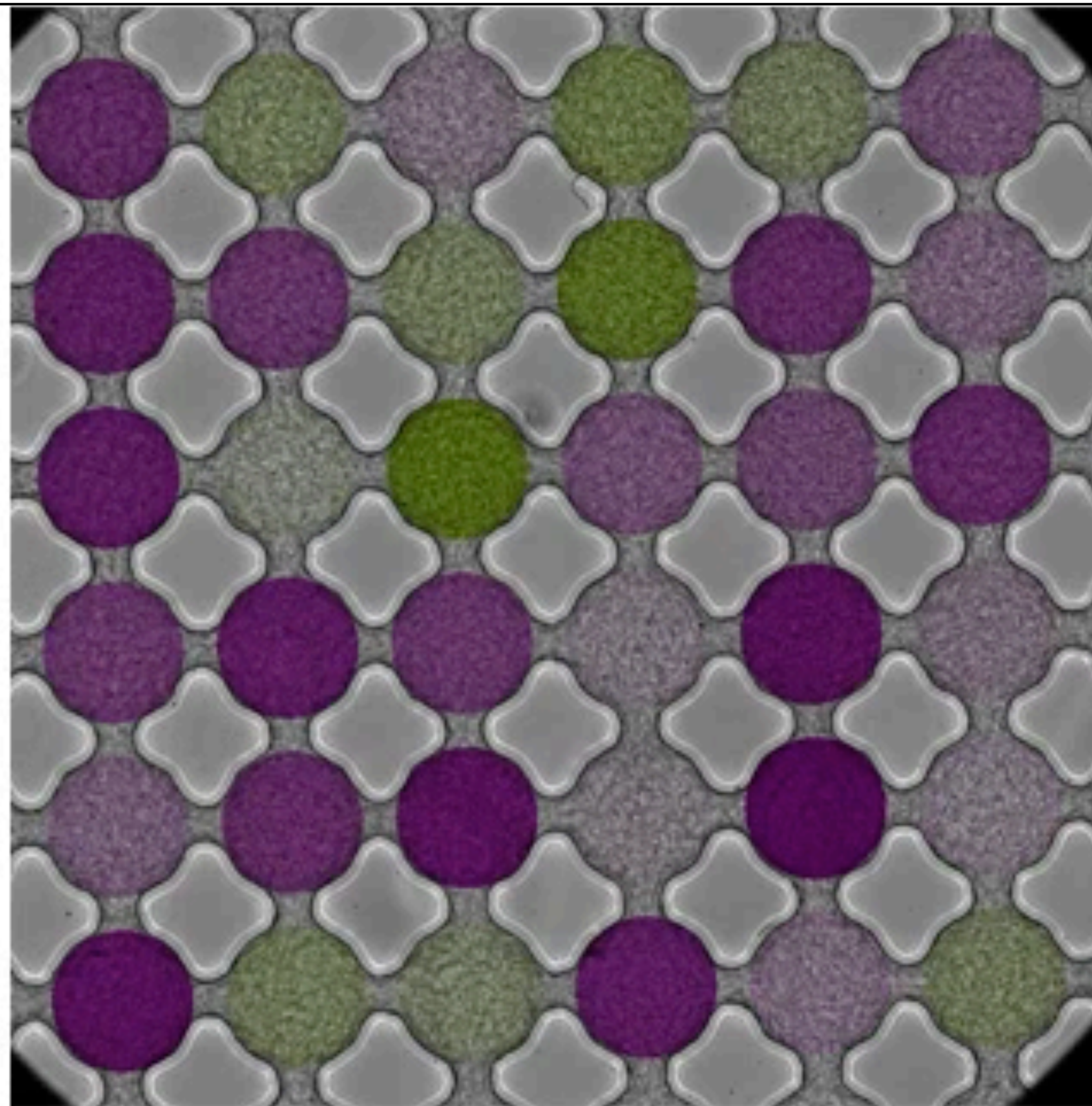
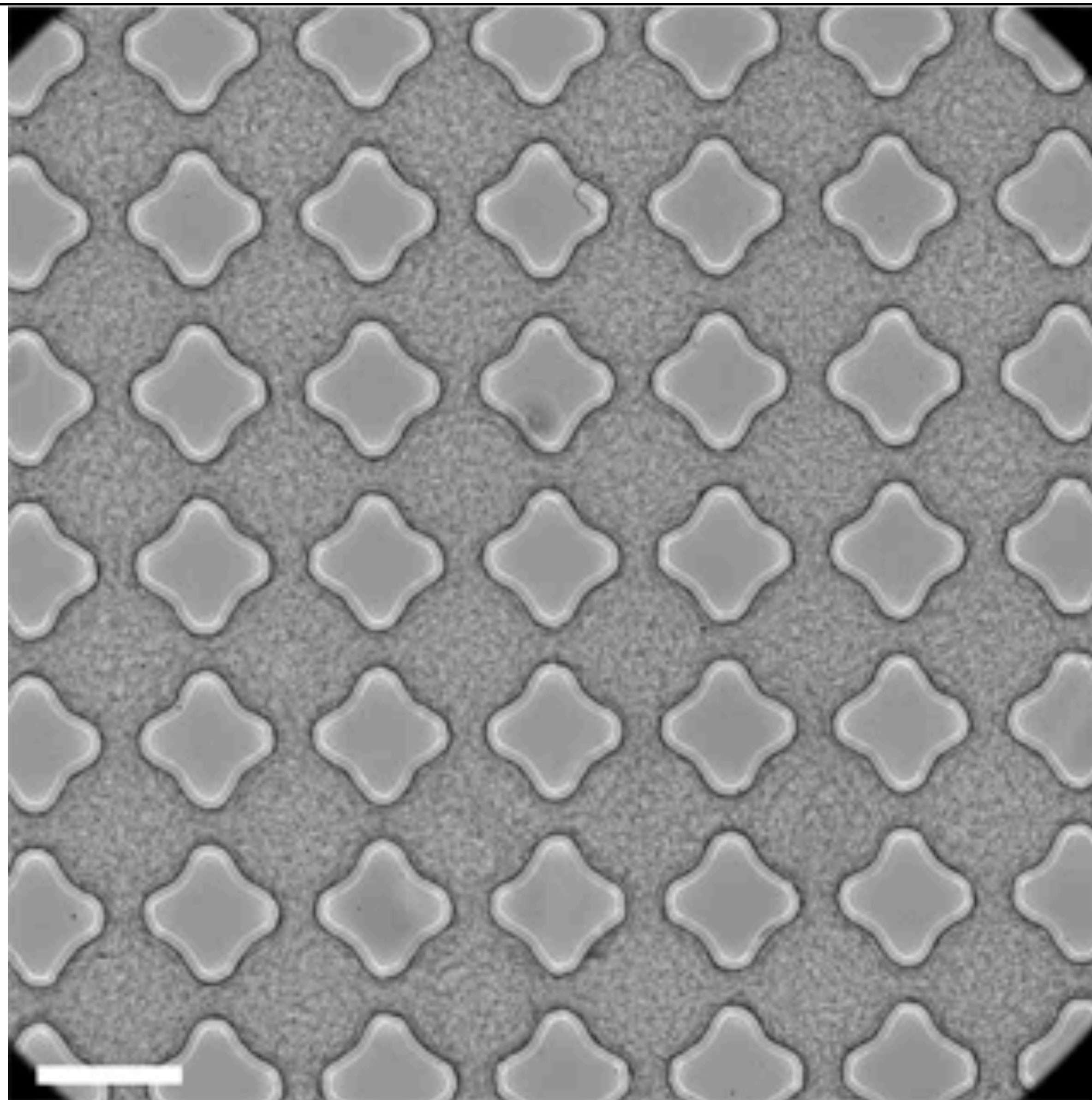
Spiral confinement



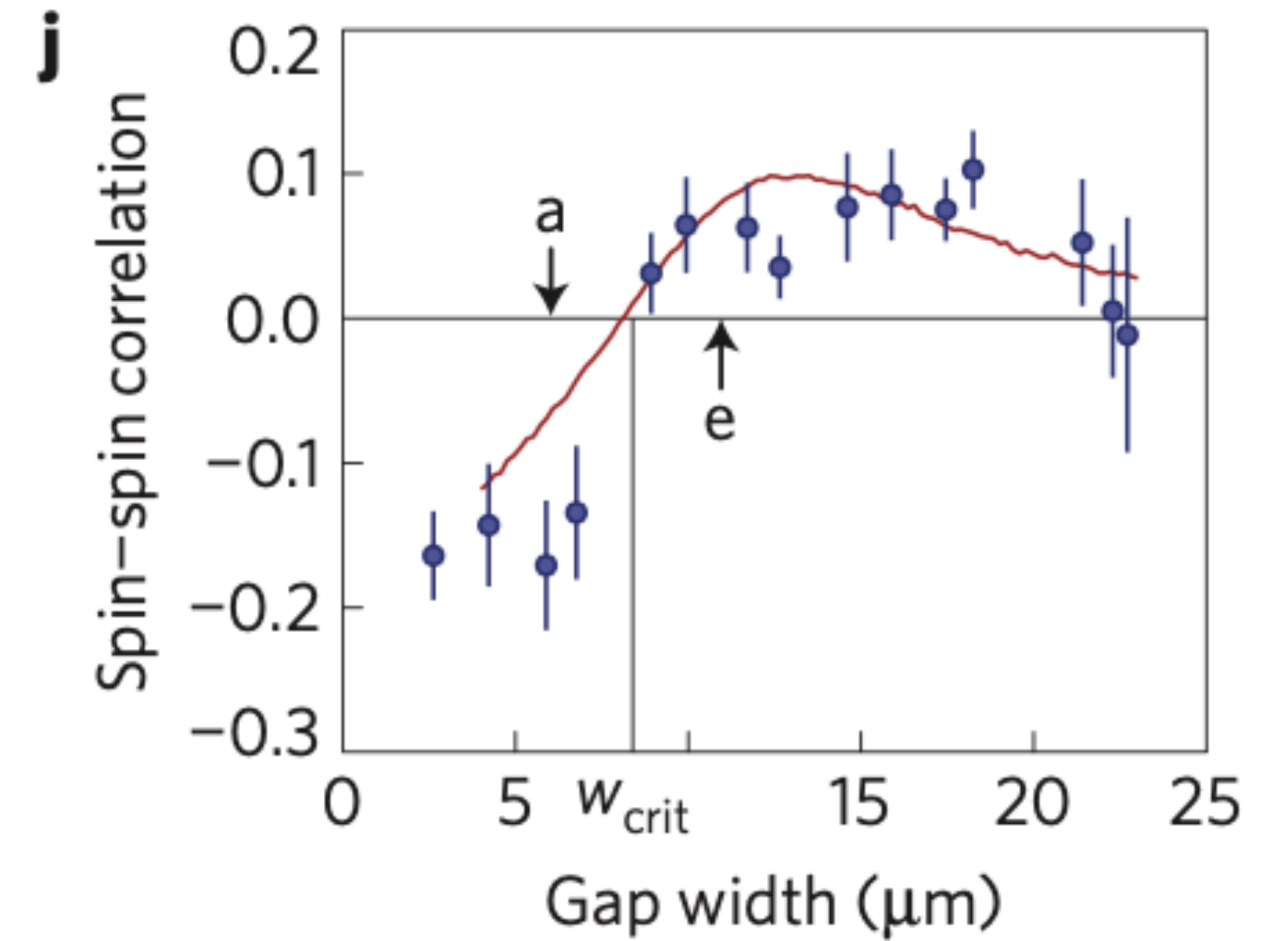
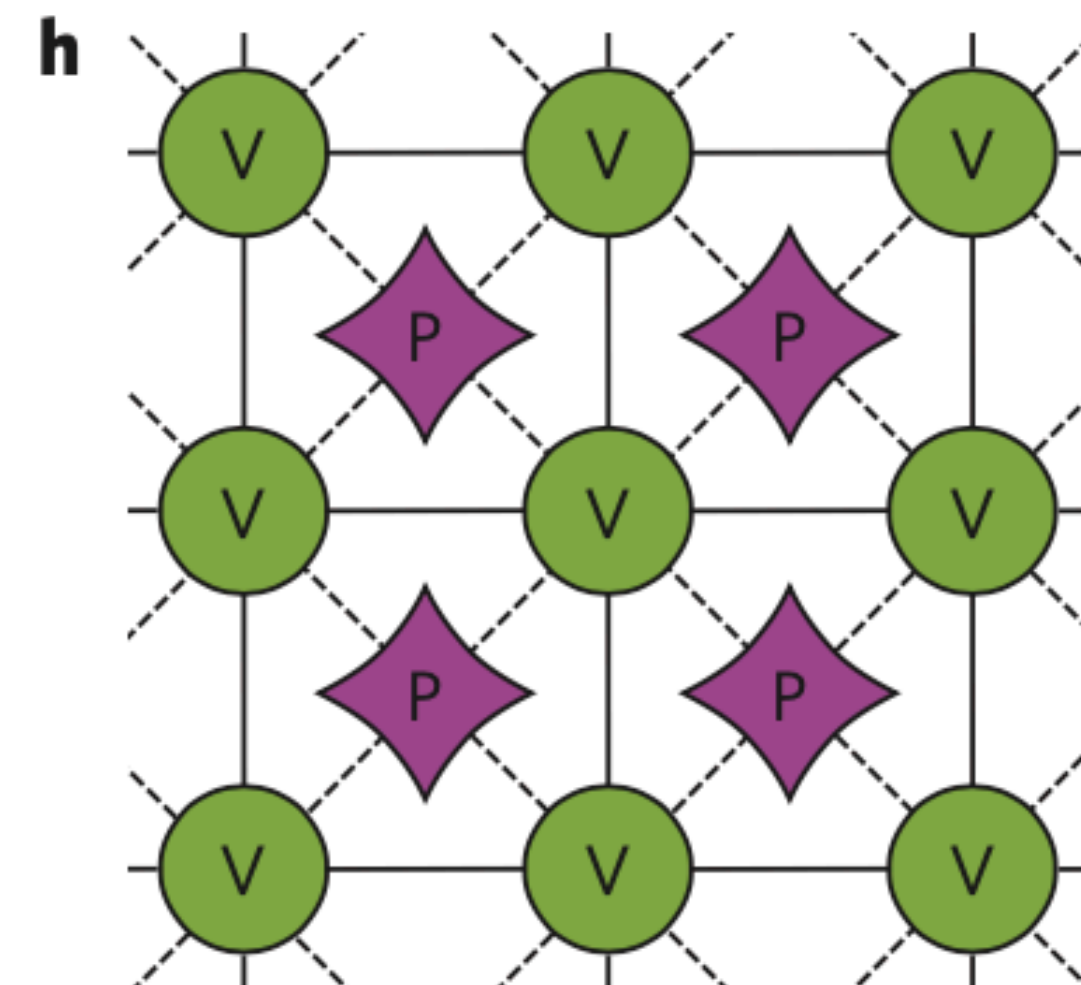
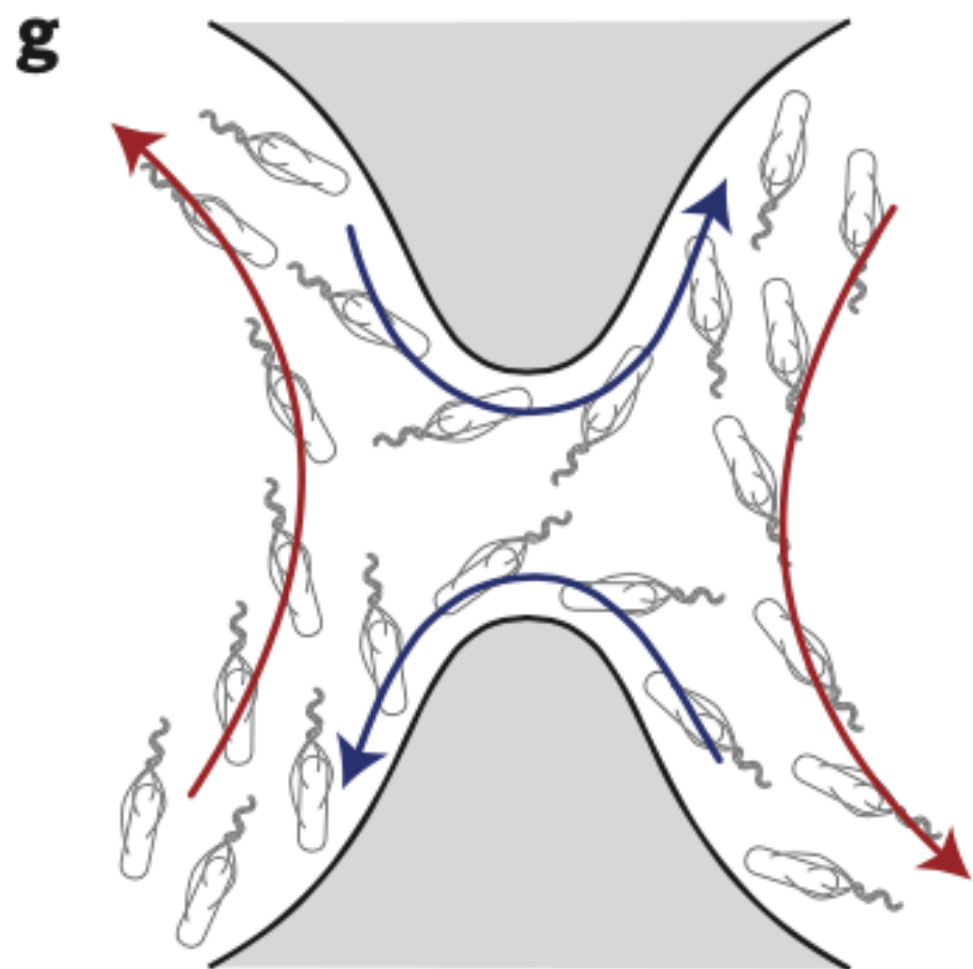
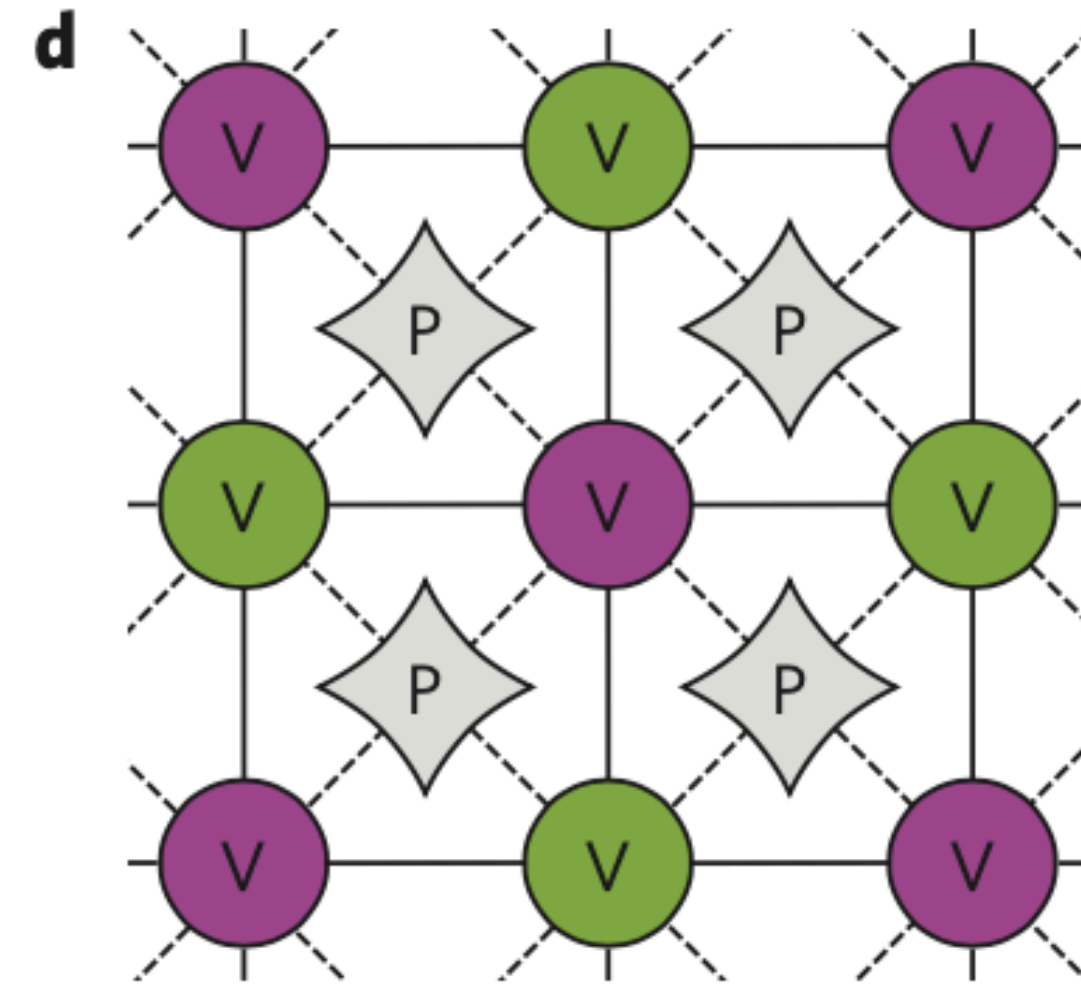
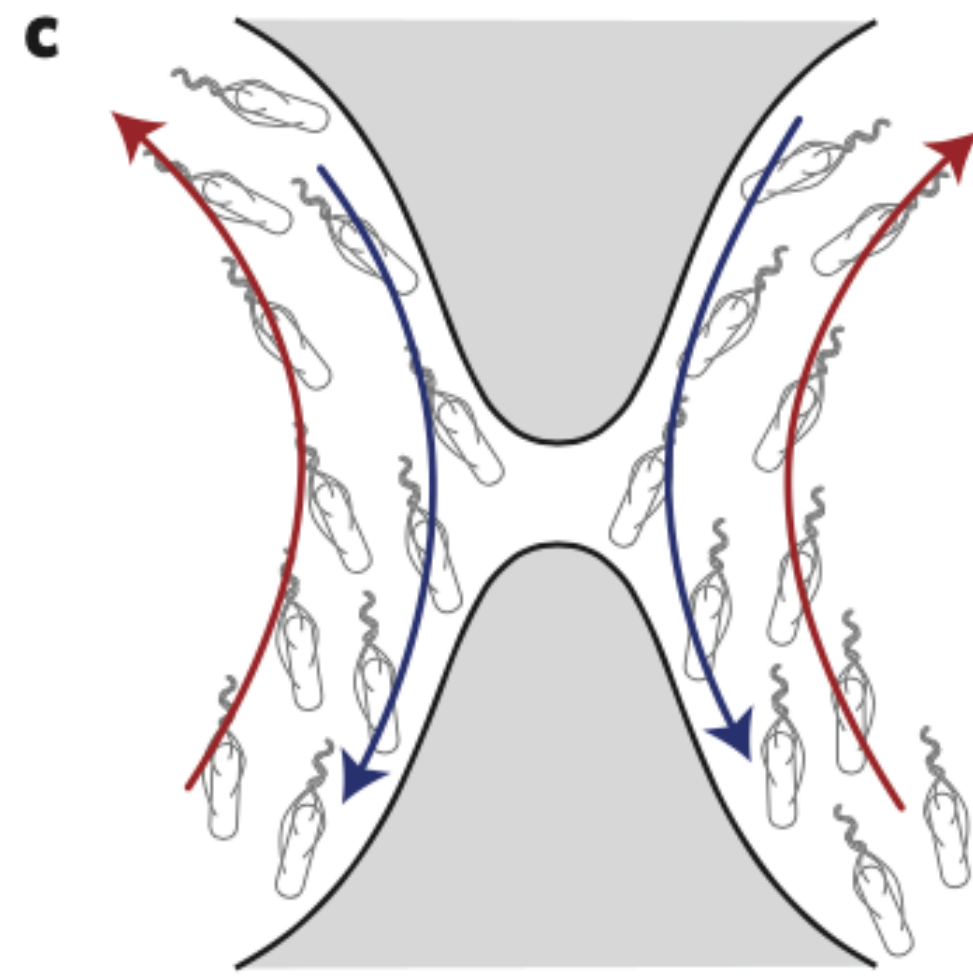
Combination of structures



Combination of structures



Combination of structures



Wioland et al., Nature, 2016

Indeed...

Conclusions

Boundaries is not a label but a **mutual definition**

Active matter can be very **susceptible to boundaries**

Perspectives

Looking for **active pressure**

Explore experimentally **soft boundaries** in active turbulence



That's all Folks!