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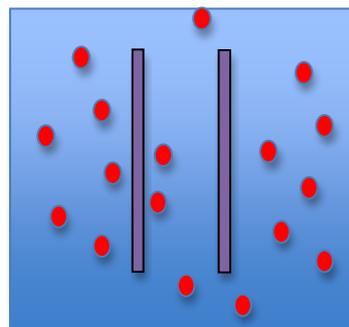
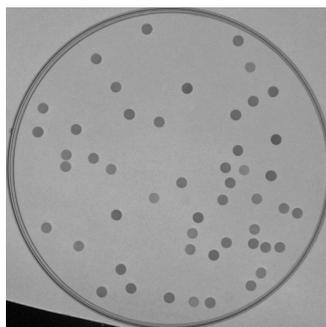
Liquids@Interfaces

Pressure and Casimir forces for interfacial swimmers

Assemblies of active individuals, capable of self-propulsion, share the fascinating property of generating collective behaviors. This effect, observed in nature from flocks of birds or fishes, down to colonies of cells or bacteria, has no equivalent in passive systems and is a striking manifestation of the out-of-equilibrium state of the system. Understanding how such dynamical order spontaneously emerges from individuals thus constitutes a fascinating challenge for physicists : providing equivalents for thermodynamics and statistical physics, without the help of the equilibrium constraints.

Doing so, one appealing approach consists in revisiting historical experiments and concepts with active systems. This is the case with the notion of pressure in active systems, a simple and basic thermodynamic variable in classical systems. Recently, some numerical and theoretical studies suggested that the **mechanical pressure**, i.e. the force exerted by an active fluid on its container, does not always satisfy an equation of state [1]. More strangely, it could even depend on the nature of the confining walls and their specific interaction with the active individuals. Boldly, changing the « color » of the container would change the pressure in the system! So far however, no experimental study has been able to investigate this question, despite the slow emergence of model artificial active systems. On top of that, other remarkable phenomena are predicted associated with the interaction of active particles with surfaces as for instance the existence of **non-equilibrium Casimir forces** [2] : active particles evolving in a system with two parallel walls should induce an attractive force between the walls.

Recently, our group has developed a macroscopic interfacial system, which allows for measuring mechanical effects in active matter. Based on this system, **the aim of this internship** will be to study experimentally the questions associated with active particles interacting with surfaces and more specifically to focus on mechanical aspects : pressure and Casimir forces.



Left : Top view of interfacial swimmers in a Petri dish (diameter of 5cm)

Right : Active particles induce an attractive force between the two plates (Casimir force)

This internship will involve experiments with interfacial active swimmers, state of the art image processing, statistical physics and fluid mechanics. **This subject could be extended for a PhD.**

[1] A. Solon et al, Pressure is not a state function for generic active fluids. Nature Phys. 11, 673 (2015).

[2] D. Ray et al, PRE, 90, 013019 (2014). A. Lee et al, Fluctuation Spectra and Force Generation in Non-equilibrium Systems Arxiv 1505.06876v4 (2016)