

M2/PhD project

Physique des Cellules et Cancer - Institut Curie

Team: Biology-inspired Physics at MesoScales

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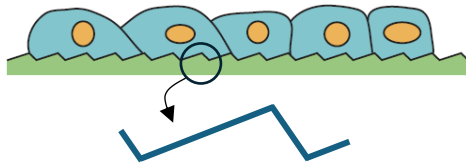
and

Gulliver lab – ESPCI

Team: Collective Effects in Soft Matter

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Locomotion induced by asymmetric friction: From cells to robots



Friction asymmetry characterized by different friction coefficients in opposite directions, is a critical feature of movement for many organisms such as snakes whose skin is covered by oriented micro-scales. It has been proposed to be central also in the motion of cells on

substrates conditioned by polar extracellular matrix and we have indeed shown that artificial substrates breaking the left-right symmetry were highly efficient in directing the transport of cells at high density close to confluence. Very interestingly, the collective effect is much stronger than the superimposition of individual behaviors. If the principle of motion in asymmetric environments is relatively well understood, this amplification of the effect at high surface density remains elusive.

To better understand this situation, we are developing a simpler system inspired by these biology experiments and consisting in active macroscopic particles (“robots”) on a vibrating ratchet-like surface. Practically, ratchet substrates can be fabricated by a variety of techniques including high resolution 3D printing or laser cutting. Seeding robots at various densities will mimic proliferating cells. In this artificial system, the physical parameters can be well controlled: speed, elasticity, weight...of the particles; elasticity, geometry ... of the surface. By playing on this limited number of parameters, we aim at reproducing the flocking-like behavior of cells with artificial particles in a beautiful example of bioinspired robots’ swarm.

Recent relevant references of the group (selection)

- Chen HY et al.: *Morphogenesis of a stratified cell mound at a vortex defect*, Nature Physics in press (2026)
- Lacroix M et al.: *Emergence of bidirectional cell laning from collective contact guidance*. Nature Physics **20**, (2024) 1324
- Sarkar T. et al.: *Crisscross multilayering of cell sheets*, PNAS Nexus, **2**, (2023), pgad034