Are biological cells just another type of active particles?

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Active matter describes systems comprising individual units able to dissipate energy to self-propel. This encompasses very different situations, from the collective motion of birds [1] to the swarming of synthetic colloidal rollers [2, 3]. Recently, a lot of effort has been dedicated to use active matter theory to try and describe the collective motion of cells and account for tissue dynamics [4, 5].

Biological cells are, however, much more complex than synthetic colloidal particles: they can deform, fluctuate, adapt, communicate, in ways which are not (yet?) accessible to synthetic units. The question of their modelling is thus particularly relevant and there is no scientific consensus on the proper theoretical description (if any) of motile cells.

In this internship, we will compare numerically how the emerging physics of large assemblies of active units evolve as one goes from the idealized model of physicists (active particles interacting via pairwise interactions) to models much closer to biological cells, involving topological, multi-body interactions of deformable objects [6].

These questions will be addressed both in a particular experimental setup used to rectify the motion of cells (Fig. 1) as well as in bulk, uniform systems. The latter will be used to characterize the N-point functions entering an exact hydrodynamic descriptions of the assemblies of particles, whose expressions will be used to construct relevant approximations and closure relations.

Thesis: This project can potentially lead to a Ph.D. thesis.

Required skills: Programming language C; interest for interdisciplinary research;

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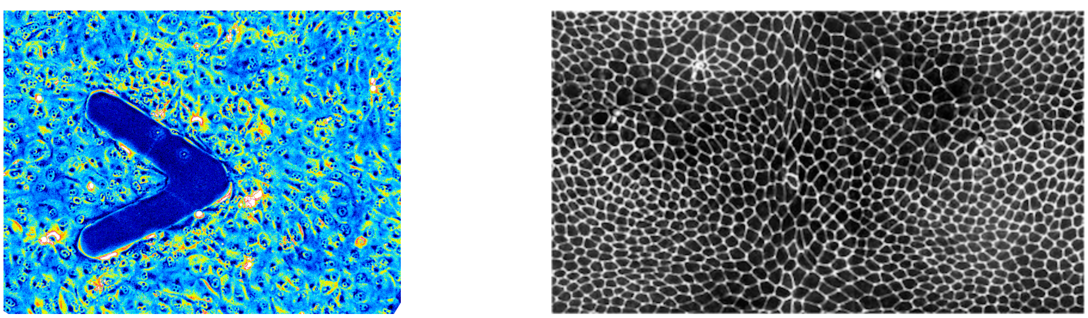

FIG. 1: **Left:** The collective migration of cells can be rectified by asymmetric obstacles. **Right:** The migrating cells of the back of a *Drosophila* live-imaged during metamorphosis [7]. The properties of the collective flows generated by boundary conditions are unknown, as are the 'Navier-Stokes equations' that would account for the bulk flows of cells far away from the boundaries.

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