Microswimming in complex environments

Active particles self-propel by absorbing energy from their surroundings or from an internal reservoir. Nature's example of these include swimming bacteria, while artificial microswimmers can be realised using active Janus colloids (Fig. 1).

Understanding how to direct and control these self-motile objects is grand challenge in soft matter physics due to the possibility to create autonomous materials, where the constituents can carry-out task independently. Recently is has been demonstrated that fluid topology, *e.g.* the orientational order of liquid crystals, can be used to orient and guide both bacterial and artificial microswimmers (Fig. 1).

In this project, we will study the hydrodynamics of spherical microswimmers in complex fluids for example in liquid crystals. The active particles move by locally stirring the nearby fluid (Fig. 1). Pullers pull the fluid towards themselves along to direction of the motion while pushers push the fluid away (Fig. 1c and d). The interactions between the particle induced flow fields (Fig. c and d) and the anisotropic nature of liquid crystals, can give a rise to aligning torques on the particles [3]. To fully realise both the microswimmer flow fields and the hydrodynamic coupling to the liquid crystalline fluid, we will use lattice Boltzmann simulations. This allows us to simultaneously resolve both the hydrodynamics of the microswimmers as well as the liquid crystalline fluid. The simulations will be supported by analytical calculations in collaboration with Alois Würger.

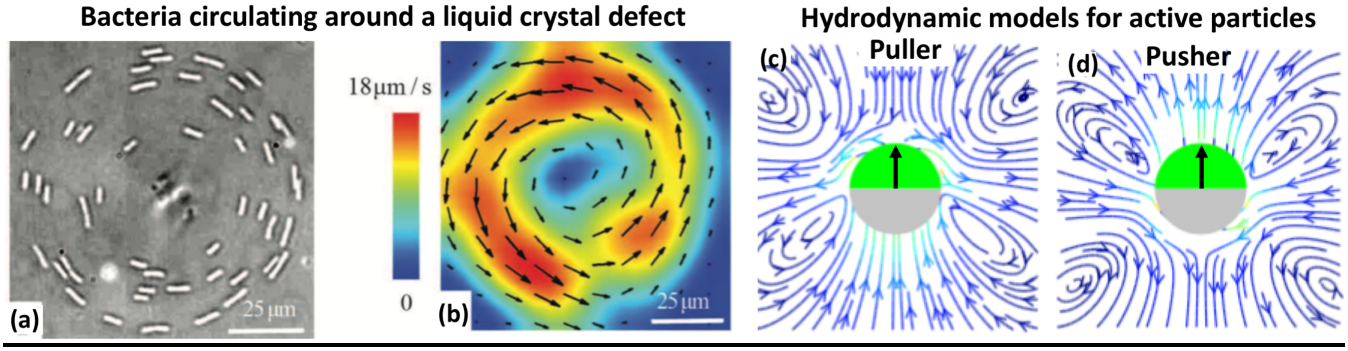

Fig. 1 (a-b): Experimentally, a rod-like bacteria (Bacillus subtilis) is observed swim around liquid crystalline defect with a speed of ~10μm/s [1]. **Hydrodynamic swimming mechanisms of active particles:** (C): A puller is propelled from front leading to the fluid flow towards the particle along the direction of the motion, while pusher is propelled from behind [2] (the arrow gives the direction of the motion).

The project would suit candidates who are interested in active soft materials. The project is computational and utilises state-of-the art simulations methods (e.g. lattice Boltzmann). It offers a rich research environment including a strong cross fertilisation between simulations and analytical theory.

Profile – Masters degree in physics, engineering, mathematics, chemistry or related field. Strong interest in numerical simulations and willingness to learn. Strong communication skills in English and/or French.

Location – The position is funded by the Ecole Doctoral of the University of Bordeaux. The project will take place in the laboratory LOMA at the Talence campus, located 15min tram ride away from the historic city centre of Bordeaux and 1h drive away from the beaches of Gironde.

Application – full CV, letter of motivation, contact details of two references and grades for master 2.

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[1] C. Peng, T. Turiv, Y. Guo, Q. H. Wey and O. D. Lavrentovich, *Science* **354**, 882 (2016)
[2] Z. Shen, A. Würger and J. S. Lintuvuori, EPJE, **41**, 39 (2018).
[3] J. S. Lintuvuori, A. Würger and K. Stratford, Phys. Rev. Lett. **119**, 068001 (2017).