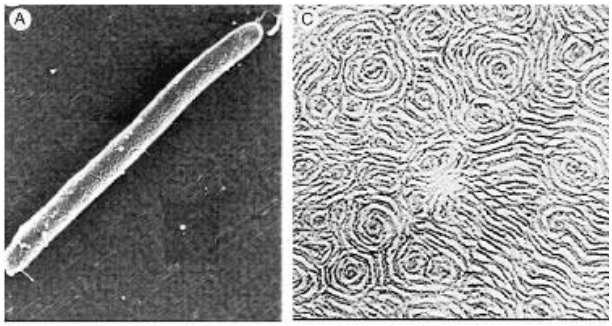
CEA Saclay –Service de Physique de l'Etat Condensé (SPEC) (page web)
Laboratoire *SPHYNX*

INTERNSHIP/PHD POSITION

COLLECTIVE MOTION: COUPLING INTERNAL AND EXTERNAL SYNCHRONIZATION

Simple models for collective motion can be seen as systems where orientational degrees of freedom (along which particles move) try to synchronize (in which case particles move together). Many active, living, self-propelled organisms also have internal oscillatory degrees of freedom which may themselves try to synchronize upon contact and that can have, in turn, some influence on motion. This has been observed for myxobacteria, who spontaneously reverse their walk from time to time: at high densities, these reversals can synchronize, leading to collective effects in the displacement of groups.



Micrograph of a myxobacterium (left). "Rippling wave" pattern formed by a starved colony (right)

The goal of this project is to explore the general theoretical idea of a non-trivial two-way coupling between synchronization of internal degrees of freedom and direction of motion. So far, apart from works modeling the case of myxobacteria, no general framework has been proposed. Recent work, in 'sociophysics', investigates how contacts between (random) walkers generate 'social networks' and how populations of such moving agents can synchronize 'opinions', but the agent's motion is not influenced by the 'opinion' they carry. The interesting case of a supplementary, reverse, feedback of internal degrees of freedom on the motion of particles has not been explored.

Starting from the case of myxobacteria, the project will consist of studying minimal models displaying non-trivial emergent phenomena due to the two-way coupling of internal degrees of freedom and motion. In a second stage, continuous effective theories of these systems will be derived and studied, using various analytical and numerical techniques.

References:

- Breaking symmetry in myxobacteria. OA Igoshin, D Kaiser, G Oster, *Current Biology* 14 (12), R459 (2004)
- K. Uriu, S. Ares, A. C. Oates, and L. G. Morelli, Phys. Biol. **9**, 036006 (2012)

CONTACTS: Hugues Chaté, 06 66 03 46 79, hugues.chate@cea.fr