M2 project: Collective effects and extreme environments

Key words: Collective effects, rare events, dynamical phase transition, non-linear physics

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Internship funded, possibility to continue in PhD through application at ED PIF.

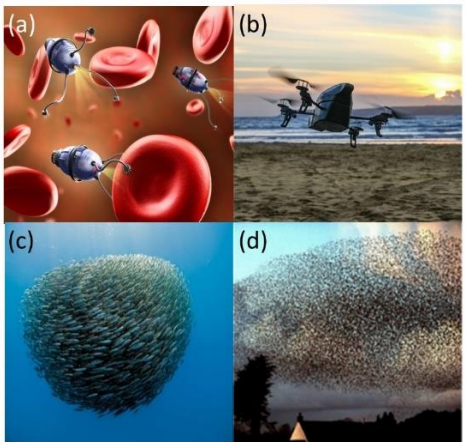

Figure 1 (a) Artistic micro-surgeons. (b) Drone and possibility of sea rescue. (c) School of fishes. (d) Flock of birds.

Future micro-surgeons in aortic flows (Fig. 1a), robotic assistance or drone sea rescuing (Fig. 1b) under degraded conditions will lead to new disruptive applications but will also face fundamental limits: their surrounding flow perturbations usually significantly surpasses their self-propulsive forces. This represents a major stumbling block for realizing their full potential. Who could possibly imagine that the artistic micro-robots in Fig 1a would be controllable in a violent aortic flow?

Surprisingly a school of fishes or a flock of birds (Fig1. c & d) is often more robust to *violent external perturbations* than an isolated individual. This originates from their local interactions and lead to an emerging collective intelligence. As a collective object, they form an ordered structure which collectively processes external perturbations. Today, even swarms of robots can be designed! From a theoretical perspectives, the modularity and programmability of the interactions between robots is fascinating as it paves very promising ways to self-learning collective phases. The goal of the internship is to explore this unchartered territory by leveraging new collective strategies for transport optimization in degraded situations.

It is a numerically/theoretically-oriented internship. Strong skills in programming (preferably C++ or matlab, Python is also fine), dynamical systems theory and phase transition physics is an asset. The group has important local computational resources as well as access to massive clusters for further intensive computations. An applicant who likes interacting with experimentalists is also the most welcome.

Gulliver is a very active anf multidisciplinary laboratory at ESPCI in the center of Paris. It research fields range from theoretical physical-chemistry, soft matter, molecular programming, statistical physics to microfluidics. It provides an international and intellectually stimulating environment with ample opportunity for cross-pollination, giving you the opportunity to widely disseminate your extensive knowledge and new insights.

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