INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Interdisciplinaire de Physique, LIPhy
CNRS identification code: UMR5588
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Internship location: Campus de l'université Grenoble Alpes, Grenoble

Thesis possibility after internship: YES/~~NO~~
Funding: ~~YES~~/NO If YES, which type of funding:

Crowd evacuation, are bees smarter than humans?


Preliminary experiment of bee crowd evacuation.

Collective motion is a fascinating phenomenon naturally observed at all scales from bacteria to birds. The ensemble of agents, such as bacteria or fish, can be seen an active matter that can deform, flow and merge only based on the self-propelled motion of each agent and their short or long-range interactions. **When urge to evacuate through a bottleneck, human crowds behave like a granular material leading to clogging and intermittent flow, and in worst cases in casualties**. This phenomenon, named the Faster-is-slower effect, has been observed for humans, sheep or vibrated grains with the claim that this non-optimal evacuation would be universal for active matter passing through a bottleneck[1]. We have recently shown that small fish avoid clogging and can be modeled by deformable frictionless bubbles rather than hard grains[2]. In this project, **we aim at exploring the collective behavior of honeybees in the evacuation setting.** Open questions are: do bees perform better than humans? If so, what can we learn from bees and adapt to human crowds? Is the bee model relevant to test different strategies in order to optimize human crowd evacuation in stressful situations?

Preliminary experiments have been done, suggesting that different mechanisms are at play compared to humans or fish. A group of bees has been placed in a quasi-2D waiting room and the evacuation has been imaged for various sizes of the aperture. This dataset must now be analyzed and numerical tools need to be implemented to track the bees and their orientation, measure the timing of the egress, the movements and density of bees in the waiting room, …

The intern will first develop numerical tools and use them to analyze the preliminary dataset. If interested, the intern will be able to perform new live-bee experiments. If the project progress rapidly, numerical simulations are also possible. Of course, the physical interpretation of the observed and quantified phenomenon will be discussed with the partners in LIPhy (P. Peyla, numerical physicist specialist of active matter) and in the frame of a larger project (A. Avarguès-Weber, ethologist specialist of bee cognition, and C. Douarche, biophysicist specialist of collective movements). This internship takes place in **a unique collaborative and multidisciplinary environment in the Laboratoire Interdisciplinaire de Physique in Grenoble** and will be a very good start for an interdisciplinary PhD thesis about the mechanics of cohesive living matter.

[1] "Clogging transition of many-particle systems flowing through bottlenecks" I Zuriguel et al. *Sci. Rep.* (2014)
[2] "Fish evacuate smoothly respecting a social bubble" R Larrieu, P Moreau, C Graff, P Peyla, A Dupont *Sci. Rep* (2023)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES/NO Soft Matter and Biological Physics: YES/~~NO~~
Quantum Physics: ~~YES~~/NO Theoretical Physics: ~~YES~~/NO