INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Interdisciplinaire de Physique
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Internship location: LIPhy, Grenoble

Thesis possibility after internship: YES
Funding: Doctoral school

Dripping of a honeybee cluster, analogy to a complex fluid

Collective motion is a fascinating observation where the ensemble of agents, such as bacteria or fish, can be seen as a single living object that can deform, flow and merge only based on the self-propelled motion of each agent and their short or long-range interactions. A wealth of approaches has been developed over the years to model such systems including discrete and continuous strategies. In this new project, **we focus on an original system that has barely been studied in the frame of mechanics and not at all in terms of rheology: a honeybee cluster**. When a colony divides, the queen bee and thousands of worker bees swarm out of the hive and hang outside for hours to days. The bees form a cohesive structure similar to a liquid drop hanging on a wire. An additional general observation from beekeepers is that, when a swarm is collected, it can flow like a paste. The intriguing apparent mechanical properties of bee crowds are reminiscent of cohesive grains, like wet sand. Unlike granular materials, bees are active and cognitive, each agent can intentionally adapt its own movements, in this perspective **the system is a promising tool to tackle new questions in the field of cognitive active matter.**

We have performed preliminary experiments to characterize the flowing behavior of honeybee clusters. About a thousand of bees were placed in a large funnel in the conditions for clustering. The fall by gravity of the cluster was observed showing an intermittent flow, like a complex fluid (e.g. ketchup) and leaving a pending drop. The statistical analysis of the time lapses, and tools developed for the evacuation of a crowd, granular material or fish in our recent work[1] revealed a complex behavior, different than for fish or humans. **The preliminary results essentially validate our working hypotheses and show that it is possible to perform rheology experiments of living bee clusters.**

To help us, we are looking for an intern with interdisciplinary interests from animal behavior to mechanics of complex materials and active matter. The intern will be actively involved in improving the experimental setup, performing experiments with living bees and analyzing the data. This internship is part of a larger project gathering specialists of active matter, granular physics, numerical modeling and ethology. This position 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.

[1] : "Fish evacuate smoothly respecting a social bubble" R Larrieu, P Moreau, C Graff, P Peyla, A Dupont (2023) Scientific Reports 13 (1), 10414

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/
Quantum Physics: /NO Theoretical Physics: /NO