Journée Thématique de l'axe Environnement
Le 6 octobre 2023
Amphi Nougaro

«Comportement collectif dans le monde animal »

8h45-9h10 : Accueil /Café

9h10 : Raphaël CANDELIER (Laboratoire Jean Perrin- Sorbonne) :
Going beyond Vicsek: how field studies and complex tasks raise new questions about collective motion

10h10 : Richard BON (Centre de Recherche sur la Cognition Animale-Cbi-UPS) :
Stop-and-go: looking for the social stimuli that govern the intermittent movements

11h10-11h30 : Pause café

11h30 : Aurélie DUPONT (Laboratoire Interdisciplinaire de Physique de Grenoble) :
Collective motion of fish in challenging environments, the emergency evacuation test

12h30-14h30 : Pause déjeuner

14h30 – 15h30 : Christian JOST (Centre de Recherche sur la Cognition Animale-Cbi-UPS) :
Nest complexity in social insects - combining experiments and modelling to disentangle the underlying behavioural coordination

15h30-16h30 : Table ronde

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9h10 : Raphaël CANDELIER (Laboratoire Jean Perrin- Sorbonne)

Going beyond Vicsek: how field studies and complex tasks raise new questions about collective motion

In 1995, Tamás Vicsek et al. introduced a simple model of collective motion with surprisingly few ingredients (a constant velocity, an alignment rule and some noise) which has been rapidly established as the cornerstone of the field. In this talk, I will present two very different works that challenge and complete this model. First, I will present the first large-scale field study of collective behavior where starlings flocks of thousands of individuals in the Roma sky were recorded and 3D-reconstructed. These data allowed us to show that the interaction ruling the bird's behavior depends on topological distance rather than metric distance, a feature that allows a better flock cohesion. Then, I will show that simulations of agents designed at odds with Vicsek's rules and driven by simple neural networks display an extraordinarily much richer phenomenology and that the coupling between the network and the collective dynamics favor the emergence of solutions for complex tasks in intelligent swarming.

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10h10 : Richard BON (Centre de Recherche sur la Cognition Animale-Cbi-UPS)

Stop-and-go: looking for the social stimuli that govern the intermittent movements

Most of terrestrial species alternate motionless and motion periods during their diurnal activity. This is evidenced by animals foraging, even in a seemingly homogeneous habitat and a fortiori in a patchy environment. To account for collective movements, most models postulate that individuals on the move choose a direction based on averaging the direction of a limited number of nearest influential neighbours. I shall present experimental and theoretical results that allow deciphering some questions regarding the social stimuli, the integration of these stimuli, the influential neighborhood and putative rules involved in departures, stops and on-going movements, using sheep as a model. We rely on spontaneous and triggered movements of individuals in different group size. We show that the stimulation can be either relatively simple or more complex depending on the periods.

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11h30 : Aurélie DUPONT (Laboratoire Interdisciplinaire de Physique de Grenoble)

Collective motion of fish in challenging environments, the emergency evacuation test

Crowd movements can be observed across species and scales: from insects to mammals but also in non-cognitive systems such as eukaryotic cells. We are interested in the collective behavior of small fish and try understand the effect of external physical perturbations. First, I will present a numerical model coupling rheotaxis and social interactions. We show that social interactions improve the rheotaxis abilities of fish[1]. Second, we asked what happens when gregarious animals must momentarily adopt an individual behavior. To question the balance between collective and individual behaviors, a school of Neons (Paracheirodon innesi) was forced to cross a constriction[2]. This experiment is reminiscent of a panicked crowd escaping through a narrow gate. Using a statistical analysis developed for granular material and applied to crowd evacuation, our results clearly show that unlike human crowds or herds of sheep, no clogging is formed at the bottleneck. Fish do not collide and wait by respecting their social distance and a minimum waiting time between two successive exits. When the bottleneck begins to be comparable to or smaller than their social distance, the individual domains set by this cognitive distance must deform and fish density increases. We show that the current of escaping fish behaves like a set of deformable 2D-bubbles, their 2D domain, passing through a constriction. Schools of fish show that, by respecting social rules, a crowd of individuals can evacuate without clogging, even in an emergency situation.

[1] R Larrieu, C Quilliet, A Dupont, P Peyla - *Phys.Rev. E* (2021)
[2] R Larrieu, P Moreau, C Graff, P Peyla, A Dupont - arXiv:2212.12514 (2022)

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14h30 – 15h30 : Christian JOST (Centre de Recherche sur la Cognition Animale-Cbi-UPS)

Nest complexity in social insects - combining experiments and modelling to disentangle the underlying behavioural coordination

Social insects, in particular termites and ants, are known for their large nests that can house up to millions of individuals. Complex architectural features help control and stabilise the internal nest climate and thus ensure the colony's survival and reproduction. In the first part of the talk I will discuss shelter construction in the black garden ant. A combined experimental and modelling approach permitted us to identify the key behaviours underlying the first stage of shelter construction, the emergence of regularly spaced pillars covered by a roof. However, the numerical complexity of the used individual based model prevented us from exploring the emergence of more complex architectural features. We overcame this limitation by translating our behavioural model into a mean field model (partial differential equations). The numerical and analytical exploration of this mean field model showed that the ant construction model is also capable to explain some features of the complex underground nests of the termite Apicotermes, notably the multiple regularly spaced floors connected by linear and helicoidal ramps.