INTERNSHIP PROPOSAL

Laboratory name : **LPENS**
CNRS identification code : **UMR 8023**
Internship supervisor : **Xiaowen Chen**
e-mail: xiaowen.chen@phys.ens.fr
Internship location : **LPENS, 24 rue Lhomond, Paris 5ème**
Thesis possibility after internship : **YES**
Funding : **NO** (need to apply to EDPIF scholarship)

Modeling and controlling collective decision making in animals and humans

From bird flocks to human crowds, collective behavior is ubiquitous in living systems. In the past decades, statistical-physics models constructed directly from data have succeeded in describing the collective phenomena in many biological systems. Nonetheless, to fully understand a system, one needs to know how to control it, and on the first order, how the system responds given various perturbations. While such prediction is given by the fluctuation-dissipation theory for inanimate systems, it is not clear how far one can extend the response theory for biological networks, especially as biological systems are out of equilibrium and undergo dynamical changes such as adaptation and learning.

This project will test out those ideas in systems of collective animal and human behaviors. Specifically, it will include analyzing real experimental data in social mice and/or in pedestrian dynamics, using a combination of agent based model and statistical inference to build interaction models that explains the observed collective behavior, analyzing the information flow between individuals of the group using techniques from causality analysis and information theory, and designing plausible probes to be implemented by experimental collaborators to perturb and control the collective behavior. It may also include investigating toy models to study the impact of perturbation on collective decision making.

Experience of coding, solid background in statistical physics, and motivation to work closely with data are expected.

Reference:
[1] Chen, Winiarski, Puścian, Knapska, Mora, Walczak, Modelling collective behavior in groups of mice housed under semi-naturalistic conditions. eLife, 2025.
[2] Puścian et al., Eco-HAB as a fully automated and ecologically relevant assessement of social impairments in mouse models of autism. eLife 2016.
[3] Kawano, O'Shaughnessy, Neiman, Deligkaris, Carretero Rodriguez, Masai, Stephens. Decomposing predictive information in social dynamics. bioRxiv 2025.
[4] Jayles, Escobedo, Pasqua, Zanon, Blanchet, Roy, Tredan, Theraulaz, Sire. Collective information processing in human phase separation. Phil. Trans. R. Soc. B 2020.

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