

## **INTERNSHIP PROPOSAL**

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

### **Statistical inference for collective dynamics 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, including bird flocks, protein-protein binding, and synchronous activities of neurons. While much success has been achieved in learning the steady state distribution, going into the (especially out-of-equilibrium) dynamics is more challenging, for example with problems such as causality, co-existing of many time scales and non-ergodicity, asymmetric interaction, partial and finite information, and dynamically-evolving landscapes. In turn, the environmental drive can also be used as an active perturbation to elicit more information.

This internship project will address this problem by starting in one example of inferring interactions for non-equilibrium dynamics, to be discussed according to the expertise and the interest of the applicant. Specifically, the internship will include inferring interaction models from real biological data from neuroscience and/or collective animal behavior, and investigating toy models of interacting spins.

Solid background in statistical physics, experience in coding, and strong motivation to work closely with data are expected.

Reference:

[1] Chen, Winiarski, Puścian, Knapska, Mora, Walczak, Generalized Glauber dynamics for inference in biology. PRX, 2023.

[2] Norton, Zhang, Girvan, Learning beyond experience: Generalizing to unseen state space with reservoir computing. arXiv, 2025.

Condensed Matter Physics: MAYBE  
Quantum Physics: NO

Soft Matter and Biological Physics: YES  
Theoretical Physics: YES