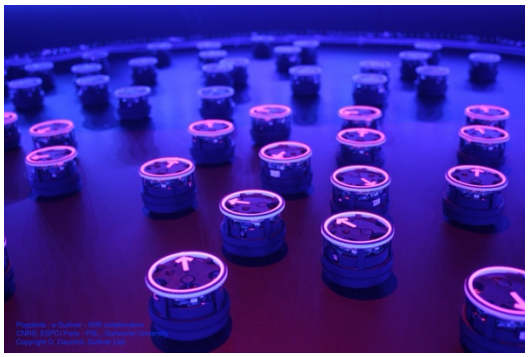
PhD Proposal, GULLIVER LAB, ESPCI Paris – PSL

***Field (cf. List of fields below):** *Physics*

Subfield: Applied Physics and Mechanical Engineering

Title: Morpho-Functional Swarm Robotics



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(Lab/Advisor website): www.gulliver.espci.fr

Short description of possible research topics for a PhD

We are interested in swarm robotics, where many robots with limited computation and communication power are considered. Our goal is to propose new design methods, with a particular focus on considering the role of physical interactions among individuals. Embodiment is critical and useful for programming self-organizing collective systems. We thus propose to achieve collective decision making using both morphological and logical computation in swarm robotics.

The PhD research will be the follow up of a 6-year research program, during which we achieved the design of a new kind of swarm robotics set-up, where the dynamics in both the real and logical space can be recorded, proposed a numerical model for smart active matter and developed a theoretical framework in the form of a first kinetic theory for smart active matter. The goal of the PhD research plan will be to design tasks of increasing complexity and enrich the theory accordingly. There are many possible avenues that can be explored, considering the on-going research effort. The PhD will take place in a dynamical environment with other PhD and Postdoc contributing to this effort.

Required background of the student: Physics

Representative publications of the group: (Related to the research topic)

1. Ben Zion, M. Y., Fersula, J., Bredeche, N., & Dauchot, O. (2023). Morphological computation and decentralized learning in a swarm of sterically interacting robots. *Science Robotics*, *8*(75), eabo6140.
2. Fersula, Jeremy, Nicolas Bredeche, and Olivier Dauchot. "Leveraging design for collective phototaxis in morphological swarm robotics." Nature Communications (2026).
3. Jung, G., Asnacios, J., Ozawa, M., Dauchot, O., & Bertin, E. (2026). Theory of collective learning in populations of adaptive agents. arXiv preprint arXiv:2607.02171.
4. Dauchot, O. (2026). From control to collective intelligence. Europhysics News, 57(3), 12-12.
5. Dauchot, Olivier. "From active to odd to smart matter." Physical Review E 114.1 (2026): 011001.