INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Institut des Systèmes Intelligents de la Robotique
CNRS identification code: UMR 7222
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Web page: http://romainbrette.fr/neuroscience-of-a-swimming-neuron/
Internship location: ISIR, 4, place Jussieu, 75005 Paris

Thesis possibility after internship: YES
Funding: NO If YES, which type of funding:

Modeling the thermal behavior of Paramecium, the "swimming neuron"

Paramecium is a unicellular organism that swims in fresh water by beating thousands of cilia. When it is stimulated (mechanically, chemically, optically, thermally…), it often swims backward then turns and swims forward again. This "avoiding reaction" is triggered by a calcium-based action potential. For this reason, some authors have called Paramecium a "swimming neuron" (Brette, 2021). This is a collaborative effort between the teams of Romain Brette (experimental and theoretical neuroscience, Vision Institute), Alexis Prevost et Léa-Laetitia Pontani (physics, Laboratoire Jean Perrin) and Eric Meyer (genetics, École Normale Supérieure), in Paris. The group has already developed experimental techniques (behavior and electrophysiology), as well as a basic biophysical model of the action potential and electromotor coupling (Elices et al., 2022).

This project aims at developing a model of thermal behavior in *Paramecium*. When placed in a thermal gradient, *Paramecium* tends to gather around a preferred temperature, thanks to temperature-triggered avoiding reactions. This behavior is mediated by membrane potential changes produced by cold- and heat-sensitive thermoreceptors. In addition, the preferred temperature shifts when Paramecium is left at the same temperature. A basic experimental device has been built in Laboratoire Jean Perrin to observe paramecia in controlled thermal gradients. The first part of the project is to refine this device and to film trajectories with normal paramecia, and with mutants that do not produce action potentials. The second part is to use the trajectories extracted with tracking software and build a model of thermosensitivity. Depending on time and interest, the student will have the opportunity to either investigate the electrophysiological basis of the inferred input-output mapping (by measuring electrical responses to thermal changes), or its molecular basis (by inactivating receptors either pharmacologically or genetically with RNA interference).

- Brette R (2021) Integrative Neuroscience of Paramecium, a "Swimming Neuron." eNeuro
- Elices I, Kulkarni A, Escoubet N, Pontani L-L, Prevost AM, Brette R (2022) An electrophysiological and kinematic model of Paramecium, the "swimming neuron." PLoS Comp Biol
- Escoubet N, Brette R, Pontani LL, Prevost AM (2023). Interaction of the mechanosensitive microswimmer Paramecium with obstacles. R Soc Open Sci

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/NO
Quantum Physics: YES/NO Theoretical Physics: YES/NO