Modeling *Paramecium* mechanosensitivity

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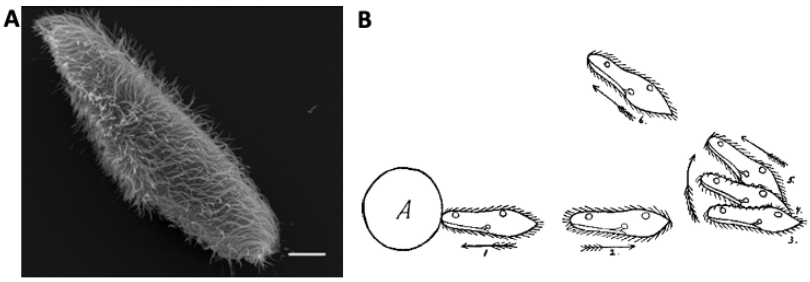
Paramecium is a unicellular organism that swims in fresh water by beating thousands of cilia. When it is stimulated (mechanically, chemically, optically, thermally…), it often swims backward then turns and swims forward again. This "avoiding reaction" is triggered by a calcium-based action potential. For this reason, some authors have called *Paramecium* a "swimming neuron" (Brette, 2021). This project belongs to a broader project aiming at developing integrative models of *Paramecium*, bridging physiology and behavior. This is a collaborative effort between the labs of Romain Brette (neuroscience, Vision Institute), Alexis Prevost et Laetitia Pontani (physics, Laboratoire Jean Perrin) and Eric Meyer (genetics, Ecole Normale Supérieure), in Paris. The team has already developed experimental techniques (behavior and electrophysiology), including a device to immobilize *Paramecium* for electrophysiology experiments (Kulkarni et al., 2020), and a basic biophysical model of the action potential and electromotor coupling.



A, Scanning electron microscopy image of Paramecium tetraurelia (scale bar: 10 µm) (Valentine et al., 2012). B, Avoiding reaction against an obstacle, as illustrated by Jennings (Jennings, 1906).

This project aims at developing an integrated model of mechanosensitivity in *Paramecium*. A first model of mechanotransduction will be established based on the existing literature (Machemer, 1985). This will be completed by electrophysiological experiments. If time allows, the student will also study habituation properties, a phenomenon that has been demonstrated in other ciliates (Wood, 1973, 1969).

In a second phase, the transduction model will be integrated with a model of the action potential and electromotor coupling, to predict the movement of *Paramecium* in the presence of obstacles. This will be compared with behavioral experiments obtained in the Laboratoire Jean Perrin. Ideally (depending on the student's profile and available time), the model will be completed with hydrodynamic modeling.

The project can be adapted to the duration of the project and the profile of the student. In particular, this could be a theoretical project, or a more experimental project.

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