# M2 internship + PhD offer

## Models of branching morphogenesis in sensory neurons

Rupprecht & Lecuit teams, Marseille, Luminy campus

As early as 1630, Descartes had the intuition that some sort of threads were connecting the skin with the brain. In 2021, the Nobel Prize was awarded for the discovery of Piezo1, the protein that allows sensory neurons to convert a local mechanical thermal stimulus into an electric impulse. Yet a fundamental question remains:

**How do sensory neurons form?**

To address such a question, the Lecuit team considers the Drosophila system, which is particularly convenient for imaging and genetic control. The focus of the project is on the class I and IV sensory neurons, which display complex dendritic arborizations while being confined in the two-dimensional space between the epithelium and the muscle; see below:

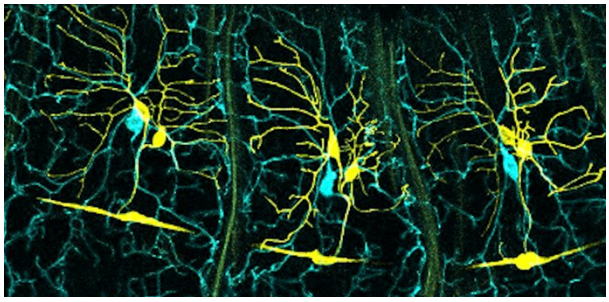

*Fig. 1. Sensory neurons (credit: Claire Bertet).*

**Experimental data:** Thomas Lecuit's group is now able to image the development of these neurons at an unprecedented time and space resolution [1].

Such resolution revealed that branches could grow and retract; furthermore, contact of neurons with neighboring branches was shown to initiate phases of retraction.

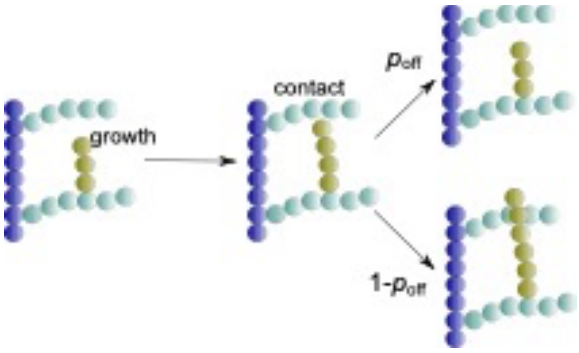


*Fig. 2. The contact-induced retraction model*

**Need for a new model** The Branching Annihilating Random Walk (BARW) model developed [2] does not incorporate retraction phases, neither spontaneous nor contact-induced. In addition, the model was validated upon comparison to fixed image experimental data; the dynamics were inferred by comparing images from different embryos. We propose to consider a branching process whose properties are affected by the process's local density (à la McKean-Vlasov). Retraction phases may not be specific to the neuronal system and likely occur during the development of other branching systems.

PhD objectives:
Analyzing branch structure data
and developing new stochastic branching models

**The teams:** Supervision shared between **Jean-François Rupprecht**, Centre de Physique Théorique, an expert in statistical physics and image analysis ;
**Thomas Lecuit**, Collège de France and Institut de Biology du Développement de Marseille Luminy is a leader in the understanding of mechanical forces during embryonic development.

**PhD student's expected profile:** We are looking for a student who enjoys coding, simulations, dealing with experimental images, and performing analytical work. We target motivated and talented Physics, Computer Science, or Applied Maths students.

**Location:** We are based in arguably the most beautiful academic site in the world – the Luminy campus, next to the Calanques National Reserve.

**Informal inquiries are welcome! Email us:**
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**Related publications**


1. A. Palavalli, N. Tizon, J.-F. Rupprecht, T. Lecuit, *Current Biology(2020).*
2. *E. Hannezo et al., Cell (2017)*
3. S. Shree et al. Science Advances (2023).