INTERNSHIP PROPOSAL

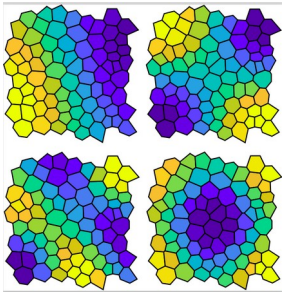
Laboratory name: LPTMS CNRS identification code: UMR8626
Internship supervisor: FRULEUX, Antoine
e-mail: antoine.fruleux@universite-paris-saclay.fr Phone number: +33 1 69 15 76 41
Web page: http://www.normalesup.org/~fruleux/
Internship location: Université Paris-Saclay, Orsay

Using statistical models to unravel how cell-cell interactions control morphogenesis

Over the past decades, a growing attention has been made to the role played by mechanical and chemical signals in coordinating cells during organs formation. We are developing statistical models and data analysis techniques to unravel these interactions from the study of fluctuations and to understand how they contribute to the self-organization of biological tissues.

For a complex and robust organism to grow from a very simple egg, information must be transferred from cells to cells. The reason is that the genetic program ruling morphogenesis applies at the cell scale, while the resulting ordering and shapes arise at the tissue and organ scales. If the ability of cells to cause mechanical and chemical cues or to respond to them is thought to control the way they organize, this relation and the exact nature of the cells responses remain largely unknown.

Building novel data analysis techniques to dissect the spatial and temporal variations of the cells properties in living tissues and developing statistical models for growing media, we are characterizing the relation between fluctuations, cell-cell interactions, and the organization of tissues. We aim at understanding the very dynamical evolution of tissues and to account for the considerable stochasticity showed by growing tissues. We expect our work to shed light on the inter-cellular interaction leading to complex organization of tissues and to unravel these interactions from the study of fluctuations.



CFT harmonics used to dissect space variations in tissues

The main goal of this internship will be to start building stochastic hydrodynamics models of growing tissues, which will involve formulating partial differential equations and solving them numerically. We will consider chemicals transport in the tissue and describe the cells response to them and to the mechanical stress in a generic way, with a view to understand how they are involved in the emergence of patterns. We will characterize these patterns and how fluctuations relate to the different sources of noise and to the cells responses to mechanical and chemical signals.

The intern will benefit from the expertise of the host team in morphogenesis, statistical and biological physics.

Fruleux, Antoine, and Arezki Boudaoud. "Cellular Fourier analysis for geometrically disordered materials." *Physical Review Research* 3.2 (2021): 023036.
Fruleux, Antoine, and Arezki Boudaoud. "Modulation of tissue growth heterogeneity by responses to mechanical stress." *Proceedings of the National Academy of Sciences* 116.6 (2019): 1940-1945.