

M2 internship and PhD thesis

Contour fluctuations in soft cellular systems

Laboratory :

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Thesis possibility after internship: YES

Funding: YES If YES, which type of funding: own fundings (internship) and Contrat Doctoral (PhD)

Summary

Foams, emulsions, and biological tissues are examples of *soft cellular systems*: they are made of units (bubbles, drops, cells) with high deformability but low compressibility, interacting through attractive adhesive interactions and soft steric repulsions. When highly compacted, they tile perfectly the available space (3D) or plane (2D), *i.e.* without gaps or overlaps [1].

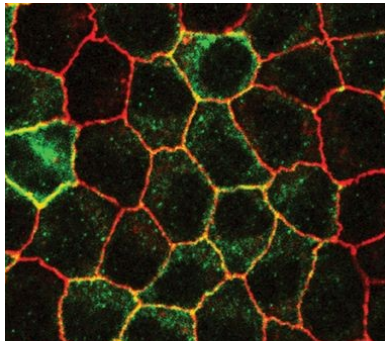
In the case of biological tissues, the structure is essential for their function. Unlike foams and emulsions, biological tissues are **active cellular systems**: they consume (chemical) energy to produce motion and fluctuations of the interfaces.

Because of the low compressibility of the cellular domains, interface fluctuations are coupled in a non-trivial way. The aim of the present study is to analytically and numerically investigate the contour fluctuations (lengths and heights) of two-dimensional active cellular systems. We will first characterize the fluctuations driven by thermal agitation (thermal equilibrium), then investigate the fluctuations caused by active processes such that those taking place in an epithelium.

Of special interest, we want to investigate whether the spectrum of fluctuations captures useful information on the structural characteristics of the pattern (such as dispersity in size and side number of the cellular domains) and/or its mechanical properties.

Required skills: the candidate should have a strong inclination for theory (especially statistical physics) and numerical simulations.

[1] M. Durand and J. Heu, arXiv preprint [arXiv:1910.02742](https://arxiv.org/abs/1910.02742), *Physical Review Letters* **123**, 188001 (2019).



Contour fluctuations in a biological cellular system (epithelium).