Colloquium

MAX PLANCK INSTITUTE
FOR DYNAMICS AND
SELF-ORGANIZATION

Tissue models with active feedback

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Epithelial tissues are one of the engines of development in multicellular organism, where they determine the emerging shapes, like during gastrulation where the embryo turns inside out. This feat is performed by cells that coordinate their collective mechanics over large spatial distances, and we aim to understand how such coordinated activity or mechanical signalling work.

Here I will present models of epithelial tissues with such active feedback. I will begin by introducing vertex models, where cells are represented by a polygonal tiling that mimics the cobble-stone pavement aspect of the tissue. Feedback can occur first through the crawling activity of cells on a substrate. Force feedback then leads to flocking, oscillatory states, and correlated motion at the tissue boundary. Second, activity can take the form of tension transmitted through cell-cell junctions. In the early stages of gastrulation in the chick embryo, deformation is driven by convergent-extension flows from active T1 transitions. These are discrete cell rearrangements against an applied stress, making the tissue perform as a distributed active engine. Our model, based on the catch-bond dynamics of actomyosin and coupled to a vertex model provides a mechanism for active T1 transitions, which act like elements of an active metamaterial. In a full, disordered tissue, we additionally find pronounced tension chain structures, with emergent convergent-extension in agreement with experiment.

I will complement this with the results of a continuum model of the same feedback mechanism. We combine a viscoelastic tissue coupled to a substrate with a tensorial actomyosin field. We robustly find convergence-extension rheology in this model, through a symmetry breaking mechanism where the stress applied at the boundary acts as a mechanical signal.

Wednesday, Nov 22nd, 2023 at 2:15 pm

MPI-DS, Prandtl Lecture Hall
Am Fassberg 11, Göttingen, and
Zoom Meeting ID: 959 2774 3389
Passcode: 651129, direct link

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