LadHyX Seminar – February 3, 11:00,

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Emulsions for in vitro and in vivo investigations of tissue mechanics

We use biomimetic oil droplets to understand the physical basis of collective remodeling in biological tissues. In particular, we focus on the interplay between adhesion and mechanical forces to control the emergence of tissue architecture during morphogenesis. In particular, we use biomimetic emulsions that were shown to reproduce the minimal mechanical and adhesive properties of cells in biological tissues. We study the elasto-plastic response of these adhesive emulsions under an applied mechanical perturbation. To do so we flow them in 2D microfluidic constrictions and track droplets deformations, as well as plastic rearrangements, through image analysis. Surprisingly, the presence of adhesion does not affect the global topology of avalanches in the emulsion, but only slows down the individual rearrangements. As a result, adhesive droplets exhibit larger deformations and are globally aligned with the direction of tissue elongation. This process could indicate that adhesion alone can induce cell polarization in elongating tissues, which would in turn trigger a mechanosensitive feedback in the tissue.

Conversely, in static packings we uncover a threshold percentage of adhesive droplets above which adhesion percolation sets the deformation of all droplets in the packing, independently of their local adhesive properties. Again, this could shed light on processes in vivo as this indicates that tuning the adhesion properties in a limited number of cells would be sufficient to modify globally the properties of the tissue.

In parallel to these in vitro approaches, we use oil droplets as force sensors in vivo, in developing zebrafish embryos. In particular, the injection of biocompatible oil droplets in their olfactory placode allowed us to measure the presence of anteroposterior compressive forces that can contribute to axon elongation in olfactory neurons. We are currently developing biocompatible self-functionalizing droplets in order to obtain the full force map in the placode and in surrounding tissues during development.