Mechanochemical Pattern Formation in Biological Tissues

Felix Brinkmann
Heidelberg University

In this talk a finite element method for mechanochemical pattern formation will be presented. A biological application of this prototypic model is embryonic development of fertilized cells.

We model biological tissues using the hyperelastic Saint Venant-Kirchhoff model. The growth processes are modeled by splitting the deformation gradient into an active part and an elastic response. The active part depends on the concentration of signaling molecules, which are modeled by an reaction-diffusion equation.

Evolving patterns are reinforced by a feedback mechanism since the experimental observations show that biological cells react to stress and to the change of their shape. I will present feedback loops using stress as well strain and compression as a mechanical response. The latter two are especially interesting since they are stable under different initial conditions.

Finally, implementation details such as stabilization will be addressed. All problems, in particular in 3D, are solved with a parallel multigrid solver of the software library Gascoigne 3D.