Pattern formation and viscoelastic dynamics of the cell cortex

The actin cortex in conjunction with the cell membrane is a thin film that encloses the viscous interior of most animal cells. The actin cortex is a complex viscoelastic material which exhibits active prestress due to inherent microscopic force-dipoles constituted by molecular myosin motor proteins.
Observations of cells show that the actin cortex film can form self-organized patterns and actively deform itself. The cortex is thus a key regulator for the emergence of cell shape and vital for cell function for instance during cell division.

In the proposed project, we will perform high resolution optical imaging of the cell cortex and complex quantitative image processing with the goal of exploring the mechanisms of pattern formation and flow generation in the active viscoelastic cortex. Experimental variation of cortical contractility and viscosity will provide a means to systematically assess their influence during mechanochemical pattern formation. In a tight combination of experimental work, numerical simulations (performed by our collaborator Prof. Sebastian Aland, TU Freiberg) and analytic approaches, we will subsequently explore cortical self-organization, and thus reach a better understanding how cells exert forces on their environment and regulate their shape.

Methods entail cell culture, atomic force microscopy, complex image analysis and mathematical analysis.

This project is part of the DFG research group FOR3013.

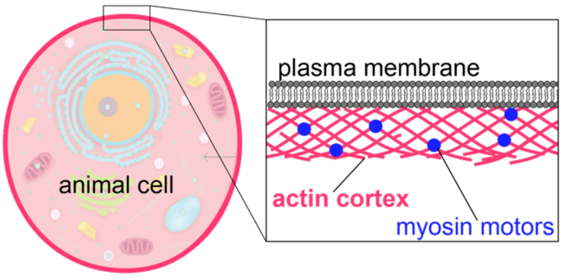

Figure 1: The actin cortex is a thin polymer film next to the outer cell membrane in most animal cells

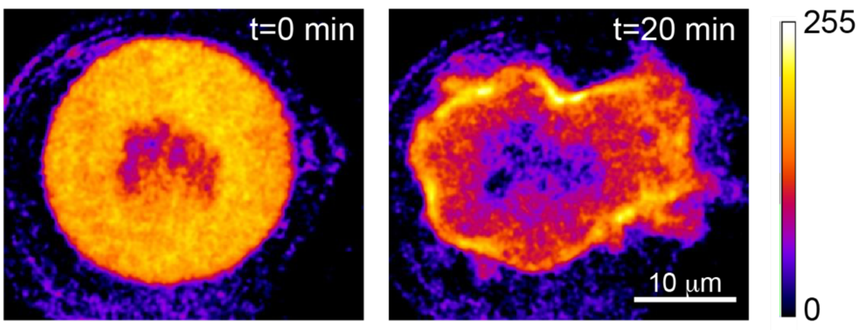

Figure 2: Mitotic human cell (orange) confined between two plates. Motor protein myosin II is fluorescently labelled. Left panel: onset of mitosis where myosin II is still mainly in the cytoplasm and cortical contractility is low. Right panel: Increased myosin II at the cortex has raised cortical contractility and induced cellular deformation.