Active gels *in vivo*: Patterns and dynamics in cytokinetic rings and their functions in cell division

Summary

Cell division is one of the most basic events for cells. Single cell organisms proliferate by dividing, and multicellular organisms grow and renew tissue by this mechanism. After the chromosomes are separated, a ring of actin, myosin and other proteins forms. Its closure leads to cell separation. This mechanism is conserved in fungi, amoebae and animal cells.

Dynamics of actin and myosin, or more generally filaments and motors are relevant for cell division, but also for cells in general, be it for their internal organization, be it for the sensing of the environment or auto-organization in tissues and embryogenesis. Networks of dynamic filaments and active motors are also termed *active gels*, since they are out-of-equilibrium systems. Therefore they constitute not only important structures in cell, but also a new kind of materials. Numerous theoretical and experimental studies have been carried out on this topic.

It is more challenging to study these gels *in vivo*, since many proteins and signaling are involved in their organization. Due to its circular geometry, the cytokinetic ring is a relatively simple active gel *in vivo*. Its components are well studied. However, it is still not clear how the ring constricts and how stress is generated in this system. By elucidating this question, we hope that we can also contribute to a better understanding of other active gel structures in cells.

Based on an existing setup for fission yeast, invented by Daniel Riveline, we developed a setup and protocol to study cytokinesis in mammalian cells. More specifically, we investigate the cytokinetic ring by using an array of microcavities, which allowed us to orient cells and to see the ring in a single plane of focus. We visualize the ring with fluorescently labeled actin filaments,

In both systems we discovered mesoscopic structures in the active gel. We characterized their patterns and dynamics and probed their changes under different conditions. Our observations and measurements led us to two models, explaining the stress generation and ring closure in the respective systems. However, it is surprising that two actomyosin rings exhibit different dynamics. Future experiments will aim at understanding, which system parameters lead to either still or rotating clusters. We suggest that the transition between states of different orders and dynamics might be one way to regulate actomyosin systems *in vivo*, in addition to traditional signaling.