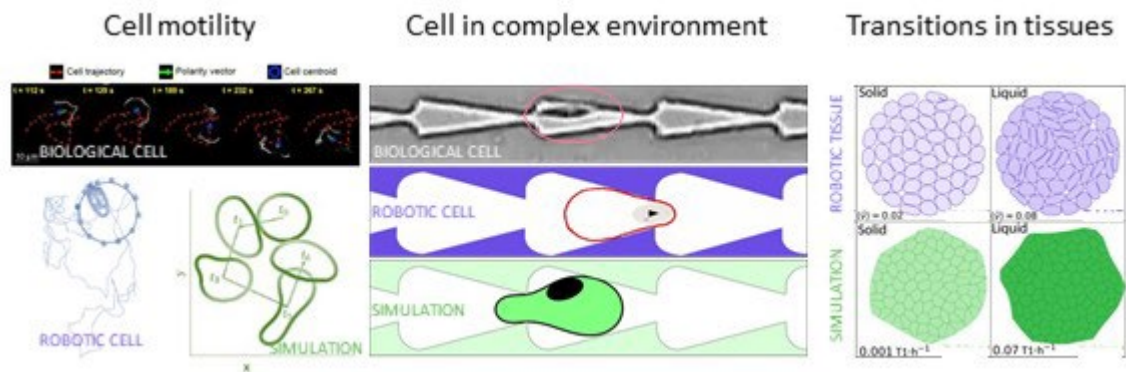


PHYSIKALISCHES KOLLOQUIUM

AM 10. NOVEMBER 2025 UM 16 UHR C.T.
IM GROßEN HÖRSAAL



THE ROLE OF MECHANICAL NON-EQUILIBRIUM ACROSS SCALES – FROM MOLECULES TO LIVING AND ROBOTIC ACTIVE MATTER ANA SUNCANA SMITH UNIVERSITÄT ERLANGEN

Biological cells and tissues endure and adapt in unpredictable environments by actively sensing, remodeling, and preserving their integrity. These behaviors arise without thought yet exhibit coordination and purpose comparable to intelligence. No synthetic material has yet achieved such self-organized resilience. By uncovering the fundamental rules governing cellular and tissue adaptation in defined mechanical environments, we create mimetic systems—first in silico and then reconstituted in soft robotic form.

I will present an analysis of locomotion phenotypes in a simple cell, showing how complex motility patterns emerge from a phase-field model coupling internal flows, dynamic shape changes, and motility to a reaction–diffusion–advection system driving actin polymerization. Some of these behaviors are reproduced in programmable robotic synthetic cells. When placed in a ratchet-like environment, such a cell exhibits directed motion even without an external field, as predicted by simulations, and observed in living systems. Moreover, I will show that ensembles of mimetic cells display a rigidification transition linked to shape variability, with theoretical analysis revealing that rigidification coincides with classical jamming transitions known from granular matter.

Together, these findings establish a bridge between biological adaptability and synthetic embodiment, outlining a path toward systems that do not merely imitate life—but begin to share its capacity for autonomous transformation.