

Enlightening cell mechanics in biological systems using optical tools

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Biophysical methods have revolutionized our understanding of many biological systems, spanning from embryonal development to cancer. The precise experimental and theoretical description of mechanical forces relevant for cell and tissue dynamics was a main driver of these advances. Many cellular functions, like cell division, cell migration and differentiation are closely related to a dynamic restructuring of the intracellular protein networks, leading to changes in the viscoelastic properties and force generation inside cells and tissue. We will discuss how optical methods provide an outstanding toolbox to study and manipulate the forces and mechanical properties of biological systems. Optical tweezers are systematically used to determine the viscoelastic properties of cells, bio-membranes and tissue, while interferometric approaches allow a nanometer and microsecond precise measurement of membrane and particle fluctuations of microscopic living objects. Optogenetic tools allow to directly trigger biochemical signaling cascades by simple illumination and classical bleaching experiments help deciphering reaction rates and dynamics in cells and tissue. But these optical tools do not only allow to study biological systems, they also help in understanding general non-equilibrium physics.

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