CPP 7 SYMPOSIUM: Polymer networks and beyond: From molecular structure to materials and biological functions II

Zeit: Samstag 10:45–12:45 Raum: TU C243

Hauptvortrag CPP 7.1 Sa 10:45 TU C243

Composite Actin Networks — •David Weitz — Dept. of Physics and DEAS, Harvard University, Cambridge, MA 02138, USA

Actin is a semiflexible polymer that is ubiquitous is cells, with actin networks providing much of their mechanical rigidity. A critical component in the formation of these networks is the actin binding proteins that serve to cross-link and bundle the actin filaments. This talk will discuss the mechanical properties of actin filaments comprised of commonly found actin binding proteins, and will explore the dramatic effects these proteins can have on the rheology of the networks. The behavior of reconstituted networks will also be compared to that of living cells.

Hauptvortrag CPP 7.2 Sa 11:15 TU C243

Biomimetic Protein Filament Networks — •Joachim Spatz, Jennifer Curtis, Wouter Roos, Jens Ulmer, Christian Schmitz, and Simon Schulz — Max-Planck-Institut für Metallforschung, Stuttgart + Universität Heidelberg, Biophysikalische Chemie, INF 253, 69 120 Heidelberg

Polymer networks consisting of protein filaments and filament associated active, or passive proteins are major functional constituents in tissues or in cells. The aim of our studies is to understand the dynamic regulation of protein filament architectures in tissues and cells, and its resultant influence on cellular activities. Examples of such protein filaments are Collagene, Fibronectin, F-Actin, or Microtubules and their respective associated proteins. Functions inherent to such protein networks are guided by the hierarchical assembly of protein and protein filaments as well as by the adaptive structural properties. Partially due to the complexity of these networks the underlying biophysics of the adaptive regulation processes of these networks is not well understood. We construct adjustable biomimetic models of F-Actin and Fibronectin networks, and subsequently perturb these systems and measure their properties using micro-mechanical devices and nanostructured interfaces. In these models, the complexity found in cells can be minimized and then controllably incremented step by step, which offers to study the physics of adaptive functions.

CPP 7.3 Sa 11:45 TU C243

Hydrodynamic theory of active polar gels — •Karsten Kruse[1], Jean-François Joanny[2], Frank Jülicher[1], Jacques Prost[2,3], and Ken Sekimoto[2,4] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden — [2]Physicochimie Curie (CNRS-UMR168), Institut Curie, Section de Recherche, 26 rue d'Ulm, 75248 Paris Cedex 05, France — [3]E.S.P.C.I, 10 rue Vauquelin, 75231 Paris Cedex 05, France — [4]LDFC Institut de physique, 3 rue de l'Université, 67084Strasbourg Cedex, France

A general theory for active viscoelastic materials made of polar filaments is presented. This theory is motivated by the dynamics of the cytoskeleton, a network of filamentous proteins that plays a key role, e.g. in cell division and cell locomotion. In this system, the continuous consumption of ATP generates a non equilibrium state characterized by the generation of flows and stresses. An application of the theory to topological point defects that appear during division and in moving keratocytes will be discussed.

CPP 7.4 Sa 12:00 TU C243

MICRORHEOLOGY OF GEOMETRICALLY CONFINED ACTIN NETWORKS — •Mireille Claessens, Rainer Tharmann, Bernd Wagner, and Andreas Bausch — TUM Physik Department E22, James Franck Straße, D-85747 Garching

The semiflexible polymer actin is one of the mayor components of the cytoskeleton and plays an important role in the mechanical properties of cells. There are several studies concentrating on the rheology of actin and other cytoskeletal polymer networks. Here we address the important aspect of the geometrical confinement imposed by the plasma membrane on the network dynamics.

We confined the actin network into the water droplets of a water-in-dodecane emulsion. To mimic the presence of the plasma membrane the droplets were stabilized with a monolayer of negatively charged phospholipids. The mean length of the actin filaments was controlled by polymerizing in the presence of gelsolin. The effect of the spherical confinement on the viscoelastic properties of entangled actin networks was studied using microrheometry. In large emulsion droplets the plateau modulus G_0 of the confined actin network was comparable to the modulus found in bulk measurements. For networks of filaments shorter than the persistence length, G_0 was found to be independent of the droplet diameter, D. However when the filaments were longer than the persistence length G_0 was observed to increase with decreasing droplet diameter. The increase scaled as D^{-3} which suggest that the presence of the droplet wall hinders rapid relaxation of tension to the ends of the chain.

CPP 7.5 Sa 12:15 TU C243

Cellular structure formation in elastic environments — Ilka B. Bischofs and •Ulrich S. Schwarz — Max Planck Institute of Colloids and Interfaces, Theory Division, 14424 Potsdam

The behaviour of adhering cells is strongly influenced by the chemical, topographical and mechanical properties of the surfaces they attach to. Recent experiments suggest that due to active mechanosensing through cell-matrix contacts, cells position and orient in favor of maximal effective stiffness in their environment. This behaviour leads to long-ranged elastic interactions of cells, which can be derived from an extremum principle in linear elasticity theory. Our theory predicts cellular structure formation in elastic environments as a function of cell density and elastic moduli. For intermediate cell densities, we predict that cells align in strings. The effective string-string interaction can be shown to be short-ranged because the cellular traction patterns inside the strings screen each other. For high cell densities, we predict isotropic ring-like structures for incompressible media and nematic string-like structures for compressible media.

CPP 7.6 Sa 12:30 TU C243

Optical Deformability as Cell Marker: Exploiting the Link between Cytoskeletal Structure and Biological Function — •Jochen Guck, Susanne Ebert, Bryan Lincoln, Maren Romeyke, Frank Sauer, Stefan Schinkinger, Kort Travis, and Falk Wottawah — Universität Leipzig, Abteilung Physik Weicher Materie, Linnéstrasse 5, 04103 Leipzig

The cytoskeleton, an internal polymer network, determines the mechanical strength and morphology of cells. This cytoskeleton evolves during the normal differentiation of cells, is involved in many cellular functions, and is characteristically altered in many diseases, including cancer. We can exploit the deformability of the cytoskeleton as a link between molecular structure and biological function to distinguish between different cells using a microfluidic optical stretcher. We find that optical deformability is sensitive enough to monitor the subtle changes during the progression of cells from normal to cancerous and even metastatic state. We can also distinguish stem cells from more differentiated cells. The surprisingly low numbers of cells required for this distinction reflects the tight regulation of the cytoskeleton by the cell. This suggests using optical deformability as an inherent cell marker for diagnosis of disease and sorting of stem cells from heterogeneous populations, obviating the need for external markers or special preparation.