BP 32: Posters: Other Topics in Biological Physics

Time: Thursday 17:15–20:00 Location: P3

BP 32.1 Thu 17:15 P3

The Nanowizard3 The Most Flexible, High Resolution AFM With True Optical Integration — •Gerd Behme — JPK Instruments, Berlin, Deutschland

The NanoWizard3 represents the latest in AFM technology. The new Vortis controller series uses the latest FPGA architecture to guarantee highest digital performance. Fast signal acquisition and control, advanced feedback and analysis are key components of a modular and ultra flexible controller. The high-speed data acquisition makes the controller perfect for time resolved force spectroscopy, higher harmonics imaging or high frequency cantilever use. Cantilever calibration by thermal noise method up to 3.25 MHz is unique. HyperDrive is a soft sample imaging technique in liquid which provides sub-nanometer lateral resolution with minimal tip-sample interactions and works with off-the-shelf cantilevers. This is made possible by the new optics and electronics of the NanoWizard3 AFM head, which gives the lowest noise level in the cantilever deflection detection system available commercially. The NanoWizard3 maximizes stability, performance and ease of handling for samples in fluid and for full integration with optical microscopy. This enables the simultaneous acquisition of high quality AFM images with optical imaging, under physiological conditions. The unique DirectOverlay software for the JPK NanoWizard systems uses the tip location to calibrate accurately the optical images and integrate them into the AFM software for direct AFM navigation. In addition, exact, quantitative correlation of AFM and optical features is possible.

BP 32.2 Thu 17:15 P3

Time resolved optical Measurements of Dye-Functionalized Quantum-Dots with Polymer-Coating: A step towards Multiplex Sensing Systems — •Sebastian Friede, Tobias Niebling, Faheem Amin, Wolfgang J. Parak, and Wolfram Heimbrodt — Fachbereich Physik und WZMW, Philipps Universität Marburg, Renthof 5, 35037 Marburg.

Modern biological sensing systems are using the spectral diversity of fluorescence dyes mostly. An alternative concept for realizing e.g. ion-sensitive sensor systems is the multiplex sensing approach in combination with temporal resolved spectroscopy. Therefore two dyes are bound to a nanoparticle: an ion sensitive dye and a reference-dye. Avoiding spectral overlaps of the reference dyes and the sensing dyes, spectral similar dyes are chosen as reference-dyes for all sensing systems. In order to determine the concentrations of multiple species of ions there is a need to distinguish the luminescence intensities of the used dyes, specially those of the reference dyes. To do so, the fluorescence lifetimes of the reference dyes can be modified by using different kinds of nanoparticles. Bearing in mind the Stokes-shift, semiconductor-quantum dots with the right-tuned emission wavelenght can act as energy-donors for fluorophores and so enhance the fluorophore fluorescence-lifetimes. In contrast, the fluorescence lifetime of dye functionalized gold-cored hybrid systems is affected differently. We could show that a clear distinction of the reference dyes of the different sensor-particles is possible by measuring the fluorescence lifetimes of the dyes.

BP 32.3 Thu 17:15 P3

The effect of glycerol and DMSO on the phase behavior of lysozyme — •Christoph Gögelein[1], Gerhard Nägele[2], Dana Wagner[3], Frederic Cardinaux[3], and Stefan U. Egelhaaf[3] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, Bunsenstr. 10, 37073 Göttingen — [2]Forschungszentrum Jülich, 52425 Jülich — [3]Heinrich-Heine-Universität Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf

Additives such as salt, glycerol and dimethyl sulfoxide (DMSO) are widely used to modify the stability of protein solutions [1]. In this work, we study the effect of these additives on the second virial coefficient and the phase behavior of lysozyme. We show that glycerol reduces the attractive interaction of lysozyme, whereas the addition of sodium chloride increases the attraction by screening the protein electrostatic charges. Adding DMSO amplifies the strength of the interaction potential so that the influence of the temperature on the second virial coefficient becomes more pronounced. We compare our experimental findings with theoretical predictions based on the Derjaguin-Landau-Verwey-Overbeek (DLVO) effective pair potential for the protein interaction. Moreover, we compute the crystallization and gas-liquid coexistence curves using thermodynamic perturbation theory (TPT). It is shown that the DLVO-type description predicts qualitatively the influence of salt and glycerol. However, the DLVO model fails to describe the effect of DMSO.

[1] H. Sedgwick, J. E. Cameron, W. C. K. Poon, and S. U. Egelhaaf, J. Chem. Phys. 127 (2007), 125102.

BP 32.4 Thu 17:15 P3

Under-filling trapping objectives optimizes the use of available laser power in optical tweezers — •Mohammed Mahamdeh[1], Citlali Pérez Campos[2], and Erik Schäffer[1] — [1]Nanomechanics Group, Biotechnology Center, TU Dresden, Tatzberg 47-51, 01307 Dresden, Germany — [2]Max Planck Institute of Molecular Cell Biology and Genetics, Pfotenhauerstraße 108, 01307 Dresden, Germany

For optical tweezers, especially when used in biological studies, optimizing the trapping efficiency reduces photo damage or enables the generation of larger trapping forces. One important parameter that affects the efficiency is the filling ratio—the laser beam width relative to the numerical aperture (NA) diameter that accords with Abbe's sine condition. Here, we measured the optimal filling ratio for 0.5–2 μm diameter microspheres and compared the results to Mie theory calculations. We show that slightly under-filling a 1.3 NA objective with a filling ratio of 0.95 using 0.85 μm diameter microspheres resulted in the highest overall trapping efficiency. Under these conditions, the maximum trap stiffness is 30 % higher compared to a filling ratio of 1.3. The optimal filling ratio varied with microsphere size in the lateral but not in the axial direction. Our finding suggests that apart from the choice of optimal microsphere size, under-filling the objective is key for optimal performance of an optical trap.

BP 32.5 Thu 17:15 P3

A simple three-point-force model for Chlamydomonas Reinhardti — •Ruud Boesten[1,2], Holger Stark[1], and Ignacio Pagonabarraga[3] — [1]TU Berlin, Germany — [2]TU Eindhoven, Netherlands — [3]University of Barcelona, Spain

There is an abundance of swimming organisms on the micrometer scale. From unicellar algae in the oceans, to pathogenic bacteria in human blood vessels. The motility of these microorganisms affects macroscopic properties. For suspensions of Bactilus Subtili a decrease of the viscosity has been measured with respect to the viscosity of the suspending medium [1]. In contrast, for suspensions of Chlamydomonas Reinhardti (CR) an increase was measured [2]. Very recently, on the millisecond time and micrometer length scale the flow field of several micro-swimmers has been measured [3]. The understanding of these phenomena on all length and time scales could give us information about the behaviour and role of micro swimming in a broad range of environments.

Inertial forces are small compared to viscous forces on the size of a microorganism. We investigated a simple 3-point-force model for CR. The resulting flow field is the superposition of the 3 induced stokeslets. This model can explain both the flow field within a beat cycle on the length scale of several body lengths, as well as the effective viscosity of a suspension of CRs on large time scales.

[1] Sokolov et al., PRL, 103, 148101 (2009)
[2] Rafai et al., PRL 104, 098102 (2010)
[3] Guasto et al., PRL, 105, 168102 (2010)

BP 32.6 Thu 17:15 P3

Sequential gene-regulatory logic: Design schemes and quantitative characteristics — •Patrick Hillenbrand, Georg Fritz, and Ulrich Gerland — Department of Physics and CeNS, LMU München

Epigenetic memory plays a pivotal biological role in bacteria and eukaryotes alike, and permits the transient storage of information. In digital electronics, logic elements that involve the processing of internal memory states are referred to as sequential logic circuits. The basic elements of sequential logic are addressable one-bit memory elements (so-called latches). Here, we study a genetic equivalent of the most versatile such element, the genetic J-K latch. The J-K latch is able to

stably hold its state, and to perform the operations 'set', 'reset', and 'toggle'. Our analysis indicates that designs based on protein-protein interaction and protein-DNA binding, are in principle sufficient to implement the desired functionality. We show that stable oscillations are necessary for the circuit to faithfully switch its state upon the toggle command. These oscillations are generated by a time delay in the system caused by overlapping protein binding sites on the DNA. Finally, we also discuss an extension of the genetic J-K latch to a master-slave latch, which switches its state upon a toggle signal without displaying oscillatory behavior. The master-slave latch exhibits a particularly robust functionality, is a useful element for synthetic biology, and may be employed also in natural regulatory circuits.

BP 32.7 Thu 17:15 P3

Measuring the non-harmonic potential of an optical trap — •Marcus Jahnel[1,2], Martin Behrndt[1,2], Anita Jannasch[3], Erik Schäffer[3], and Stephan W. Grill[1,2] — [1]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [3]Biotechnology Center, TU Dresden, Germany

Using optical traps to measure or apply forces on the molecular level requires a precise knowledge of the trapping potential. Close to the trap center, this potential is usually approximated as harmonic. However, applications demanding high forces at low laser intensities can probe the light-bead interaction beyond the linear regime. Here we measure the full non-linear force and displacement response of an optical trap in two dimensions using a dual-beam optical trap setup. We observe a stiffening of the trap beyond the linear regime that depends on bead size, in agreement with Mie theory calculations. We also find that the linear range for inferring forces from a back-focal-plane voltage detector signal is much larger than for inferring bead displacements from the same signal. Our approach thus allows for a complete two-dimensional characterization of the force response of an optical trap.

BP 32.8 Thu 17:15 P3

Grating-based X-ray phase contrast tomography of human cerebellum — •Georg Schulz[1], Timm Weitkamp[2], Irene Zanette[3], Franz Pfeiffer[4], Christian David[5], Elena Reznikova[6], and Bert Müller[1] — [1]BMC, University of Basel, Switzerland — [2]Synchrotron Soleil, Gif sur Yvette, France — [3]ESRF, Grenoble, France — [4]Department of Physics / Biophysics, TUM, Garching, Germany — [5]LMN, PSI, Villigen, Switzerland — [6]IMT, KIT, Karlsruhe, Germany

Here, we demonstrate that grating-based X-ray tomography provides much better contrast and spatial resolution than MRI microscopy for the human cerebellum. Using a grating interferometer, which consists of a beam-splitter and an analyzer absorption grating, one can detect deflection angles differences of approximately 20 $nrad$. The experiments performed with a photon energy of 23 keV at the beamline ID19 (ESRF Grenoble, France) reached a measurement sensitivity of the real part of the refractive index of $2.3{\cdot}10^{-10}$ corresponding to an electron density sensitivity of 0.15 electrons per nm^3 and a mass density sensitivity of 0.25 $mg\ cm^{-3}$ for such aqueous specimens. The spatial resolution using the FReLoN camera with a pixel size of 5 μm was sufficient to identify individual Purkinje cells within the brain tissue without using any contrast agent. This achievement is regarded as an important milestone in three-dimensional imaging of soft tissue post mortem.

BP 32.9 Thu 17:15 P3

A Riemannian geometric approach to human arm dynamics, movement optimization and invariance — •Armin Biess[1], Tamar Flash[2], and Dario G. Liebermann[3] — [1]Max-Planck-Institute for Dynamics and Self-Organization, 37073 Göttingen, Germany — [2]Department of Applied Mathematics and Computer Science, The Weizmann Institute of Science, Rehovot 76100, Israel — [3]Physical Therapy Department, Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv 69978, Israel

In modeling human arm movements optimization principles have been used to describe mathematically the kinematics and dynamics of point-to-point arm movements. Most models have assumed an underlying Euclidean structure of space in the formulation of the cost functions that determine the model predictions. We present a generally covariant formulation of human arm dynamics and optimization principles in Riemannian configuration space. We extend the one-parameter familiy of mean squared-derivative (MSD) cost-functionals, previously considered in human motor control, from Euclidean to Riemannian space. Solutions of the one-parameter family of MSD variational problems in Riemannian space are given by (re-parametrized) geodesic paths, which correspond to arm movements with least muscular effort. Finally, movement invariants are derived from symmetries of the Riemannian manifold. We argue that the geometrical structure of the arm's configuration space may provide insights into the emerging properties of the movements generated by the human motor system.