SoftComp
SOFT MATTER COMPOSITES
Network of Excellence

www.eu-softcomp.net

newsletter
No. 7 · Feb. 2009

Editorial

The SoftComp project is reaching the end of the EU grant but is as vital as ever. The forthcoming SoftComp Annual Meeting will be held in Venice, Italy, May 3-7 2009, and a new strategy has been outlined to emphasise the scientific aspects of the meeting.

As usual, the programme of the SoftComp Annual Meeting includes plenary lectures, Network Area and Research Platform meetings. In additions, special sessions have been planned: ***1) Network Area Round Tables*** *with the goal of intesifying the discussion on industrially relevant topics. These meetings are organised in cooperation between scientists from industry and academia addressing scientific topics of mutual interest such as: the wetting of complex fluids onto modelled surfaces - from rocks to skin -, surfactant adsorption onto porous systems or nanofoams.* ***2) Planning of Future Collaborations and Work*** *to bring together senior and young scientists for brainstorming on the future development of the scientific activities; we expect these two session types will incourage a large network participation with lively and useful discussions. Moreover, with an eye to the medium-term future, the SoftComp research road map will be updated to include new research interests evolved during the last 24 months. On the final day, two management meetings of the Network Governing Board and the Network Coordination Committee will take place.*

Dieter Richter & Flavio Carsughi

In This Issue

Biological Cells as Active, Soft Composite Materials

Nir Gov and Sam Safran
Weizmann Institute of Science, Rehovot, Israel

Research at the interface of physics and biology is an exciting new adventure that can take several different directions. Some physical scientists choose to move completely into biology, applying their experimental tools and theoretical concepts to problems involving large-scale genetic networks of interest to systems biology and bioinformatics. These approaches generally focus on the overall biochemistry of the cell; the role of the macromolecules, membranes, vesicles, and cytoskeleton[1] is only included as the various rate constants that govern the protein network. At the other end of the spectrum, there are physical scientists (physicists, physical chemists, materials scientists, and materials/mechanical engineers) whose focus is on the mechanics, structure, and dynamics of cellular substructures, macromolecular and vesicular transport, as well as on the larger-scale properties of entire cells and tissues. Such materials-science approaches to biological matter are also being applied to design and understand synthetic systems composed of biomolecules or cells. The goal, as summarized by the NSF program on the physics of living systems[2], is to "emphasize the physical principles of organization and function of living systems, including the exploration of artificial life. While the problem under study must be important to advancing our understanding of the living world in a quantitative way, particular emphasis will be placed on those projects in which lessons learned from the biological application also expand the intellectual range of physics."

At the Weizmann Institute of Science in Rehovot, "biological physics" research

Figure 1a

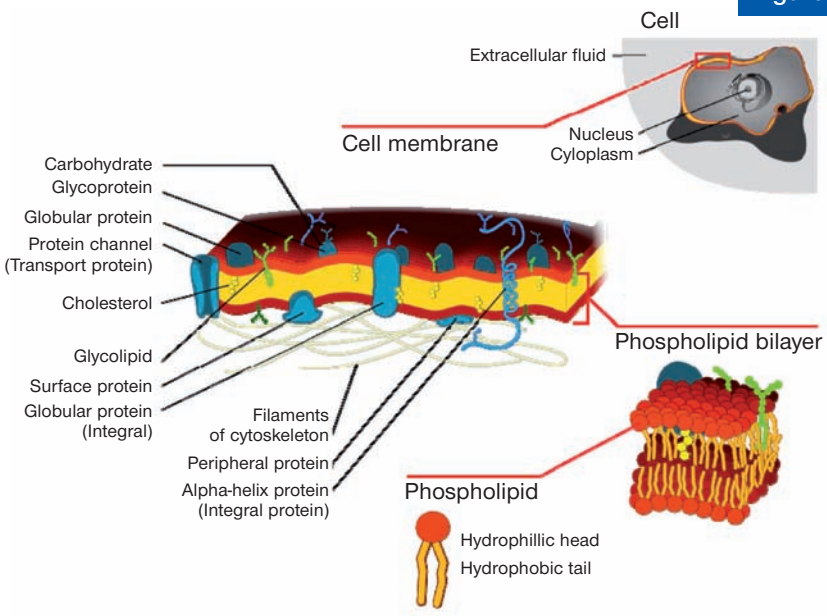


Fig. 1a: Schematic of cell showing the soft composite consisting of the cell membrane and the cytoskeletal filaments. [From: http://upload.wikimedia.org/wikipedia/commons/thumb/1/11/Cell_membrane_detailed_diagram_3.svg/772px Cell_membrane_detailed_diagram_3.svg.png]

Biological Cells as Active, Soft Composite Materials (continued)

Figure 1b

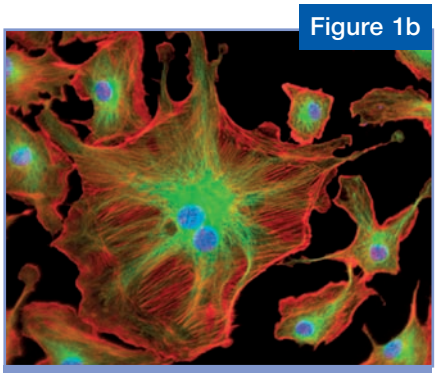


Fig. 1b: The image shows both the actin fibers and microtubules in cow endothelial cells indicating their prevalence and structure. The actin fibers are red, the microtubules are yellow and the nuclei of the cells are stained blue.
[From: www.cancerquest.org/images/mt_actin_nuc.gif]

encompasses studies of both cellular and synthetic properties, focusing on the physical properties of biomaterials. Studies include: synthetic gene chips that utilize DNA brushes, artificial neural circuits in either one or two dimensions, biolubrication, DNA transport through the nucleus, protein folding in the presence of excluded volume constraints, AFM studies of the elasticity and morphology of cells, and polymer network theory applied to evolutionary dynamics. The biological physics "group"[3] includes about 10 PIs, currently located in several different departments but with a common seminar and a fledgling graduate course program.

Our own research as part of this group has emphasized the fact that cells are a complex composite material consisting of fluid membranes that are coupled to the elastic cytoskeleton (Fig. 1a). The composite is "soft" since it can re-form under a variety of conditions as dictated by the cell. Moreover, the elastic modulus of the cell is in the range of 10 kPa; this should be contrasted with the much higher values of crystal moduli of 100 GPa. What is completely unique is that the structure and dynamics of these "live matter" soft composites are often dictated by active processes, in which energy consumption is used to change molecular conformations in order to generate internal forces within the cell. Important examples of this are the protrusive forces applied to membranes by actin bundles as they polymerize and the internal tension of the actin cytoskeleton due to the presence of molecular motors[4]. This activity-driven tension translates itself into lateral forces that cells exert when placed on substrates. These lateral forces allow the cell to mechanically explore its environment and exist in addition to the usual normal forces that result from the adhesion of even "dead matter" to a substrate.

1 *The cytoskeleton refers to various semi-flexible biopolymers that provide the cell with its mechanical integrity. Among these are the proteins that assemble into crosslinked actin gels, actin bundles, microtubule filaments (see Fig. 1b).*
2 *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6673*
3 *http://www.weizmann.ac.il/Biological_Physics/*
4 *The protein myosin functions as a molecular motor that exerts force on bundled actin polymers and puts them under tension. This process arises from a conformational change that results from the consumption of ATP by the myosin and is thus a manifestly non-equilibrium effect.*

Cellular substructures and active instabilities (Gov group)

Cells of a multi-cellular organism come in a variety of shapes, according to their different functions inside the body, from the simplest form of the red-blood cell (RBC) to the most complex cells of the nervous and hearing systems. Cells achieve these shapes by utilizing the forces produced by their internal cytoskeleton. One of the major players in determining the dynamics of cellular shapes is the actin network. We propose a new organizing principle in cells, based on the coupling of the local membrane shape and the forces produced by the actin cytoskeleton.

The actin filaments that polymerize close to the membrane produce a normal (on average) protrusive force, pushing the membrane outwards. This force is therefore proportional to the local density of the actin filaments, which we assume is simply proportional to the local density of membrane proteins that activate the actin. This protrusive force can bend the membrane, while the membrane bending and tension forces act to restore the membrane to a flat configuration. When the membrane proteins have a convex curvature, so that they have a lower energy at the tips of growing protrusions, the system displays a dynamic instability (finite wave-vector instability), due to the positive feedback between the membrane shape, local density of proteins, and local protrusive force (Fig. 2). Our model [1,2] is unique in that it proposes a mechanism based on coupling of the cytoskeleton to the membrane shape through the spontaneous

Figure 2

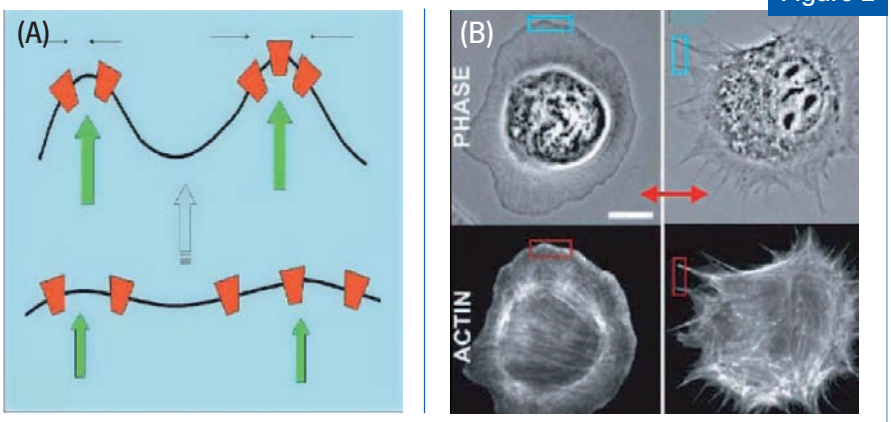


Fig. 2: (A) Schematic description of the dynamic instability when membrane proteins with convex spontaneous curvature (red objects) induce actin polymerization and a protrusive force (green arrows). A small initial perturbation deforms the membrane (solid black line), which causes an increase in the protein density and a further increase of the local force. (B) Example of spontaneous cellular shape transitions [From: Applewhite, D. A., M. Barzik, S. I. Kojima, T. M. Svitkina, F. B. Gertler, and G. G. Borisy, 2007. Ena/VASP proteins have an anti-capping independent function in filopodia formation. Mol. Biol. Cell. 18:25792591].

Figure 3

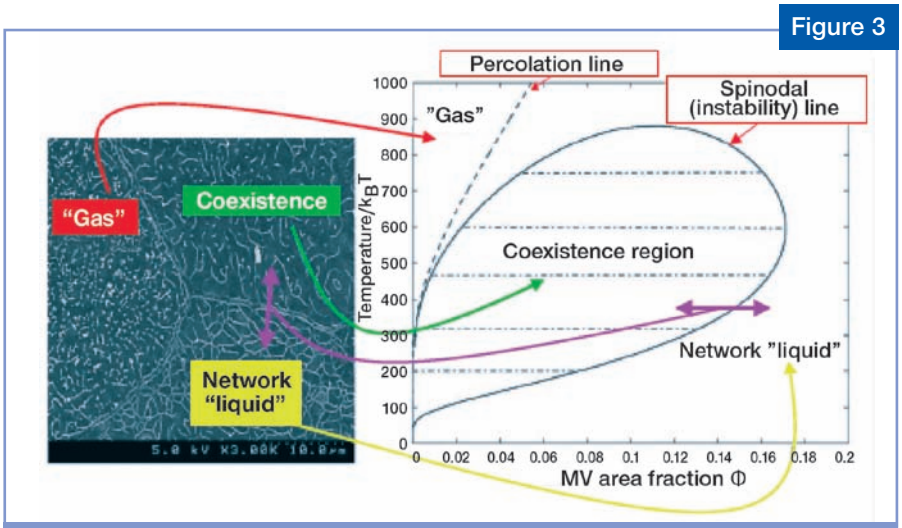


Fig 3: Calculated phase diagram of protrusions and comparison to observed morphologies [From: Gorelik, J., A. I. Shevchuk, G. I. Frolenkov, I. A. Diakonov, M. J. Lab, C. J. Kros, G. P. Richardson, I. Vodyanoy, C. R. W. Edwards, D. Klenerman, and Y. E. Korchev, 2003. Dynamic assembly of surface structures in living cells. PNAS 100:5819-5822].

curvature of membrane proteins, [3] and allows us to make quantitative predictions concerning the density of the protrusions and how it is affected by the various parameters of the cell.

Myosin molecular motors attach to the actin filaments and are able to exert a contractile force on the membrane, basically pulling the membrane back into the cell. We calculated the effect of this contractility on the instability discussed above and found that the system changes to a waveinstability when the contractile force dominates the protrusive force of actin polymerization [4-6]. This wave instability means that the membrane can exhibit robust, traveling waves, with no or very little damping – all this in a system where all motion is usually highly damped by the viscosity of the surrounding fluid. Membrane waves and "ruffles" that propagate over the entire surface of the cell, and along its perimeter, have been observed and studied for some time [7,8], but there are very few theoretical models that describe such phenomena. Our model is the first to clearly demonstrate that the coupling of the forces of the cytoskeleton to the membrane can give rise to robust traveling waves; the quantitative predictions relate the properties of such waves to the forces of the actin and myosin.

When a large collection of membrane protrusions interact they give rise to a large variety of surface morphologies. The collective arrangement of these protrusions depends on the forces acting on the individual protrusions. These forces are internal, due to the actin filaments that form the protrusions and due to interactions among the protrusions. The internal forces produced by the polymerization of actin filaments have a normal component that pushes the membrane and produces the protrusion and is eventually balanced by the restoring force of the membrane when the protrusion has reached its steady-state height. We have considered the statistical mechanics of a collection of protrusions that show a gas-liquid transition within a network-forming model in which the "gas" phase is isolated protrusions and the "liquid" phase consists of a connected network [9].

Such large-scale transitions are indeed observed on cell surfaces (Fig. 3), and we attribute them to changes in the "active thermodynamic" phase of the protrusions. The strength of the interactions strongly depends on the protrusion height; longer protrusions have higher adhesion energies.

Such models as described above may allow us in the future to give a full description of the process of formation of individual cellular features and their eventual arrangement into complex collective patterns.

Active cellular mechanics and dynamics (Safran group)

The understanding of the mechanical activity of cells is important for wound healing, muscle growth, tissue assembly, and development. Biological cells sense their mechanical environment [10] (i.e., its rigidity and the presence of external strains) and respond to these factors in an active manner. Cells respond differently to static or quasi-static strain (on the scale of many minutes) compared with rapidly varying cyclic strain (on the scale of 1 Hz) [11]. When the matrix in which the cells are embedded is subjected to a static or quasi-static strain, cells tend to orient along the direction of applied stress. However, for rapidly varying strains, cells tend to orient away from the stress direction; for high-frequency cyclic strain, cells align nearly perpendicular to the strain direction.

We have developed a comprehensive, theoretical treatment of the orientational response to external stress of active, contractile cells embedded in a gel-like elastic medium [12,13]. The active cell is modeled as a "force dipole" (Fig. 4), which is the elastic analogy of an electric or magnetic dipole. The actin stress fibers that join the adhesion regions on opposite sides of the cell are under tension due to the forces exerted on the actin by the myosin molecular motors. It is this active, ATP-dependent tension that results in a pair of nearly equal and opposite forces that are transmitted to the matrix to which the cell adheres (Fig. 4). The theory includes both the forces that arise from the deformation

Biological Cells as Active, Soft Composite Materials (continued)

Figure 4

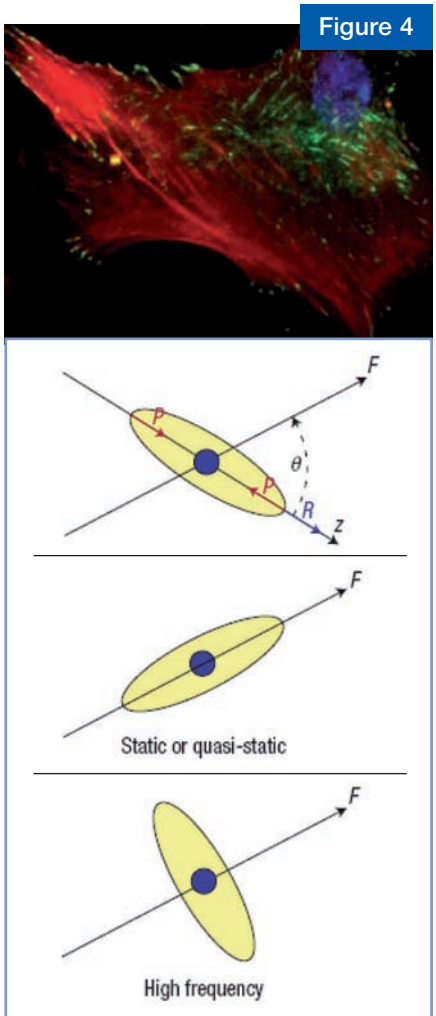


Fig. 4: Stem cell and coarse-grained dipole model. The fluorescence image shows the cytoskeletal actin fibres that generate stress (red), the sites of adhesion to the substrate (green) and the cell nucleus (blue). The model proposed in Refs. [11, 12] consists of a contractile force dipole P along the z-axis oriented at an angle θ to the direction of an external force field F. R is the reaction stress in the adjacent elastic matrix due to the cell's contractility. In the static and low-frequency case, the cell aligns parallel to the strain; at higher frequencies, the cell orients nearly perpendicular to the oscillating stretch.
[From Florian Rehfeldt and Dennis E. Discher, Nature Physics 3, 592 (2007)]

of the matrix as well as noise and random forces. In addition, there is a special focus on forces due to the internal regulation of the stress fibers and adhesions of the cell. This latter effect is unique to living matter and related to energy consumption within the cell. Based on experiments, we assume that the regulation has a steady-state, set-point value for the stress. We calculate the time-dependent response of both the magnitude and the direction of the elastic dipole that characterizes the active forces exerted by the cell for various situations. For static or quasistatic external stress, cells orient parallel to the stress while for high-frequency dynamic external stress, cells orient nearly perpendicular (Fig. 5). In addition, we predict the relaxation time for the cellular response for both slowly and rapidly varying external stresses; several characteristic scaling regimes for the relaxation time as a function of applied frequency are predicted. The high-frequency regime is in agreement with recent results [14]. More recent theoretical work takes into account the effects of noise that can cause cells to orient randomly, instead of parallel to the stress in the static case.

Our model also shows [15] that the orientation is a strong function of Poisson's ratio of the matrix when cell activity is governed by the matrix strain; if cell activity is governed by the matrix stress, the orientation depends only weakly on Poisson's ratio. These results can be used to distinguish systems in which the strain or stress determine the setpoint for the mechanosensitivity of cells [16].

Finally, recent work has shown that cells respond to stresses generated within the matrix even in the absence of external stress. In particular, the polarization of the actin stress fibers along the long axis of cells can be understood in terms of a feedback mechanism in which the direction of the actin fibers is coupled to the stress in the matrix, which in turn is determined by the active cellular forces. The polarization is thus sensitive to the elastic constant of the matrix. Results of recent experiments by the Discher group at the University of Pennsylvania are consistent with these predictions. These results may be important in controlling cell function via variation of the matrix rigidity [17,18].

Figure 5

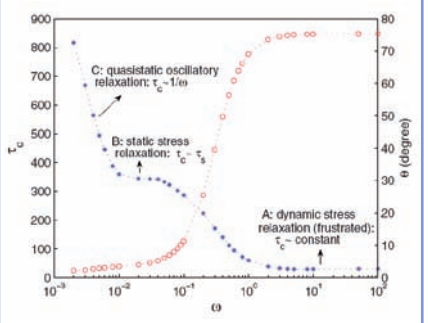


Fig. 5: Theoretical prediction [11, 12] of the characteristic relaxation time τ_c (in units of the intrinsic relaxation time of cells which is on the scale of several tens of minutes) for the cell to reach a steady-state orientation angle relative to the applied stress, as a function of the dimensionless frequency ω (which is the product of the frequency of the applied stress and the intrinsic relaxation time of the cell) as shown by the stars in blue. The corresponding steady-state value of the cell orientation angle θ is shown by the red circles. (The small dots are just a guide for the eye).

References

1. N. Gov and A. Gopinathan, Biophys. J. 90 (2006) 454.
2. Alex Veksler and Nir S. Gov, Biophys. J. 93 (2007) 3798.
3. Mattila, P. K., and P. Lappalainen, 2008. Nat. Rev. Mol. Cell Biol. 9:446-54.
4. Roie Shlomovitz and Nir S. Gov, Biophys. J. 94 (2008) 1155.
5. R. Shlomovitz and N. S. Gov, Phys. Rev. Lett. 98 (2007), 168103.
6. R. Shlomovitz and N. S. Gov, Phys. Rev. E 78 (2008) 041911.
7. H. G. Döbereiner et al., Phys. Rev. Lett. 97 (2006) 038102.
8. M. Machacek and G. Danuser, Biophys. J. 90 (2006) 1439.
9. N.S. Gov, Phys. Rev. Lett. 97 (2006) 018101.
10. D. E. Discher, P. Janmey and Y. Wang, Science 310 (2005) 1139.
11. J. H.-C. Wang, C. P. Goldschmidt, J. Wille and F. C.-P. Yin, J. Biomech. 34 (2001) 1563.
12. R. De, A. Zemel and S. A. Safran, Nature Physics 3 (2007) 655.
13. R. De and S. A. Safran, Phys. Rev. E 78 (2008) 031932.
14. S. Jungbauer, H. Gao, J. Spatz, R. Kemkemer, Biophys. J. 95 (2008) 3470.
15. Rumi De, Assaf Zemel and Samuel A. Safran, Biophys. Journal Letters 94 (2008) L29.
16. A. Saez, A. Buguin, P. Silberzan and B. Ladoux, Biophys. J. Letters 89 (2005) L52.
17. A. J. Engler, S. Sen, H. L. Sweeney and D. E. Discher, Cell 126 (2006) 677.
18. A. Zemel, I. B. Bischofs and S. A. Safran, Phys. Rev. Lett. 97 (2006) 128103, A. Zemel and S. A. Safran, Phys. Rev. E, 76, 021905 (2007).

Neutrons for Soft Matter Research at JCNS

Reiner Zorn, Dieter Richter
Jülich Centre for Neutron Science, Forschungszentrum Jülich, Germany - r.zorn@fz-juelich.de; d.richter@fz-juelich.de

Even before the term 'soft matter' was coined, neutron scattering had established itself as an important tool in this field. The confirmation of Flory's chain conformation model for polymer melts in 1974 by Schelten et al. [1] can be considered as a seminal experiment. In this experiment a small amount of polymer was blended into a melt of the same polymer with hydrogen replaced by deuterium. Only by this isotopic labelling could the single chain be made visible without significantly disturbing the interactions between the chains.

Since then, neutron scattering has found numerous applications because of the specific advantages it offers for the study of soft matter systems:

(1) The most important atoms of which soft matter is constituted (C, H, O) are all light atoms. This means that their scattering cross section is low for x-rays. Neutron scattering has become an indispensable tool especially for the localisation of hydrogen atoms.

(2) Because nearly all soft materials contain hydrogen, the 'Schelten trick' to replace it by deuterium is always applicable if deuterated variants can be synthesised. This can be used – as in the original work – to create contrast but also to make parts of the molecules 'invisible' to neutrons.

(3) While having wavelengths in the same order as x-rays, neutrons have a much smaller kinetic energy (in the order of k_BT). This implies that they are scattered with a noticeable energy transfer. This inelastic scattering allows the microscopic motions to be inferred Neutron scattering shows "where atoms are" and "what they do." [2]

(4) Neutrons are scattered in different ways depending on the isotope and the spin orientation of the scattering nucleus. This causes incoherent scattering, which (in contrast to x-ray scattering) originates from the self-correlation. Through this mechanism properties such as self-diffusion coefficient or atomic mean square displacement become observable.

Powerful neutron sources are required to perform neutron scattering experiments. These exist in the form of research reactors or spallation sources at various large-scale facilities around the world. Of these, the Jülich Centre for Neutron Science (JCNS) is closely related to SoftComp and will be presented here.

Jülich Centre for Neutron Science

JCNS is an institution which integrates the neutron scattering activities of Forschungszentrum Jülich, one of the SoftComp partners. It operates neutron scattering instruments at three facilities, the research reactor FRM II in Garching close to Munich, Germany, the Institut Laue-Langevin (ILL) in Grenoble, France, and the Spallation Neutron Source (SNS) in Oak Ridge, USA.

Ultimately, JCNS will participate in 16 instruments, most of which are located at FRM II. The primary objective of JCNS is to run a user service which allows interested researchers to request beam time through a proposal system. In addition to this service, which is standard for neutron scattering facilities, JCNS takes on the rôle of a centre of expertise. Users will be supported throughout the process from experiment design to data evaluation. Furthermore, JCNS offers extensive user training in form of laboratory courses and workshops. All this is possible because JCNS combines the world's best instrument technology with world-class scientific competence, especially for soft matter research, which is a strong focus at Forschungs-zentrum Jülich.

Figure 1

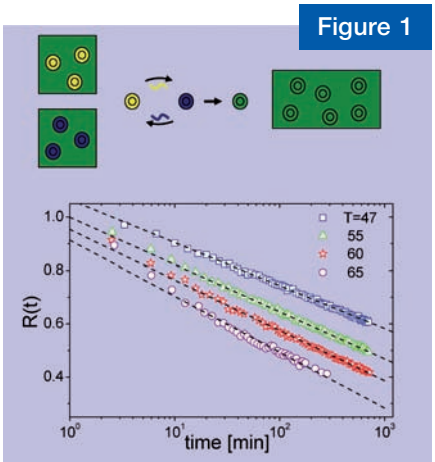
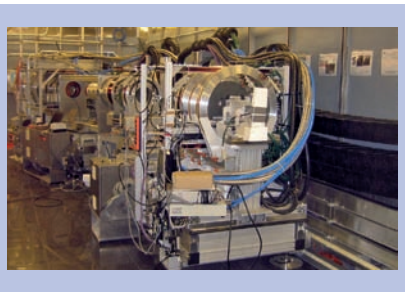


Fig. 1: Schematics of the isotopic substitution SANS experiment to observe the equilibrium exchange kinetics in micellar solution (top) and its result, the logarithmic decay of the excess of labelled chains (bottom).

Instrumentation

For the sake of brevity only the instruments most relevant for soft matter research will be presented here.




Neutrons for Soft Matter Research at JCNS (continued)

For two of them, the 'soft matter workhorses' SANS and NSE, examples of their application will be reported.

Small-angle neutron scattering (SANS)

SANS is probably the most relevant neutron scattering technique for structural investigations of soft matter. The instruments used are diffraction cameras which are optimised for a small scattering angle and long neutron wavelengths. In this way, structures of 2–600 nm size can be studied, a range that is of interest for many soft matter systems.

In the final stage, two SANS machines will be available at JCNS, one optimised for flux and one for special purposes (polarised neutrons).

In order to exploit their specific strength, SANS experiments are almost always used with the technique of isotopic (H/D) substitution. A typical experiment performed by JCNS researchers is the investigation of equilibrium exchange kinetics between polymer micelles [3]. Although the size distribution of micelles in a solution in equilibrium is stationary there is still an exchange of molecules. At first glance, it seems impossible to observe this exchange because all polymer molecules are identical. Chemical labelling is not an option because this may change the equilibrium state. Neutron scattering offers a solution for this problem by isotopic substitution. Two micellar solutions are prepared and in one of them the polymer is deuterated. Upon mixing the two solutions, the exchange of molecules will lead to an averaging of the neutron scattering properties (symbolised by the mixing of yellow and blue to green in Fig. 1). If this average is the same for the solvent, then the molecule exchange can be observed as a decay of the scattering contrast and consequently of the total scattering of the sample. As shown in the plot, the kinetics follows a very unusual logarithmic time-dependence, a behaviour which is still not fully understood.

Figure 2

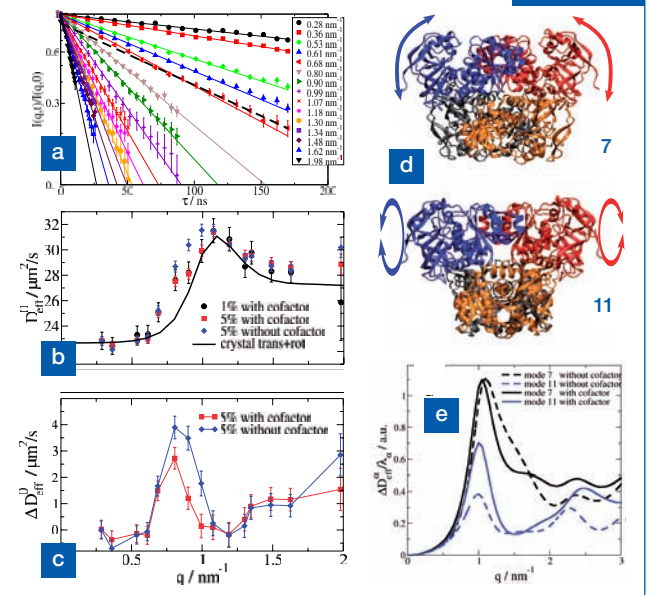


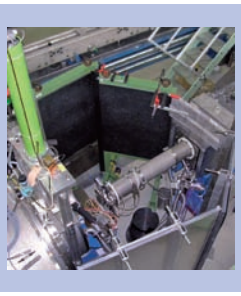
Fig. 2: a) dynamic correlation function from the NSE experiment the Q values in the legend determine the spatial scale (d≈2π/Q), b) effective diffusion coefficient D_{eff} (Q), c) effective diffusion coefficient after subtraction of translational and rotational part, d) normal modes 7 and 11 of ADH, e) diffusion form factor of modes 7 and 11.

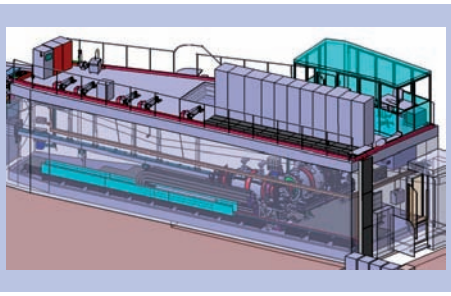
Neutron spin echo spectrometer (NSE)

The NSE spectrometer employs inelastic neutron scattering to observe the molecular dynamics. With its unique principle of using the Larmor precession of the neutron spin as an intrinsic clock it is able to produce correlation functions in the time domain with probing times of 1 ps - 300 ns. At the same time, the spatial resolution is comparable to that of SANS.

One NSE instrument has already been in operation at JCNS since 1996 and has proven to be the most important instrument for inelastic scattering on soft matter systems. Another NSE instrument will be opened in 2009 at the SNS, Oak Ridge. It will be optimised for a spallation source and use superconducting coils for a larger precession field. In this way, probing times > 1 μs will become available.

A typical study of the dynamics of biological soft matter has recently been performed on the protein alcohol dehydrogenase (ADH) [4]. This protein is important in organisms in order to use ethanol as a carbon source and for detoxification. Its function requires a cofactor (NAD+) to be incorporated in a cleft between two protein domains. This process is presumably assisted by a cleft-opening motion. Therefore, it is interesting to study the intramolecular dynamics of ADH, a task which is made possible by NSE. The correlation function (Fig. 2a) can be described by an exponential as for simple diffusion.





But in contrast to that, here the effective diffusion coefficient (Fig. 2b) depends on the length scale (expressed through the scattering vector Q). This shows that besides translation also other modes exist, the simplest being rotations of the whole molecule. As the black curve in Fig. 2b shows, rotation alone cannot fully explain the Q-dependence. The deviation (Fig. 2c) shows a distinctive difference depending on whether the cofactor is incorporated or not. A numerical normal mode analysis reveals that the most important intramolecular modes are those in Fig. 2d, modes 7 and 11. Both modes yield an excess diffusion $\Delta D(Q)$, which strongly resembles the experimental finding (Fig. 2e). Mode 7 also shows the qualitative change with the introduction of the cofactor as in the experiment. This demonstrates that the biologically relevant dynamics can be identified by NSE and quantities such as the spring constant of the intramolecular 'hinge' can be obtained.

Diffuse neutron scattering (DNS)

For soft matter studies this instrument is usually deployed as a diffractometer with polarised neutrons and polarisation detection. By means of this technique it is possible to separate coherent and incoherent scattering and to normalise the result to absolute scattering. This is especially important in combination with computer simulation data thus permitting a parameter-free comparison. A fine example of such a study was published in a previous issue of this Newsletter [5].

Ultra-small-angle neutron scattering (uSANS)

For structures in the µm range conventional SANS cameras do not provide sufficient resolution. The uSANS machine extends the size range by a decade to length scales of 10 µm.

Backscattering-spectrometer (BSS)

Under certain conditions (e.g. if deuteration is not possible), NSE experiments may be difficult or even impossible. In these cases, the BSS provides access to the microscopic dynamics in a frequency domain with a resolution of 1 µeV. The corresponding probe time ranges up to 2 ns.
JCNS also participates in a spallation-source-based BSS instrument operated at the SNS, Oak Ridge. Due to its different construction it covers a wider energy range, but at the expense of energy resolution.

In addition to the neutron scattering instruments, JCNS has a wide range of ancillary methods at its disposal: dielectric spectroscopy, rheology, calorimetry, and (more and more importantly) computer simulation. For research on polymers, chemical facilities for sample preparation and characterisation are also available. All these techniques can be used in collaboration with JCNS scientists.

Use of JCNS facilities

All instruments at JCNS are open to external users. Prospective users must submit a short experiment proposal at the website:
http://www.jcns.info/jcns_proposals
The proposals will be evaluated by an international selection panel and beam time granted on the basis of scientific merit.

For SoftComp partners there are no charges (beam fee) for the use of the instruments and the researchers travel expenses will be reimbursed. In the past many SoftComp groups have made use of this possibility; e.g. more than 20% of the experiments on the NSE spectrometer in 2005/6 were performed by SoftComp researchers.
The annual JCNS Laboratory Course Neutron Scattering (co-sponsored by SoftComp) is open to students from all over the world, especially from Soft Comp universities. Participation is free of charge and travel expenses are reimbursed as for experiments. The next lab course will be held from 7 to 18 September 2009.
More information is available and application forms can be downloaded at:

www.neutronlab.de

References

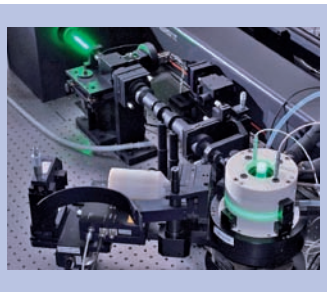
[1] J. Schelten, G. D. Wignall, D. G. H. Ballard, W. Schmatz, Neutron small-angle scattering by mixtures of H and D-tagged molecules of polystyrene and polyethylene, Coll. Polym. Sci. 252, 749–752 (1974)

[2] C. Nordling: Nobel Prize presentation speech for B. Brockhouse and C. G. Shull (1994)

[3] R. Lund, L. Willner, J. Stellbrink, P. Lindner, D. Richter, Logarithmic Chain-Exchange Kinetics of Diblock Copolymer Micelles, Phys. Rev. Lett. 96, 068302 (2006)

[4] R. Biehl, B. Hoffmann, M. Monkenbusch, P. Falus, S. Préost, R. Merkel, D. Richter, Direct Observation of Correlated Interdomain Motion in Alcohol Dehydrogenase, Phys. Rev. Lett. 101, 138102 (2005)

[5] J. Colmenero, A. Arbe, F. Alvarez, D. Richter, Doing Molecular Dynamics Simulations on Polymers as Neutron Scattering Practitioners, SoftComp newsletter 6, 1–4 (2008)




SoftComp
SOFT MATTER COMPOSITES

newsletter

Vacancies

PhD projects available in DYNACOP
Marie Curie Initial Training Network

DYNACOP (DYNamics of Architecturally Complex Polymers) is a new EU Marie Curie Initial Training Network (ITN) with ten universities (among those, seven SoftComp partners) and two industrial companies across Europe. Its goal is to obtain a fundamental understanding of the flow behaviour and dynamics of blends of topologically complex macromolecular fluids and their role in the processing and properties of nanostructured blends. Twelve PhD (doctoral training) positions are available at all universities, covering experimental, theoretical and computational approaches to this problem.

The ITN provides an excellent opportunity for scientific and personal development, with regular training courses at different locations throughout Europe and the chance to consult with leading scientists in the field (including several international visiting scientists).

The partner universities are listed below.

For general enquiries, please contact:
Prof. Peter Olmsted (p.d.olmsted@leeds.ac.uk) or
Dr. Daniel Read (d.j.read@leeds.ac.uk).

UK	Universities of Leeds and Durham
Germany	Forschungszentrum Jülich,
Greece	Foundation for Research and Technology Hellas, National and Kapodistrian University of Athens
Spain	Universidad del Pais Vasco/Euskal Herriko Unibertsitatea
Netherlands	Universiteit Twente
Belgium	Université Catholique de Louvain
Denmark	Dansmarks Tekniske Universitet
Italy	Universita degli Studi di Napoli Federico II

A post-doc position
(duration between 18 and 22 months) ...

... is available at Laboratoire des Colloides, Verres et Nanomateriaux Université Montpellier II/CNRS, Montpellier, France.

The project is financially supported by Agence Nationale de la Recherche grant. Starting date before July 1st 2009.

The aim of our project is to understand in vitro, using purified proteins and biomimetic membranes, the interplay between specific proteins and lipids with actin in the organisation of the linkage between the cytoskeleton and the plasma membrane. These components contribute to the anchoring of a cell in its environment as they are localised in membrane protrusions.

Applicants should contact:
Laurence RAMOS
phone : +33 (0)4 67 14 42 84
www.eu-softcomp.net/news/jobs

Coming Up...

SoftComp Conferences & Workshops	Date
SoftComp Topical Meeting Assembly and Biomimetics 2009 Weizmann Institute, Israel www.eu-softcomp.net/meet/TM_w09 N. Gov · Nir.Gov@weizmann.ac.il S. Safram · sam.safran@weizmann.ac.il	11-12 Mar 09
SoftComp Topical Meeting on Colloidal and Polymer Synthesis Vigo, Spain www.eu-softcomp.net/meet/TM_v09 L. Liz-Marzan · lmarzan@uvigo.es	18-20 Mar 09
Workshop on Mesoscale Simulations of Soft Matter Out of Equilibrium Forschungszentrum Jülich Jülich, Germany www.fz-juelich.de/iff/MESOSOFT/ R. G. Winkler · r.winkler@fz-juelich.de G. Gompper · g.gompper@fz-juelich.de	18-20 Mar 09
Biological and Soft Matter Conference Warwick University, UK www.iop.org/Conferences/Forthcoming_Institute_Conferences/biosoftmatter/index.html C. Garland · claire.garland_AT_iop.org L. Cornwell · lisa.cornwell_AT_iop.org	06-08 Apr 09
Annual European Rheology Conference Cardiff, Wales, UK www.rheology-esr.org/AERC/2009/	15-17 Apr 09
SoftComp Annual Meeting Venice, Italy **- Plenary sessions** **- Network Area meetings** **- Planning the future** **- NGB** **- NCC 22** www.eu-softcomp.net/meet/annual/am09 D. Richter · d.richter@fz-juelich.de	04-07 May 09 04-06 May 09 04-06 May 09 06 May 09 07 May 09 07 May 09
Course on Light Scattering and Microscopy Jülich, Germany J. Dhont · j.k.g.dhont@fz-juelich.de	May 09

Coming Up (continued) ...

SoftComp Conferences & Workshops	Date
Ampere NMR School 2009 Zarkopane, Poland Depart. of Macromolecular Physics, Adam Mickiewicz University, Poznan www.staff.amu.edu.pl/~school/ S. Jurga · stjurga@amu.edu.pl J. Morawska · school@amu.edu.pl	21-27 Jun 09
Mainz Materials Simulation Days 2009 Mainz, Germany www.mpip-mainz.mpg.de/mmsd W. Paul · wolfgang.paul@uni-mainz.de	03-05 Jun 09
13th Laboratory Course on Neutron Scattering Jülich/Garching, Germany www.neutronlab.de R. Zorn · r.zorn@fz-juelich.de	07-18 Sep 09
Workshop on Trends and Perspectives in Neutron Scattering on Soft Matter JCNS Jülich/Munich, Germany www.jcns.info/Workshop D. Richter · d.richter@fz-juelich.de	05-08 Okt 09
Jülich Soft Matter Days 2009 Gustav-Stresemann-Institut Bonn, Germany www.fz-juelich.de/iff/jsmd2009 J. Dhont · j.k.g.dhont@fz-juelich.de G. Gompper · g.gompper@fz-juelich.de D. Richter · d.richter@fz-juelich.de	10-13 Nov 09

Personalia

Prof. Luis M. Liz-Marzan, Universidade de Vigo, has been appointed as Senior Editor for the journal Langmuir, ACS.

Prof. Tom McLeish has been promoted to Pro-Vice-Chanceller for research at Durham University, Durham, UK.

Prof. Dr. Christos N. Likos, Heinrich-Heine-University of Düsseldorf, has been selected by the American Physical Society as an "Outstanding Referee" for Physical Review and Physical Review Letters.

For more frequently updated information, please see also the SoftComp web pages...
Vacancies: **www.eu-softcomp.net/news/jobs** · SoftComp News: **www.eu-softcomp.net/news/**
SoftComp Events: **www.eu-softcomp.net/news/cal**

Credits/Disclaimer

Acknowledgements: This research project was supported by the European Commission under the 6th Framework Programme through the Key Action: Integrating and Strengthening the European Research Area. Project title: SoftComp, Soft Matter Composites – An approach to nanoscale functional materials
Contract Type: Network of Excellence · Contract: NMP3-CT-2004-502235

SIXTH FRAMEWORK PROGRAMME

Photos and graphics credits:
Forschungszentrum Jülich, Weizmann Instute, Israel

Editorial Details

Editors:
Friedrich Hugo Bohn, Gerhard Gompper
SoftComp NoE
Forschungszentrum Jülich GmbH
52425 Jülich · Germany

Contact:
Tel.: +49 24 61-61 21 83
Fax: +49 24 61-61 57 57
f.h.bohn@fz-juelich.de
www.eu-softcomp.net

SoftComp
SOFT MATTER COMPOSITES