FROM QUANTISATION IN THE GRAVITATIONAL FIELD TO CORRELATED ELECTRON SYSTEMS - PERSPECTIVES OF RESEARCH WITH NEUTRONS (SYRN)

gemeinsam veranstaltet
vom Fachverband Physik der Hadronen und Kerne (HK),
vom Arbeitskreis Festkörperphysik und
dem Arbeitskreis Biologische Physik (AKB)

Thomas Brückel
Forschungszentrum Juelich GmbH
D-52425 Juelich
E-Mail: t.brueckel@fz-juelich.de

Michael Loewenhaupt, Dresden
Werner Press, Grenoble

ÜBERSICHT DER HAUPTVORTRÄGE UND FACHSITZUNGEN

(Hörsaal TU HE101)

Hauptvorträge

SYRN 1.1	Di	14:00	(TU HE101)	**The impact of neutrons on biological systems**, Olwyn Byron
SYRN 1.2	Di	14:30	(TU HE101)	**Soft Matter Science**, Richter Dieter
SYRN 1.3	Di	15:00	(TU HE101)	**Magnetic Nanostructures**, H. Zabel, K. Theis-Bröhl, F. Radu, M. Wolff
SYRN 1.4	Di	15:30	(TU HE101)	**Neutron scattering from correlated electron systems**, Bernhard Keimer
SYRN 1.5	Di	16:30	(TU HE101)	**Scientific Perspectives with New Sources and Methods**, Helmut Schober
SYRN 1.6	Di	17:00	(TU HE101)	**Neutrons in Material Science and Engineering**, Anke Rita Pyzalla
SYRN 1.7	Di	17:30	(TU HE101)	**Gravity at a Micron and Mixing of Quarks - Particle Physics with Cold Neutrons**, Hartmut Abele
SYRN 1.8	Di	18:00	(TU HE101)	**Neutrons as Quantum Objects**, Helmut Rauch

Fachsitzungen

SYRN 1	**Perspectives of research with neutrons**	Di 14:00–18:30	TU HE101	SYRN 1.1–1.8

Fachsitzungen

– Hauptvorträge –

SYRN 1 Perspectives of research with neutrons

Zeit: Dienstag 14:00–18:30 Raum: TU HE101

Hauptvortrag SYRN 1.1 Di 14:00 TU HE101

The impact of neutrons on biological systems — •Olwyn Byron — Division of Infection and Immunity, Joseph Black Building, University of Glasgow, Glasgow G12 8QQ, Scotland, UK

This is an exciting time at which to be exploring biological systems with neutrons. Neutrons are of particular utility in biology because of the large negative isotropic scattering length of the 1H nucleus compared with the large positive values for common biological nuclei and the 2H nucleus. This allows contrast variation experiments to be performed in which certain components of complex biological systems are made to be invisible. In addition, neutrons do not damage biological samples in the same way as their x-ray counterparts may do.

In this talk I will review recent developments in the field and will summarise progress in the use of coherent and incoherent neutron scattering to study both the structure and dynamics of biological macromolecul es and their complexes. I will concentrate particularly on structural studies, including small-angle neutron scattering, single-crystal neutron diffraction and specular and off-specular reflectivity with reference to the role played by advances in comput ational modelling and molecular biology in promoting this work.

Hauptvortrag SYRN 1.2 Di 14:30 TU HE101

Soft Matter Science — •Richter Dieter — Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany

The lecture commences with an introduction into soft matter science and the role of neutron scattering in this field. Thereafter some examples for outstanding neutron results on key problems in soft matter science will be given.

(i) We will examine neutron spin echo results addressing the molecular dynamics of polymer chains in the melt, elucidating the role of entropic forces and topological confinement: two key elements in the dynamics of complex soft matter systems.

(ii) Real time kinetic neutron studies on transient phenomena in soft matter gain in importance. We will address a combined high resolution NMR and neutron small angle scattering study on the relation between chemical reaction kinetics and structure formation in anionic polymerisation.

(iii) Relevant systems in soft matter are often multicomponent materials, where key components at low concentrations determine the properties. As an example we will consider amphiphilic polymers which boost the emulsification efficiency of surfactants in microemulsions.

(iv) Finally, selforganisation is one of the key phenomena in soft materials. We will look on selfassembling polymers which winterize Diesel fuel as well on proteins which inhibit the calcification in soft tissue of mammals.

Hauptvortrag SYRN 1.3 Di 15:00 TU HE101

Magnetic Nanostructures — •H. Zabel, K. Theis-Bröhl, F. Radu, and M. Wolff — Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany

The current interest in magnetic nanostructures is driven by their manifold applications in the magneto- and spin-electronic area. Polarized neutron reflectivity (PNR) studies provide a layer resolved vector magnetometry, even for deeply buried layers. This feature is essential for the analysis of the magnetization reversal mechanism in ferro- /antiferromagnetic heterostructures exhibiting the exchange bias effect[1], as well as for modelling magnetic superlattices with biquadratic interlayer exchange coupling[2]. Furthermore diffusely scattered neutrons have shown new directions for analysing magnetic domains and domain wall distributions in thin films. Periodic arrays of magnetic stripes and islands is a new and intriguing topic. PNR is highly suitable for studying different remagnetization processes in these patterns, as it can distinguish between reversals via coherent rotation or domain nucleation and wall movement. Bragg peaks from the lateral periodicity offer the possibility to filter out correlation effects between individual magnetic units[3]. After introducing the PNR method, a number of recent studies on magnetic heterostructures and lateral nanostructures will be discussed. - We gratefully acknowledge support from BMBF 03ZA6BC1 and SFB 491: Magnetic Heterostructures.

1. F. Radu et al. Phys. Rev. B **67**, 134409 (2003).
2. V. Lauter-Pasyuk et al., Phys. Rev. Lett. **89**, 167203 (2002).
3. K. Theis-Bröhl et al., Phys. Rev. B **68**, 184415 (2003).

Hauptvortrag SYRN 1.4 Di 15:30 TU HE101

Neutron scattering from correlated electron systems — •Bernhard Keimer — Max-Planck-Institut für Festkörperforschung

The unusual physical properties of materials with strong electronic correlations, such as high-temperature superconductivity, are currently at the forefront of condensed matter physics. The magnetic structure and dynamics elucidated by neutron scattering are incisive "fingerprints"of the microscopic mechanisms underlying this intriguing behavior. We will illustrate the power of neutron scattering with several examples, including cuprate and cobaltate superconductors and materials with orbital degeneracy. We will also illustrate novel perspectives opened up in this field by intense new neutron sources such as the FRM-II research reactor.

Hauptvortrag SYRN 1.5 Di 16:30 TU HE101

Scientific Perspectives with New Sources and Methods — •Helmut Schober — Institut Laue Langevin, 6 rue Jules Horowitz, BP 156, 38042 Grenoble Cedex 9

The international landscape of neutron scattering facilities is currently undergoing major reshaping. The new source in Munich (FRM-II) has just been commissioned and will produce first scientific results in 2005. Its nearly complete set of instruments will add unprecedented experimental capacity to existing installations. Like FRM-II neutron facilities all around the world profit from new technology to upgrade the performance of their sources and spectrometers. The upgrade of the facilities is met by efforts of the user community to propose smarter experiments on leading-edge science. During the last decade this process has attained an impressive momentum. Improved flux and higher resolution both in space and time allow for always more precise measurements on samples growing smaller and smaller (0.001 mm3) or becoming more and more dilute (10 ppm). Modern sources and spectrometers equally open the door towards faster kinetic studies. Clever manipulation of the neutron spin leads to new ways to investigate surfaces and interfaces. Dedicated infrastructures make neutrons accessible to engineers and biologists. A completely new dimension of experiment is to be expected from the second-generation spallation sources that are presently under construction in both the United States and Japan. German research centers are actively participating in these efforts.

Hauptvortrag SYRN 1.6 Di 17:00 TU HE101

Neutrons in Material Science and Engineering — •Anke Rita Pyzalla — TU Wien, Institute of Material Science and Technology, 1040 Wien, Austria

Due to their high penetration depth in structural materials neutrons offer outstanding possibilities in material science and engineering. The physical methods used comprise diffractometry, small angle scattering and tomography. Neutron texture analyses are a unique means for determining the orientation distribution function of crystallites and thus are essential for optimizing the physical and mechanical properties of materials and components. Strain/stress analyses using neutron diffraction also play an important role in science and industry since detrimental internal stress state are often responsible for early and unexpected component failure. Neutron small angle scattering enables characterizations e.g. of precipitation states and particle sizes, which are a necessary link between material microstructure and material properties. Neutron tomography is unique for revealing inner structures of complex industrial components non-destructively. Examples for innovative applications of neutron diffraction, small angle scattering and tomography in material science and engineering will be given and an outlook on future possibilities arising at new instruments and upcoming sources will be presented.

Hauptvortrag

SYRN 1.7 Di 17:30 TU HE101

Gravity at a Micron and Mixing of Quarks - Particle Physics with Cold Neutrons — •Hartmut Abele — Physikalisches Institut, Philosophenweg 12, 69120 Heidelberg

Galilei Galileo would be somewhat surprised. According to his famous free-fall experiment, all objects fall independent from its mass with constant acceleration g. But neutrons do not fall as larger objects do. When neutrons become ultra-cold, the fall experiment shows quantum aspects of the subtle gravity force in the sense that they don't fall continuously. We find them in bound quantum states with discrete energy levels of pico-eV, opening the way to a new technique for gravity experiments and measurements of fundamental properties. New motivations for gravity experiments come from frameworks where the Planck scale is taken to the energy scale of the Standard Model, the theory of particle physics. Considering the very early stage of our universe, we have the strong feeling, that a Standard Model description is incomplete, and many new observables pointing to physics beyond the Standard Model emerge from superstring theory, supersymmetry or other Grand Unified Theories. Furthermore, the quark-mixing (CKM) matrix remains unexplained in the Standard Model as well as CP-violation, which might explain the baryon-antibaryon asymmetry of the universe. Some observables of these theories require neutron physics, for others the neutron provides one of several possible ingredients.

These examples show that questions of particle physics and cosmology at highest energies can be pursued at the other extreme of the energy scale, using neutrons at the lowest energies down to the pico-eV range.

Hauptvortrag

SYRN 1.8 Di 18:00 TU HE101

Neutrons as Quantum Objects — •Helmut Rauch — Atominstitut der Oesterreichischen Universitaeten, 1020 Wien, Austria

Neutrons are widely used for the investigation of static and dynamic properties in condensed matter research. In this area the kinematical features, like energy, momentum and the direction of the magnetic moment of the neutron play a central role. On the other hand neutrons are also ideal tools for the observation of quantum phenomena with massive particles . Many pioneering experiments in quantum optics were first performed with neutrons, like the observation of the 4pi-symmetry of spinors, the spin-superposition law, the magnetic Josephson effect and various post-selection experiments. Most of these experiments have employed perfect crystal neutron interferometers in which widely separated coherent beams can be manipulated individually. More recently, a confinement induced neutron phase has been measured that results from the transverse quantization of the neutron wave-function between narrow slits, indicating that the neutron is influenced by the walls even though it does classically not touch them. This demonstrates the non-local feature of quantum mechanics and stimulated work to demonstrate, for the first time, the property of quantum contextuality, which means that even commuting variables can be correlated (entangled). Various quantum optics methods can be adapted to neutrons, like quantum state reconstruction, quantum state engineering, phase space compression and phase space transformation. New understanding of quantum phenomena and novel beam tailoring techniques may arise from the application of these methods.