ECNS 2003
Introductory Course

Abstracts

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3rd European Conference
on Neutron Scattering
September 3-6, 2003, Montpellier, France

Introductory Course at the
French Neutron Centre
Laboratoire Léon Brillouin, Saclay, France
September 1-2, 2003

Organisers
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In collaboration with
European Neutron Scattering Association
Société Française de la Neutronique
Institut Laue Langevin
The Introductory Course is organised at the French neutron centre (Laboratoire Léon Brillouin CEA-CNRS). The program of the Introductory Course is intended for participants with little knowledge in the field of neutron scattering. The first day is devoted to basic courses including the principles of scattering experiments and the performances of neutron scattering to probe structural and dynamic properties of condensed matter (including magnetism). The comparison with complementary techniques such as light, X-ray scattering, NMR etc, will be stressed. On the second day, the applications of neutron scattering in different fields are illustrated in three parallel sessions about magnetism, biology and materials, respectively. Practical sessions will complement the fundamental lectures. Lecture notes will be collected and distributed to all participants. A CD-ROM will be available after the School.

A visit of the Orphée reactor is organised at the end of the Introductory Course. This visit is opened to all participants of ECNS2003. A transportation from Saclay to Montpellier is organised at the end of the visit.

Information on the Laboratoire Léon Brillouin can be found on the web site: http://www-llb.cea.fr.

We acknowledge the Laboratoire Léon Brillouin for its financial support, and particularly Chantal Pomeau, Bernard Mailleret and Chantal Marais for their efficient help during the preparation of the Introductory Course.

The organisers
M.-C. Bellissent-Funel (LLB), F. Ott (LLB) and H. Schober (ILL)
Program

Monday 1st, 2003

Domaine de Saint Paul, Saint-Rémy-lès-Chevreuse : room C7

Chairperson : M.-C. Bellissent-Funel

Putting Neutrons into Perspective
*Helmut Schober, ILL*

Principles of the scattering experiment: “Why is it so simple?” s-wave approximation, Born-approximation. “What can we learn from it?” Double differential cross-section, correlation functions. Comparison with a few competing techniques: Light and X-ray-scattering, NMR etc.

Probing Structural Properties
10h00 *From the Macro- to the Nanoscale*
*Loïc Auvray, LLB*
SANS, Reflectometry.

11h00 Coffee break

11h30 *On the Atomic Scale*
*Theresa Fernandez-Diaz, ILL*
Crystals, glasses and liquids (including texture, kinetics etc.)

12h30 Lunch

Chairperson : F. Ott

Probing Dynamic Properties
14h00 *Statistical Motion*
*Marc Bée, Université Joseph Fourier*
Translational and rotational diffusion, spin fluctuations, quasi-elastic scattering and EISF

15h00 *Correlated Motion*
*Götz Eckold*
Phonon dispersion and width, density of states, spin waves etc.

16h00 Coffee break

Chairperson : H. Schober

Fundamental Physics with Neutrons
16h30 *Oliver Zimmer*

Neutron Sources Now and in the Future
17h30 *M. Alba - Pierre Monceau, LLB*
Types of sources, Geographical location, Access etc.

20h00 Dinner
Thematic sessions

Laboratoire Léon Brillouin : rooms 15, 16 and room Jean Rossat-Mignot

Magnetism

Chairperson : G. Eckold

9h00  Magnetism and Superconductivity
      Joël Mesot

10h00  Molecular Magnetism
       Eric Ressouche

11h00 Coffee break

11h30 Thin films magnetism probed by reflectometry
      Frédéric Ott
      Multilayers, spin-valves, magnetic domains.

Biologie

Chairperson : M. Bée

9h00  Structures of biological molecules/ deuteration
      Dean Myles

10h00  Reflectivity on biological systems
       Tim Salditt

11h00 Coffee break

11h30 Dynamics/ fluctuations in biological systems
      Stéphane Longeville

Materials

Chairperson : M.T. Fernandez-Diaz

9h00  Polymer Dynamics
      Michael Monkenbusch

10h00  Stress and Strains
       Monica Cerretti

11h00 Coffee break

11h30 Emulsions, Membranes
      Giovanna Fragneto

12h30 Buffet

14h00 Visit of Orphée reactor of LLB
16h00 Coffee break
16h30 Departure to Paris “Gare de Lyon” by bus
18h24 Departure by TGV 6217 (Gare de Lyon) to Montpellier station
21h46 Arrival at Montpellier station
Putting Neutrons into Perspective

Helmut Schober
Institut Laue-Langevin, 6, rue Jules Horowitz; F-38042 Grenoble Cedex 9, France

Principles of the scattering experiment: “Why is it so simple?” s-wave approximation, Born-approximation. “What can we learn from it?” Double differential cross-section, correlation functions. Comparison with a few competing techniques: Light and X-ray-scattering, NMR etc.

Neutron scattering is an important tool for scientific research in areas as diverse as physics, chemistry, materials science and biology. In this introductory course we will try to expose the basic principles of neutron scattering. Emphasis is given to simple concepts that will be illustrated by modern experiments.

Due to its rather weak interaction with most atoms neutrons penetrate deeply into the material. Despite this bulk sensitivity the experimentally determined cross-sections can be directly converted into physically meaningful correlation functions. The neutron scattering experiment thus yields extremely robust first hand information on the mean values and fluctuations of atomic degrees of freedom like the position of the nucleus and the spin of the electrons. Corrections for absorption and multiple scattering are generally small and well controlled. In the case of nuclear scattering the elementary scattering events take place between the neutron and the nuclei. The wavelength of the neutrons used in scattering experiments considerably exceeds the dimensions of the nucleus. Apart from the spin the neutron experiences the nuclei as structureless point-like particles. The scattering thus can be simply described by a spin dependent complex number the so-called scattering length. The scattering length depends in an arbitrary way on the isotopes of the elements. This makes it possible to create scattering contrast via isotopic substitution working particularly well in the case of hydrogen and deuterium.

In the case of scattering via the magnetic moments generated by the electrons the situation is close to that of X-rays scattered by the electronic cloud of the atoms. In both cases the extended character of the scattering medium has to be accounted for by a Q-dependent form factor. Depending on the nature of the phenomenon under investigation a large variety of theoretical concepts is used to describe the double differential scattering cross-sections. All of these concepts rely in one way or another on the use of the above mentioned correlation functions. A particularly useful quantity is the susceptibility that can be directly compared to theoretical predictions based on linear response calculus.

If the structures probed by the neutrons strongly exceed the neutron wavelength we can apply simple concepts from ordinary optics to describe the scattering events. A typical example is specular neutron reflectometry or the contrast variation in small angle scattering.

Neutron scattering allows probing nuclear and magnetic structures from less than a tenth to several hundred Angstrom on time scales ranging from a few femtoseconds to fractions of microseconds. The vast field of application is covered by a variety of dedicated neutron scattering instruments. Given this broad dynamic range there is considerable overlap with a variety of other
experimental probes like optical spectroscopy, NMR and X-ray scattering. Choosing a few examples we will demonstrate the complementarity of these methods.

**Probing Structural Properties**

*From the Macro- to the Nanoscale*

Loïc Auvray

Laboratoire Léon Brillouin (CEA/CNRS), CEA Saclay, F-91191 Gif sur Yvette

In this one-hour lecture we will attempt to describe how the neutron scattering technique can be used to probe different aspects of the static time-averaged structures exhibited by condensed matter. We will focus mainly on the small angle scattering and reflectometry techniques and choose our examples in the field of soft condensed matter, except for a short reference to magnetic systems.

The basic formula, the only one to be remembered, is the expression of the static intensity scattered coherently by an assembly of $N$ scatterers:

$$i(q) = \sum_{i,j=1}^{N} b_i b_j <e^{i(q \cdot \tau_{ij})} >.$$ 

This expression is a Fourier transform which imposes the fundamental relationship between the spatial resolution of an experiment $\Delta r$ and the scattering vector of observation $q$:

$$q \cdot \Delta r \ll 1.$$ 

The $b_i$'s are the scattering lengths of the different scatterers, they depend on the isotopic composition of the studied material, on the spin of the incident neutrons and of the nuclei in the sample and also on the possible magnetic moments of the atoms. These dependences are at the origin of different techniques of isotopic substitution, contrast matching, contrast variations, polarization analysis and of course magnetic scattering.

Depending on the range of scattering vectors investigated one probes the structures from a quasi-macroscopic scale (as $q$ goes to zero, this is the thermodynamic limit of a scattering experiment) to an atomic scale in passing by an intermediate supra-molecular scale where a continuous description independent of the molecular details is possible. We show different examples and uses of the different scales of studies, measures of molecular weight, evidence for aggregation, universal behavior of some polymeric and fractal systems etc…

Of particular interest for the studies of dispersed colloidal systems with microscopic well-defined interfaces is the range where the local microscopic surfaces in the sample appear flat at the scale of observations $q^{-1}$. This is the range where the scattering experiments and the reflectometry experiments have a common description, which allows the study of interfacial structures.
Probing structural properties on the atomic scale

*Maria-Theresa Fernández-Díaz*
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The knowledge of atomic positions in condensed matter is a prerequisite for the understanding of its physical properties and a valuable aid for a rational development of new materials.

To examine the structure of matter at an atomic level, we need a radiation with a wavelength comparable with the spacing of between atoms. Thermal neutrons meet that requirement and furthermore, the specific features of the neutron-atom interaction make neutron diffraction a unique technique for the study of matter. Even if X-ray diffraction is the technique of choice for structural determination, the refinement of structural and thermal parameters is better done with neutrons due to their Q-independent scattering power.

The non-systematic variation of the scattering cross section with the number of nucleons represents also a major advantage of neutrons. This property allows precise structural refinement when light and heavy atoms are present, and in particular the distances between hydrogen and other atoms can be measured accurately, avoiding any possible effect of the redistribution of charges when forming the chemical bond. Moreover, it is possible to locate atoms or ions with slightly different atomic number like neighbouring elements in the periodic table and by the use of different isotopes of the same element contrast variation experiments can be done.

Neutron diffraction provides capital information for the study of structural phase transitions in solids, not only because the structural parameters can be determined with high precision, but because the low absorption of neutrons makes possible the use of complicated sample environments.

Finally, the interaction between the magnetic dipole moment of the neutron and the magnetic field of the unpaired electrons gives magnetic scattering. Magnetic interaction is of the same order of magnitude as the nuclear one; making of neutron diffraction the primary and simplest tool for obtaining direct information about the arrangement of magnetic moments in solids.

In that lecture a short review will be given, at an introductory level, of the use of neutrons for the study of structure by means of neutron diffraction.

Starting from the particular characteristics of the neutron-matter interaction we shall give a summary of the relevant scattering formulae as far as diffraction is concerned. We will discuss the field were neutron diffraction can give a valuable and in some cases unique information. The contributions of neutron diffraction to the structural refinement in crystalline solids as well as the structural correlations in liquids and glasses, the study of structural phase transitions, and magnetic structure determination will be illustrated through several examples.
Probing Dynamic Properties

*Translational and rotational diffusion, spin fluctuations, quasielastic scattering and EISF*

Marc Bée

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Incoherent quasi-elastic neutron scattering has undergone a remarkable development from the 1970’s and 1980’s when the resolution of spectrometers first allowed an accurate analysis of the exact shape of the energy spectra. These pioneering years were characterised by a multitude of theoretical works and the invention of a considerable number of dynamical models adapted to more and more complex physical situations. The scattering laws concerned long range diffusion of atoms or molecules in various environments as well as localised rotational motions of chemical groups or of whole entities. Nowadays quasi-elastic neutron scattering is still as active and thriving, but it deals with more and more complex systems. It has moved away from academic subjects towards more applied cases directly connected to industry, development of high-performance materials and, recently, biological macromolecules. These new fields of investigation are the natural consequence of the continuous building of new spectrometers with improved performance. Interpretation of the results often comes up against many problems related to the complexity of the samples under study. However, new approaches to data analysis have been undertaken. Without trying to make an exhaustive review of the more or less recent studies in quasi-elastic neutron scattering, several examples attempt to illustrate the on-going importance of this technique in the investigation of diffusive processes. Original and recently developed approaches, from a theoretical point of view as well as from numerical simulation techniques, are described. In conclusion, some general trends on the future of this technique are outlined.
Correlated Motion

Götz Eckold
Institute of Physical Chemistry, University of Göttingen, D-37037 Göttingen

Correlated motions in solids are characterised by the elementary excitations of crystal lattices. These are the normal modes of lattice vibrations - the phonons - and, in the case of magnetically ordered structures, the magnetic spin waves or magnons. The variety of different modes of an infinite crystal carries the most detailed information about interatomic interactions. Their knowledge is essential for the understanding of the microscopic behaviour and the properties of solids.

In this lecture, fundamental properties of these excitations are presented. Dispersion, eigenvectors, anharmonic effects are described along with lattice instabilities associated with soft modes. It is shown, how the frequency and the polarisation vectors of phonons and magnons can be determined by inelastic neutron scattering. Selected examples are used to demonstrate the power of this experimental method for the investigation of the dynamics of condensed matter.
Physics of subatomic particles has two major goals. The first one is to find fundamental constituents of matter and to understand their interactions. The second aim is to understand how the properties of the composite objects emerge from the underlying theory.

Probing matter for structures at shorter and shorter distances, a hierarchical organization shows up – atoms contain a nucleus made from nucleons, which themselves are made out of quarks and gluons. Particles appearing to be point-like at all scales accessible experimentally are considered as “fundamental”. Presently, these are believed to be quarks and leptons, which interact via force fields of photons, gluons and the heavy W and Z bosons. A very successful theory, called the “standard model of particle physics” has thus far withstood all attempts to demonstrate its limitations (apart from recent observations of neutrino oscillations which, however, can be accommodated in the existing framework).

Once having at hand a fundamental theory, we are still left with the tremendous task to understand the properties of the composite “large-scale objects” (nucleons, nuclei), i.e. to describe the many-body-problem of strongly interacting particles. It is only a first step to define the relevant degrees of freedom together with effective interactions. The effective couplings of such a theory can often be related rather directly to measurable quantities. Modern effective field theories (which are built on a most general interaction respecting basic symmetries of the underlying fundamental theory) provide a powerful framework to predict any observable within the range of the theory on the basis of a few input observables. However, although fully satisfactory from a practical viewpoint, this can be counted only as a partial success with respect to the second goal – it still does not answer the question, how the effective couplings of the theory are linked to the fundamental theory.

The neutron, as a neutral particle taking part in all known interactions, is very well suited to contribute significantly to both of these goals, complementary to work done at particle accelerators. Many static and decay properties of the composite system “neutron” and a plethora of neutron-nucleus interactions can be investigated. Tiny symmetry violation effects are accessible in high-accuracy experiments, which can be employed as fingerprints to focus on weak, and eventually new interactions. Parity non-conservation is very important in this respect, but also time reversal invariance violation, which one searches for in neutron decay and in attempts to measure a non-vanishing electric dipole moment of the neutron. Neutron lifetime measurements in combination with angular correlation experiments open another window for physics beyond the standard model. The lecture intends to briefly present the framework of particle physics and highlight a few examples where neutron studies make significant contributions.
Neutron Sources Now and in the Future

Michel Alba, Pierre Monceau
Laboratoire Léon Brillouin (CEA/CNRS), CEA Saclay, F-91191 Gif sur Yvette

The different types of existing neutron sources will be presented: steady state reactors and spallation sources. These two types of sources are available in Europe. The largest existing steady state reactor in Europe is the ILL in Grenoble, which is a European facility. A number of national sources do exist. These facilities are also opened to foreign scientists. A new reactor FRMII will start operation next year in Munich. ISIS in the United Kingdom is the European example of a spallation source. ISIS 2, an upgrade project of this source, is under way. A description of the access to these facilities through the European programs will be given. Presentation of the high-flux sources under construction in the USA and Japan (SNS and J-PARC) will be shortly made.
Magnetism

*Magnetism and High-Temperature Superconductivity*

Joël Mesot
Paul Scherrer Institute and ETH-Zurich, 5232 Villigen PSI, Switzerland.

More than 17 years after the discovery of high-temperature superconductivity (HTSC) in the cuprate perovskites, the role played by magnetism for the pairing mechanism remains an open and fascinating issue. Neutron scattering has become over the years one of the most important technique to investigate the microscopic properties of these compounds and a review of the unusually strong antiferromagnetic excitations observed in several classes of materials will be presented.

Beside the Cu-spin excitations, neutron scattering is also a very powerful method to investigate the vortex phase diagram of superconducting materials, has demonstrated by recent reports of unconventional vortex structures in HTSC.

The emphasize will be put, in both cases, on the possible relations existing between the magnetic and electronic degrees of freedom in these compounds.
Molecular Magnetism

Eric Ressouche
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38054 Grenoble cedex 9, France.

‘Molecular magnetism’ is a branch of material science which has attracted a lot of attention in the last twenty years. The main reason of this increasing interest is for sure the technological importance of magnets. The synthesis of new compounds combining the usual properties of molecular materials such as transparency, low density, solubility, electrical insulation, chirality or bio-compatibility..., to room temperature magnetic properties had become a ‘Grail Quest’ for many laboratories all around the world. Beside this quest, the use of these new molecules as model systems for fundamental physics is also growing up. A great deal of experimental and theoretical work has been recently devoted to clusters, linear chains, or bidimensional systems using molecular compounds.

A fine tuning of the desired magnetic properties in these materials requires however a good knowledge of all the coupling mechanisms, often subtle, involved. In this context, neutron diffraction can play a key role. The most widespread use of this technique is of course the determination of magnetic structures. In such studies, the distribution of the magnetization around magnetic atoms is taken from ab-initio calculations. However, on a sub-atomic scale, neutron diffraction also permits to go beyond this approximation and to investigate this distribution. And because it involves only the highest lying molecular orbitals, the magnetization distribution carries precious information on the electronic properties of the sample such as the nature of the ground state, the effects of the chemical bonds (spin delocalization), the effects of the interactions with neighbors in the solid, the spin polarization effect, and therefore on the different possible coupling mechanisms. In addition, the experimental distribution can be directly compared to ab-initio calculations and can provide a stringent test for theory.

Such an experimental determination of the magnetization distribution requires very precise measurements of the so-called magnetic structure factors, which can be reached using polarized neutrons. During the presentation, an introduction to the ‘classical polarized beam’ technique will be made. The information brought from such experiments on molecular compounds will be discussed through recent examples obtained in this field.
Neutron reflectivity allows to characterise surfaces and interfaces of ultra thin film layered systems down to a nanometric scale (~2 nm). It is especially a powerful tool for the study of magnetic and polymer thin film structures. The neutron magnetic interaction is very large and makes polarised neutron reflectivity a very sensitive tool for probing magnetic multilayers. It allows the determination of magnetic ordering and coupling in new artificial magnetic multilayers (either metallic, semi-conducting or oxides). Examples of studies in the field of GMR (Giant Magneto Resistive) sensors used in hard drive and tape read heads will be given. The search for efficient spin-injection materials which could be used in spin electronics is also a growing field of activity. Several material candidates are presently evaluated. Recent studies on such materials will be presented: oxide materials (Fe2O3 - Fe3O4) epitaxial thin films; multilayer systems involving semiconducting materials ([Fe/Si]n, [GaMnAs/GaAs]).
Biologie

Neutrons, Protons and Proteins.
Dean A.A. Myles
EMBL - Grenoble Outstation, 6 rue Jules Horowitz, BP 181, 38042 Grenoble Cedex 9 France.

Neutron diffraction offers unique advantages for molecular structural biology by enabling key and individual hydrogen atoms to be located in biological structures that cannot be seen by X-ray analysis alone. In the past, the problems associated with the relatively low flux of available neutron beams have restricted such application to only a few projects of specific technical interest. The field of neutron protein crystallography is now undergoing significant development as new detector technologies and parallel advances in molecular biology push the capabilities towards atomic resolution. A new generation of advanced 2-D protein neutron diffractometers are being built worldwide. In Europe, for example, the LADI Laue diffractometer at ILL/EMBL provides dedicated facilities for neutron protein crystallography that allow high-resolution (1.5Å) data to be collected with 10-100 fold gains in efficiency compared with conventional neutron diffractometers. Parallel developments in deuterium-labelling techniques promise additional gains and will allow more sophisticated experiments to be performed. These advances make feasible studies of larger biological complexes and smaller crystals than previously possible. We will review the significant developments in the field and present examples of their application to problems concerning enzymatic mechanism, ligand binding interactions, solvent effects, structure dynamics and their implications. Structure and dynamics of lipid membranes
Structure and dynamics of lipid membranes

Tim Salditt
Universität Göttingen

Lipid membranes composed of lipid bilayers in water with additional membrane-active biomolecules like membrane proteins or peptides are important model systems for different membranes of the cell. Fundamental aspects of how molecules assemble and interact in a membrane can be studied in such systems. In order to gain molecular resolution under physiological conditions of temperature and hydration, we study oriented membranes in the fluid state by neutron reflectivity techniques. While specular reflectivity gives access to the bilayer density profile, the non-specular (diffuse) scattering is used to measure thermal fluctuations, and elasticity parameters (bending rigidity, compressional modulus). We point out specific advantages of neutron reflectivity both in the monochromatic and time-of-flight mode, and discuss technical details of each method. As an example, we show how the methods can be applied to pure phospholipids as well as lipid-peptide mixtures (antibiotic peptide magainin).

At larger momentum transfer in the plane of the oriented membranes, the short range quasi-liquid order between lipids can be measured, reflecting the molecular packing and interactions. Beyond structure, inelastic neutron scattering (INS) can be used to measure the dispersion relation of the collective lipid chain motions [1]. These short wavelength density fluctuations (as opposed to bilayer bending modes) are likely to play a key role in the transport of small molecules across the bilayer, and can also be compared to modern Molecular Dynamics (MD) simulations.

Proteins need thermal energy to reach their equilibrium structure and to maintain their biological function. A now well studied example is the fixation of molecular oxygen by myoglobin: examination of the high resolution structure of this protein shows that no path exist for the dioxygen from the solvent to reach the heme binding site, near the molecule centre [1]. Fluctuations of the molecule create dynamical path to allow oxygen fixation within reasonable time for biological processes. Cold neutron scattering has been a useful tool to investigate the fluctuations of the molecule [2] with the aim to relate it to biological activity.

Another interesting aspect concerns the kinetics of biochemical reactions. Apart the temperature dependence of kinetic constant of the reaction, biochemical reaction can be limited or assisted by the diffusion of the molecules. Diffusion processes become complicated at high molecular fraction which correspond to in-vivo concentrations [3,4]. To obtain a consistent description of the mechanisms one require to combine different techniques probing different times and length scales or even individual or collective behaviors. Therefore, in order to complete the historical macroscopic study diffusion, based on the Fick equations analysis, various techniques has been employed such as Dynamic Light scattering (DLS), Pulsed Field Gradient NMR (PFG NMR), or fluorescence recovery after photo bleaching (FRAP). In all these techniques the characteristic length scale exceed largely the mean intermolecular distance at physiological volume fractions and hence the interpretation is performed in the general frame of the continuity equation. Neutron scattering spectroscopy provide a certain number of advantage with respect to such studies. i: It allows for measurement over both length scale of intermolecular distance and the relevant associated time scales, to measure the generalized diffusion coefficient D(\(q,t\)), ii: both coherent (pair correlation functions) and incoherent (self-correlation function) can be studied, iii: the problem of absorption and multiple scattering are negligible under particular experimental conditions, this is of particular interest for dark protein solutions (like haemoproteins), iii: the high penetrating power of neutron in matter and the H/D contrast variation method provide the capability to study diffusion mechanism directly inside cells.

In a first part, I will present how elastic and quasi-elastic neutron scattering can help in understanding the internal dynamics of small proteins like myoglobin, in relation to oxygen capture. The main part will be on the study of protein diffusion at high volume fraction. Structure and dynamics of highly concentrated solutions can be studied by Small Angle Neutron Scattering (SANS) and Neutron Spin Echo spectroscopy (NSE) [5,6]. It is then possible to study diffusion processes at the scale of intermolecular distance, and to relate them to direct interactions deduced from structural analysis of the solution. I will show some results performed in vitro as a function of the concentration and ionic strength on myoglobin solution. I will also show some results of the study of hemoglobin diffusion inside erythrocytes and how it can help understanding the capture of oxygen at a cellular level.

The molecular motions in polymers may be analyzed with the help of inelastic neutron scattering. Intermediate to large scale motions of polymer chains in melts or solutions are intimately connected to the rheological properties of these systems. Scattering signals that contain the single chain dynamics in the corresponding regime are obtained by h-labelling a few polymer chains in a matrix of deuterated molecules. The dynamics is then observable by neutron spin-echo (NSE) spectroscopy that -as Fourier method- yields the intermediate scattering function $S(Q; t)$ where $Q$ is the length of the scattering wave vector and $t$ the (Fourier-) time. The small angle neutron scattering (SANS) intensity is proportional to $S(Q) = S(Q; t = 0)$. First the established basic dynamical models for polymer chains in melts and solution, i.e. the ROUSE and ZIMM models respectively, will be presented. Longer chains show a deviating behavior due to “entanglements”. The associated effects are consistently described by the reptation model of deGennes. The scattering as well as the connections to the rheology of melts are discussed. Finally a short outlook to the application of inelastic neutron scattering on dense solutions, gels and block-copolymer melts or blends is given. At shorter length scales polymer melts exhibit relaxations that are observed in glass formers ($\alpha, \beta$-relaxations). Neutron scattering (NSE and backscattering spectroscopy) may reveal the associated displacement patterns.
Residual stresses are generally introduced into engineering components during their manufacturing process and also during use. They are quite important as they can have magnitudes when approaching to the elastic limits of components and consequently can substantially affect their performance and fatigue live. For this reason design engineers need to be able to calculate and to measure residual stress fields to ensure the integrity of the components under consideration. Several techniques exist for the evaluation of residual stresses which can broadly be divided into three categories: mechanical, physical and diffraction techniques. Out of these, the only method enabling non-destructive in-depth measurements is neutron diffraction.

Since the beginning of systematic stress analysis using neutron diffraction in the early 1980s, much research has been focused on developing this technique to study bulk residual stresses.

In order to summarize the state of the art of this development, we will give an overview on stress analysis using neutron diffraction techniques. After a brief introduction concerning some definitions and classification of residual stresses we will focalise on their applications in materials science. A special emphasis will be laid on experimental techniques and instruments specifications. The importance of this technique will be discussed and illustrated on several cases with industrial relevance. Concluding remarks will be given on the development of international residual stress measurement standards and future developments.
The use of neutrons to probe phenomena at interfaces
Giovanna Fragneto
Institut Laue-Langevin, 6, rue Jules Horowitz; F-38042 Grenoble Cedex 9, France

Over the last twenty years neutron reflection has emerged as a powerful technique for investigating surfaces and interfaces with a resolution of a fraction of nanometer. The technique offers many advantages with respect to traditional techniques as well as to X-ray reflection. In particular it is non-destructive and can be applied to buried interfaces which are not easily accessible to other techniques. In addition it provides the advantage that isotopic substitution can be used to achieve large contrasts in the scattering length density. Neutron reflection is now being used for studies of surface chemistry (surfactants, polymers, lipids, proteins and mixtures adsorbed at liquid/fluid and solid/fluid interfaces), surface magnetism (ultrathin Fe films, magnetic multilayers, superconductors) and solid films (Langmuir-Blodgett films, thin solid films, multilayers, polymer films). After an introduction to the theory and measurement of neutron reflectivity, examples of applications at solid/liquid interfaces will be given with special emphasis on adsorption of surfactants, proteins and polymers and the study of model biological membranes.
To reach the ECNS2003 Introductory School

The ECNS2003 Introductory school starts at Saint-Rémy-lès-Chevreuse at the Domaine de Saint-Paul on September the 1st, 2003. There is a RER connection from Paris. (RER B4 direction St-Rémy-lès-Chevreuse)

**Arrival at Roissy airport**
You should take the RER B train connection (blue line) direction Saint-Rémy-lès-Chevreuse. The connection is direct. At the station Saint-Rémy-lès-Chevreuse, a shuttle will take care of you on the evening of the 31st of August.

**Arrival at Orly airport**
Take the OrlyVal connection to the station Antony. From there take the RER B train connection (blue line) direction Saint-Rémy-lès-Chevreuse. The connection is direct. At the station Saint-Rémy-lès-Chevreuse, a shuttle will take care of you on the evening of the 31st of August.

**Arrival at the train station Gare de Lyon**
You should take the underground line A (red) or D (green) to station Châtelet les Halles. From there, you should take the RER B train connection (blue line) direction Saint-Rémy-lès-Chevreuse. The connection is direct. At the station Saint-Rémy-lès-Chevreuse, a shuttle will take care of you on the 31st in the evening.

**Note**: The last train leaves Paris from the station Paris-Châtelet-les-Halles at approximately 00h30.

**Arrival at the station of Saint-Rémy-lès-Chevreuse**
The Saint-Rémy-lès-Chevreuse station is very small and there will be signs guiding you to the meeting point. The meeting point is “inside” the station. Our “shuttle” will be operating from 18h00 to 00h00 on the Sunday evening with a service every 20 minutes.

If it is sunny, it is possible to walk to the accommodation place (15’ walk) (see map below)

The key will be available at the Main Gate of the Domaine de Saint Paul (from 18h00 till the last participant arrives)

**I. NOTE**
There is no meals at the Domaine de Saint-Paul on Sunday. For organisation purposes, we are asking you to have dinner on Sunday evening before coming to the Domaine de Saint Paul. A possibility is to have dinner in the pizzeria in front of the train station at Saint-Rémy-Lès-Chevreuse.

**Phone numbers**
In case of emergency, you can call the following number:
06 62 68 88 99 (Marie-Claire Bellissent-Funel)
01 30 85 22 02 (Domaine de Saint Paul)
Domaine de Saint-Paul

1. restaurant
2. accommodation place
   Hotel « Le Pavillon »
9. Conference center

Saint-Rémy-lès-Chevreuse

Main gate
(where to get the key)

Hotel « Le Pavillon »
Conference center

Website :
Additionnal information can be found on the WebSite : www.ecns2003.org