Director's Report

This report presents an overview of the scientific activities of the Laboratoire Léon Brillouin LLB during the 2001-2002 period.

The LLB is a CNRS-CEA mixed research unit ("Unité mixte de recherche" UMR12) funded by the "Centre National de la Recherche Scientifique" (CNRS) and the "Commissariat à l'Energie Atomique" (CEA).

The LLB is a neutron laboratory dedicated to a triple mission:

- Large national facility to perform neutron scattering experiments proposed by external users, including industrial firms, in the best conditions
- Training centre for young researchers, in particular thesis students preparing PhD diploma essentially based on neutron scattering techniques and instrumentation
- Research laboratory with its own scientific activity centred on the use of the LLB facilities and performed by permanent or associated teams.

This triple character of the LLB mission, neutron facility, training centre and research laboratory, leads to an integrated scientific environment for neutron scattering of excellence and the research performed at the LLB is acknowledged worldwide in many scientific fields. The LLB, as the French national neutron facility, benefits from the quality of the Orphée reactor, one of the best neutron steady sources in the world, almost exclusively dedicated to research. Orphée is perfectly run and maintained by the Direction of the Nuclear Energy (DEN) of the CEA.

Neutron beam time: Around 3600 beam time days are delivered per year on 25 spectrometers: 65% for the French community, 22% for CEE countries, 4% for Russia and 5% for ex-PECO countries which will join the CEE in 2004. Six (6) spectrometers benefit from a Collaborative Research Group agreement with Germany (3), Russia, Italy and Austria.

Orphée-LLB and the European Community: The LLB has been selected by Brussels since 1993 in the access programs for large installations. In the framework of the fifth program (FP5) running until February 2004, the LLB delivers 170 days of neutron beam time to the research teams of the CEE and associated countries. Orphée-LLB participates actively in the "Neutron Integrated Initiative" of the sixth EU framework programme for Research and Technological Development (FP6). Aside the access program, several research projects have been defined, two of which being coordinated by LLB researchers.

Research done at LLB is following the main strategic schemes and topmost priorities of the French research agencies, in particular the CNRS and the CEA.

Nanosciences: The LLB uses neutron techniques to bring valuable contributions in the field. Adhesion phenomena, solubilization, chemical reactivity and grafting on nanocomposites, protein interactions are important processes operating at interfaces that can be studied by standard neutron reflectivity whereas polarised neutron techniques probe the magnetic structures of layered devices for the future spin electronics.

Life sciences: The research activities in this field are in constant increase at the LLB. The focus is on protein unfolding and the structure-function relationship in biological systems. Neutron diffusion allows to characterize both the folded and the unfolded states of proteins modified by temperature, pH, chemicals and hydrostatic pressure and can bring important clues for a complete understanding of the factors stabilizing their folded conformation. As for the dynamics at physiological temperatures, the diffusion in protein solutions is very complex due to the rich variety of possible correlations under the influence of concentration or hydration. Neutron spectroscopy is a powerful tool to resolve the protein motions in the time range from picoseconds to tens of nanoseconds (time of flight, backscattering, spin echo techniques), with the help of the large cross section of hydrogen/deuterium atoms. For example, work on myoglobin and haemoglobin, done in biological conditions i.e. at 37°C in very concentrated solutions, is very promising to understand fundamental aspects of oxygen transport.

New projects are developed at the LLB concerning environmental problems, earth sciences, innovative materials for cleaner energies like membranes for fuel cells, Lithium batteries, special steels for new reactors (e.g. the aging behaviour under irradiation).

Industrial developments and technological transfers: The activity of LLB in Engineering Sciences has significantly increased in the last years. Numerous industrial problems were studied, in general within the framework of contracts (Man technologies AC, EADS, PSA and SNCF), or by the means of European programs (in particular TRAINSS). As an example, the residual thermal stresses of Ti-SiC composites have been analysed by neutron diffraction to model their long-term behaviour during in-service operation, as they are considered by SNECMA to be used in a near future for compressor parts in their motors. In 2002, a CEA researcher from the LLB, Alain Menelle was the co-laureate, together with the CILAS company, of the ROCARD prize of the "Societe Francaise de Physique" for his work on technological transfers for supermirror neutron guides.
Instrumental developments at Orphee-LLB: These projects are gathered under the theme CAP2010. The neutron spectrometers must be continuously refurbished and upgraded to be kept attractive at an international level. First, it is proposed to stop the less efficient spectrometers, in particular the G4.4 machine for diffuse scattering, the G4.3 cold triple-axis "VALSE" and the MESS spin echo. The first priority of the LLB is now modernize the high-resolution powder diffractometer 3T2, highly demanded by the solid-state chemistry laboratories. In parallel, the time-of flight reflectometer EROS will be upgraded to face the growing studies on liquid surfaces and interfaces in soft matter and complex systems. We plan to shorten the collimator system in a first step and then move the whole spectrometer to an end position to increase the flux and flexibility. The last project concerns the time of flight spectrometer Mibemol that still performs very well in terms of energy resolution but could benefit of a higher flux. A new time of flight spectrometer is under study, to be placed also on an end guide position. Aside these three major instrumental projects, there is a rising request of large two-dimensional detectors to be financed and built.

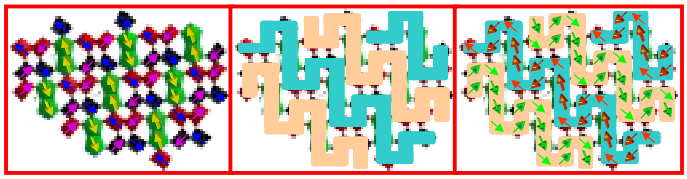
It has been decided to discontinue the LLB users' meeting "Tables Rondes"organized every year before the fall scientific committee. It will be replaced by regular workshops focusing on scientific or technical subjects of interest for the neutron and synchrotron community. The aim is to make of the "Saclay Plateau" a meeting point for complementary techniques as successful on a French stand as in other countries or in Grenoble on a European level with the ILL and the ESRF.

The following pages illustrate the LLB activities in the 2001-2002 period. For each research domain, Structures, Magnetism, Material Science, Liquids and disordered systems, Soft matter and Life sciences, a outline of the LLB scientific activity is presented, focussing mainly on in-house research and close collaborations. Each summary is followed by a few selected recent highlights illustrating the work performed on the LLB instruments by our researchers and the external users. This report contains a new chapter dealing with the theory and modelling of scientific problems related to neutron scattering and data reduction. It is followed by a chapter on instrumentation, a presentation of the LLB activity with statistics summarizing the user activities and a list of publications for 2001-2002.
We are in a stimulating phase when the main European countries, like Great Britain and Germany, develop their national neutron sources while reinforcing their association with the ILL, the European high-flux reactor. The Munich reactor FRMII will soon start and complement the neutron work done at Julich and Berlin. ISIS will invest 100M£ to build a second target station and the related instrumentation. The researchers of the LLB have collaborated closely with all these centres to promote the case of the European spallation source ESS in the last years. Now the spotlight has moved on the SNS, the new spallation source built in the United States, showing that Neutron is an essential technique in many research domains like material science, superconductivity, nanosciences, chemical physics and life science. We heartily hope that ORPHEE-LLB will continue to play a fundamental role in all these domains.

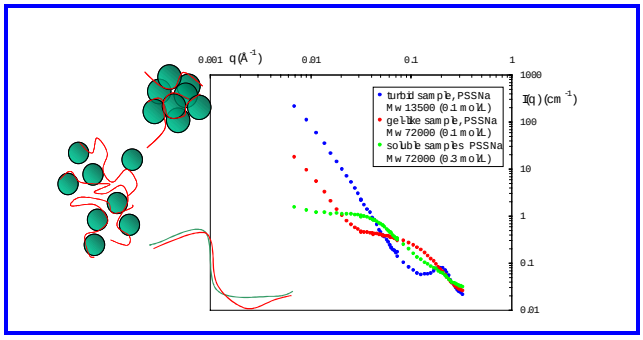
M. ALBA, P. MONCEAU
May 6, 2003

SCIENTIFIC HIGHLIGHTS

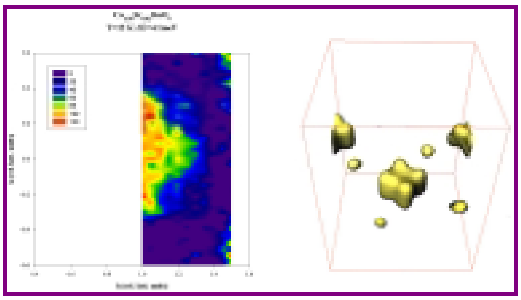
STRUCTURES AND PHASE TRANSITIONS



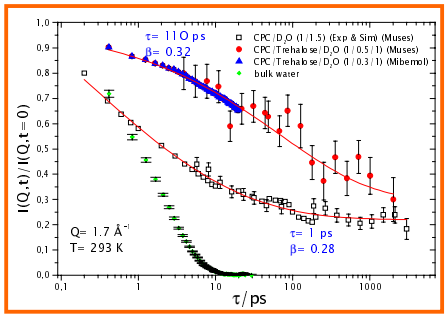
SOFT MATTER AND BIOMATERIALS



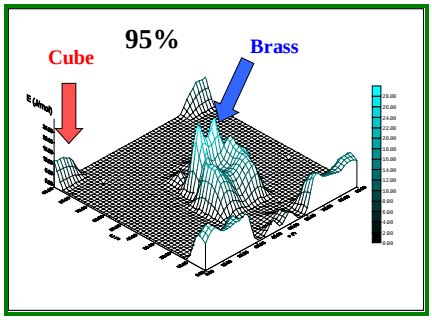
MAGNETISM AND SUPERCONDUCTIVITY



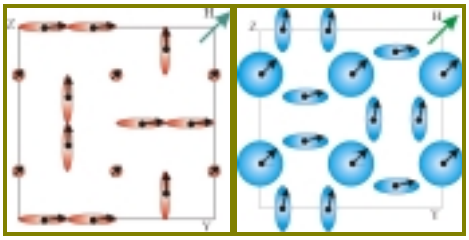
LIFE SCIENCES



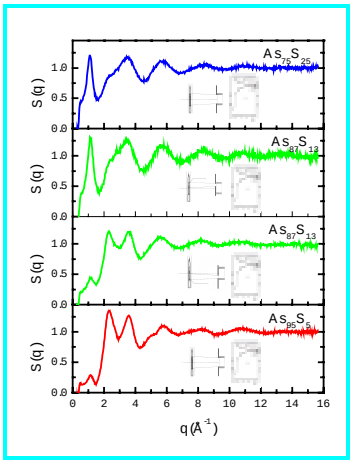
MATERIAL SCIENCE



MODELLING



LIQUIDS AND DISORDERED SYSTEMS



TECHNICAL AND INSTRUMENTAL DEVELOPMENTS