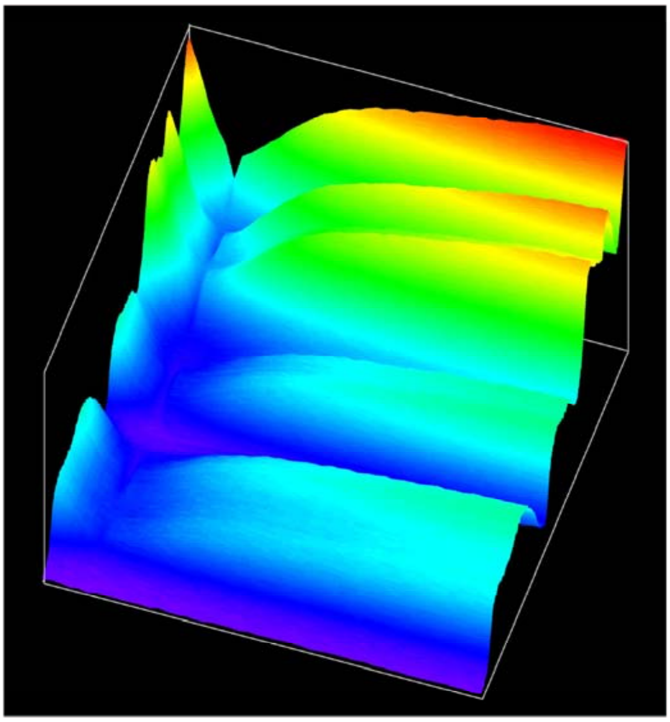
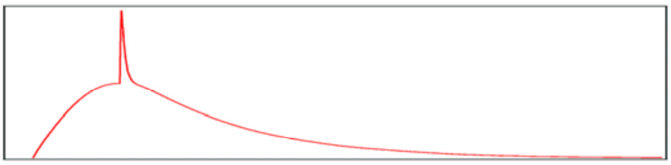
Laboratoire National des Champs Magnétiques Pulsés





Annual Report 2004

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Front page

Absorption spectra sequence of carbon nanotubes in the 75 Tesla coil-in coil-ex pulsed magnet (upper panel). Lower panel shows the field (up to 71 T)- time (up to 200 ms) profile.

Introduction

Before you, you have the 2004 annual report of the Laboratoire National des Champs Magnétiques Pulsés, a mixed research unit between the Centre National de la Recherche Scientifique, the Institut National des Sciences Appliqués de Toulouse, and the University Paul Sabatier of Toulouse.
After a very hectic year 2003, with the completion of the new LNCMP building and the organisation of the Research in High Magnetic Fields Conference, 2004 has been a year of scientific and technical progres and of international recognition.
- The two European infrastructure projet proposals in which the LNCMP is involved as major partner (I3 EuroMagNET) or coordinator (Design Study DeNUF) have been granted by the European Commission. These two projects will fund the external user activities, and scientific and technical developments for a four year period.
- A mobile pulsed field installation, based on a small mobile capactior bank and designed and built by the LNCMP was put into operation on a beamline of the European Synchrotron Radiation Facility in Grenoble. This installation has performed according to specifications and this approach will be further developped in collaboration with the ESRF and other interested parties.
- The in-house magnet development has produced several new magnet types that will find their application in future experiments.
- The in-house scientific activities are continuously increasing in volume and impact and are attracting new external users to the LNCMP installations.
We are therefore looking forward to an even more succesful year 2005.

Geert Rikken, director LNCMP — Toulouse, 17th January 2005

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Magnetism

Personnel involved:

Permanent : J.M. Broto, M. Goiran, B. Raquet, H. Rakoto

PhD students: M. Costes

Postdoc : R. Klingeler

Magnetic and/or electronic transport properties of low dimensional magnetic systems :

High magnetic fields allow through magnetization measurements (traditional or by magneto-optics in the case of thin layers) for direct probing of the fundamental state of a system, which can be related to quantum fluctuations for low spin systems and more generally to magnetic frustrations.

Vanadates :
Collaborations P. Millet, Fabienne Duc (CEMES) F. Mila (EP Lausanne), A. Stepanov et A. Ghorayeb (L2MP, Marseille)
In the case of the η phase of the NaV_2O_5 system, we have measured the spin gap value appearing in the vicinity of 40K by 50T magnetization measurements. EPR experiments up to 36T show that the lowest energy state of the triplet is the fundamental state of the system. Magnetization curves reveal the presence of a plateau at M_{sat} /9. These experimental results are in agreement with the crystallographic structure determined by F Duc et al.
We have also studied the properties of the $Na_2V_3O_7$ compound, which has a tubular structure with a diameter of the order of 0.5 nm. With EPR measurements, we attempt to probe the Dzyaloshinsky - Moryia interactions expected in this system.

Cuprates :
Collaborations E. K Arushanov (Kishinev), V. Kataev (IFW Dresden), C. Deville (ESPCI)
In the bulk single-crystal $CaCu_2O_3$, the EPR signal under high magnetic field comes from a small proportion of uncompensated spins strongly coupled to the anti-ferromagnetic network. The data show that these uncompensated spins are involved in the anti-ferromagnetic order below T_N = 25 K. The study of the EPR frequency-field diagram makes it possible to highlight a gap for the magnetic excitations of about 0.3meV below T_N. This low gap value explains the existence of the spin flop transition observed at low magnetic field (B_{SF} ~3 Tesla).

Magnetic properties of the quasi 1D systems of the type A'_3ABO_6 :
Collaborations: A. Maignan (CRISMAT), Mr. Novak (UFRJ)
A'_3ABO_6 systems with A' = Ca, Sr... With = Co, Fe, Ni, Cu, B = Co, Ir, Rh, Pt, Ni, Ru, are composed of ABO_6 chains separated by A' cations, which give them a strong one dimensional character. We study more particularly the compound $Ca_3Co_2O_6$, Sr_3NiIrO_6 and Ca_3CoIrO_6. The low dimensionality and the presence of frustrations in these systems imply the stabilization of a frozen state at low temperature characterized by important dynamic effects. Measurements of magnetization, on non-oriented powders, highlight an extremely abrupt jump at high field and low temperature which could be related to a reversal of magnetization controlled by magneto caloric effects. The study of dynamic susceptibility at low temperature makes it possible to reach the relaxation times; the values we obtain are of the order of the relaxation times for super-paramagnetic systems.

Surface magnon in nano-structured ferromagnetic systems :
Collaborations : M. Viret (SPEC- CEA), D. Ravelosona (IEF)
Surface magnons are collective spin excitations which induce in particular spin-flip scattering in devices with giant magneto-resistance like ferromagnetic tunnel jonctions. However, very few techniques exist to investigate their energy spectrum. By measurements of magneto-transport under intense magnetic field on ultra-thin ferromagnetic layers, it is possible to probe the electron-magnon scattering and the magnon damping under magnetic field. The first measurements carried out on the Pt/Co(0.8nm)/Pt system indicate an electron-magnon scattering very different from the one observed in bulk Co. The study is in progress to characterize the surface effects on the spin excitations in the ultra-thin layer.

Individual Nano-objects

Personnel involved:

Permanent : J.M. Broto, M. Goiran , B. Raquet

PhD students : B. Lassagne, Ch. Power , M. Sagnes

Postdoc: G. Fedorov

Invited: J Gonzalez

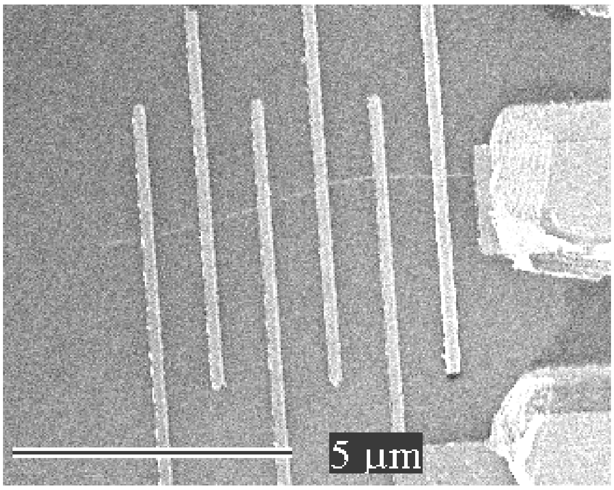
Electronic transport properties of individual carbon nanotubes :

Our activity consists of the study of quantum transport in isolated carbon nanotubes (single, double walled and next, multi-walled) with magneto-transport experiments in an extreme environment combining intense magnetic field (60T pulsed) and large range of temperature (300K-2K).

The application of a magnetic field makes it possible to probe the conduction modes and the quantum effects related to the electronic confinement or interference phenomena of the electronic waves functions along the circumference of the tube.
The implementation of this work requires the control of various processes : synthesis of nanotubes, their purification, and finally their nano-manipulation with their electric nano-connection. We set up collaborations with teams recognized on the international level in the fields of the growth of carbonaceous materials, characterization and nanotechnologies (CIRIMAT, CPAT, LAAS, CEMES, LPST) as well as numerical simulation (CEA DRFMC). Our program is supported by the ministry through the financing of an ACI Nanoscience (NOCIEL) which we coordinate.

Our last work concerns the realization of nano-electronic devices based on a double walls nanotube (DWNT), on which we can modify electronic conduction by the application of a gate voltage through the insulating substrate. Our results of electronic transport combining gate effects and magnetic field up to 50 Tesla highlight the competition between quantum interferences related to the disorder and the magnetic field induced modulations of the density of electronic states. These results are in the course of publication. Work continues on individual SWNT and MWNT on which we combine magnetic field effects, electrostatic doping and characterization of the same nano-object by μ-Raman spectroscopy (collaboration LPST).

Within the framework of the ACI, the study of filled and hybrid nanotubes are in progress. We will first study DWNTs filled with PbI_2, a lamellar semiconductor in the bulk state. If it is difficult to predict the effects of the interactions between the carbon tube and its contents, it is clear that the reduction of the dimension of material in the range of the nanometer could stabilize new crystallographic structures. Electronic confinement may also modify the electronic structure and the modes of conduction. Preliminary Raman experiments and optical absorption (up to the near-infrared) under isostatic pressure have been performed in the frame the visit of Pr J Gonzalez, invited researcher in our laboratory, and in collaboration with the LPST. Others hybrid nanotubes will be studied, like the peapods and nanotubes filled with Se, Te and Fe.



SEM picture of CNT (horizontal) on contact array

Organic conductors

Personnel involved:

Permanent : A. Audouard, L. Brossard (until 1/7/2004), E. Haanappel, M. Nardone and D. Vignolles

PhD students : E. Perez

Invited : J.Y. Fortin, W. Kang

Frequency combinations in coupled orbits networks:

Collaborations: ICMaB (E. Canadell, V. Laukhin); Institute of Problems of Chemical Physics, Chernogolovka (R. Lyubovskaia, R. Lyubovskii, T. Prokhorova, E. Yagubskii); LPT, Strasbourg (J.-Y. Fortin); GHMFL, Grenoble (I. Sheikin). Supported by CNRS-RAS (project 16390) and CNRS-CSIC exchange programs.

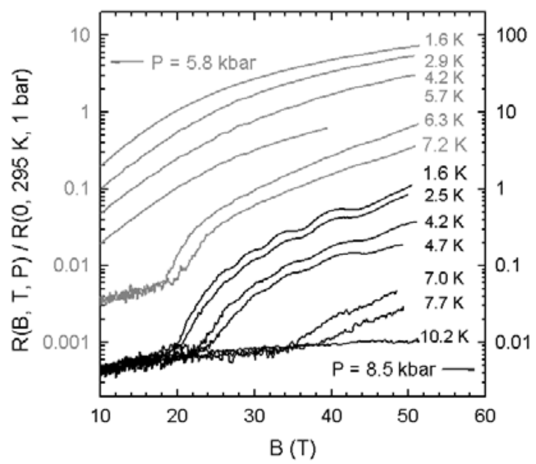
Simultaneous measurements of the interlayer magnetoresistance and magnetization of the quasi-two dimensional (q-2D) compensated organic metal $(BEDT\text{-}TTF)_8Hg_4Cl_{12}(C_6H_5Br)_2$ have been performed for various directions of the magnetic field. Shubnikov-de Haas (SdH) and de Haas-van Alphen (dHvA) oscillations spectra exhibits frequency combinations typical of networks of orbits coupled by magnetic breakthrough (MB). Even though some of the SdH oscillations cannot be interpreted on the basis of neither conventional MB orbits nor quantum interference, the temperature and field orientation and magnitude dependence of all dHvA spectra's Fourier components can be consistently accounted for by the conventional Lisfhitz-Kosevich (LK) model. This result is at variance with data for electronic multiband Fermi surfaces (FS).

Further development: We will study the relationship between the topology of the FS tuned by hydrostatic pressures of up to 12 kbars and the ground state (superconducting or metallic) of the organic metals β”-$(BEDT\text{-}TTF)_4(NH_4)[M(C_2O_4)_3]\cdot DMF$ (M = Fe^{3+}, Cr^{3+}). We will also study frequency combinations and deviations from LK behaviour at high field and low temperature in $(BEDO\text{-}TTF)_5[CsHg(SCN)_4]_2$.

Fast oscillations of the magnetoresistance and spin density wave in Bechgaard salts:

Collaborations: Ecole Nationale Supérieure de Chimie de Montpellier (S. Bouguessa, J.-M. Fabre), Ewha Womans University, Séoul (W. Kang).

The interlayer magnetoresistance of the Bechgaard salt $(TMTSF)_2NO_3$ has been investigated up to 50 teslas. This compound, the FS of which is q-2D at low temperature, is a semi metal under pressure. Nevertheless, a field-induced spin density wave (FISDW) is evidenced at 8.5 kbar above ~ 20 T. This state is characterized by a drastically different spectrum of the quantum oscillations compared to the ambient pressure spin density wave state. In contrast, $(TMTSF)_2FSO_3$ did not exhibit a FISDW in pressures of up to 12 kbars.



Further developments: Experiments in dilution fridge are planned in order to get more insight on the (B, T, P) phase diagram of $(TMTSF)_2NO_3$ and to evidence an eventual FISDW cascade.

High T_c superconductors

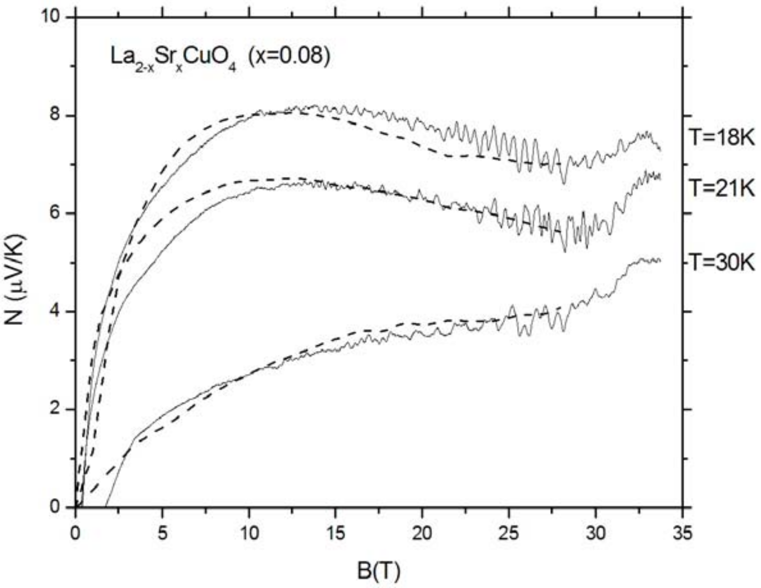
Personnel involved:

Permanent: E. Haanappel, M. Nardone, C. Proust and L. Rigal

Invited : S. Vedeneev

Nernst Effect *(C. Proust, L. Rigal)*

During this year, the Nernst effect setup has been intensively tested under pulsed magnetic field up to 35 T. To achieve these tests, we have measured a well characterized $La_{2-x}Sr_xCuO_4$ (x=0.08) sample. We finally succeeded to overcome all the technical problems such as pickup voltages, mechanical vibrations and we have reproduced some data obtained in DC magnetic field up to 28T (see Fig. 1). The next step is to extend this measurement up to 60 T in a new 3 MJ coil where vibrations and pickup voltages will be more challenging in terms of signal-to-noise ratio. We plan to measure the Nernst effect and the thermopower, in collaboration with K. Behnia (ESPCI, Paris), in three $La_{2-x}Sr_xCuO_4$ samples at different doping levels.



Nernst coefficient of $La_{2-x}Sr_xCuO_4$ (x=0.08) measured in pulsed magnetic field (solid lines) at different temperatures. The low field data were obtained in DC magnetic field at Grenoble (dash lines).

Collaborations (*C. Proust, M. Nardone, E. Haanappel)*

Two sets of experiments have been performed in collaboration with:

- S. Vedeneev (Lebedev Institute, Moscow) with whom we performed magnetoresistance measurement up to 55 T and down to 0.4 K in $Bi_2Sr_2Cu0_{6+\delta}$ for magnetic field applied parallel to the conducting planes. The paramagnetic limitation of superconductivity is proposed as an explanation of the observed behavior (submitted to PRB).

- L. Taillefer (Université de Sherbrooke, Canada) for whom we have measured the normal state resistivity (H_{c2}~50 T) of an ultra clean $YBa_2Cu_3O_{7+\delta}$ (δ=0.5) sample. The results indicate that the impurity level takes a major role for the so-called *metal-insulator* transition in cuprates (to be published).

Thermal conductivity *(C. Proust)*

In collaboration with K. Behnia (ESPCI), we have tested the Wiedemann-Franz (WF) law in underdoped $Bi_2Sr_2Cu0_{6+\delta}$ samples at 25 T (LCMI) in the sub-Kelvin temperature range. The data show a clear deviation from the expected value given by the WF law. However, we have noticed that this violation can also be correlated to the level of disorder of the sample. It is thus difficult to distinguish if the origin of this violation is electronic and/or disorder-induced (to be published).

Magneto-optics

Personnel involved:

Permanent: G. Rikken, O. Portugall, R. Battesti (since 1/9/2004)

PhD students: S. Batut (starting 1/10/2004)

Invited: J. Kono (Rice University)

Magnetic birefringence of the vacuum

The quantum vacuum is not just "nothing" but has non-trivial optical properties, as predicted by quantum electrodynamics. One particular prediction from Heisenberg and Euler is that under an applied magnetic field, the vacuum becomes birefringent, similar to the Cotton-Mouton effect in materials. This effect has never been observed experimentally, due to the fact that the predicted order of magnitude is extremely small. In a joint long term project with the Laboratoire Collisions, Aggregats et Réactivité (LCAR, Prof. C. Rizzo), a setup is under construction to measure this effect. It consists of a polarimeter based on a very long, high finesse Fabry-Perot resonator, inserted into a long, oscillating field pulsed magnet with the field perpendicular to the axis. In 2004, the LCAR has assembled the resonator, whereas the LNCMP has completed the necessary pulsed field generator, has built and tested prototype magnets and has improved the coil design.

Magneto-electric anisotropy

Applying crossed electric and magnetic fields to a medium makes it anisotropic along the axis perpendicular to the two external fields. This phenomenon is called magneto-electric anisotropy and was recently observed in optical absorption experiments. We have shown theoretically that this effect should also manifest itself in any form of diffusive transport, and have succesfully performed electrical transport measurements on field effect transistors to experimentally verify this prediction.

MFISHG

Second harmonic generation (SHG) of light is forbidden in isotropic media, like gases or liquids, and only occurs in certain crystal classes. Applying an electric field to an isotropic medium makes SHG allowed. This phenomenon is used to create artificial SHG active media, and to measure the hyperpolarisability of molecules (electric field induced SHG, EFISHG). Theory predicts that applying a magnetic field does not induce SHG, unless the medium is chiral (magnetic field induced SHG, MFISHG), but so far no experiments have been done.
At the LNCMP, a setup has been constructed to investigate MFISHG. The optical part is completed and the first measurements have been performed with a small 2 Tesla electromagnet. A high field, pulsed split coil magnet is under construction and will soon be put into operation.

Magneto-optical spectroscopy of carbon nano-tubes

The electronic wave-functions of carbon nano-tubes in an applied magnetic field are subject to competing phase coherence requirements imposed by the tube circumference on one hand and the enclosed magnetic flux on the other hand. The Aharonov-Bohm phase associated with the latter lifts the degeneracy between quasi-classical orbits with opposite sense of revolution. The respective splitting of energy levels was clearly resolved for the first time by means of interband-absorption measurements on liquid suspensions of carbon nano-tubes in fields up to 71 T. The obtained results (see front page) also gave evidence for the dynamic alignment of nano-tubes, that manifests in both the amplitude and splitting of absorption peaks.

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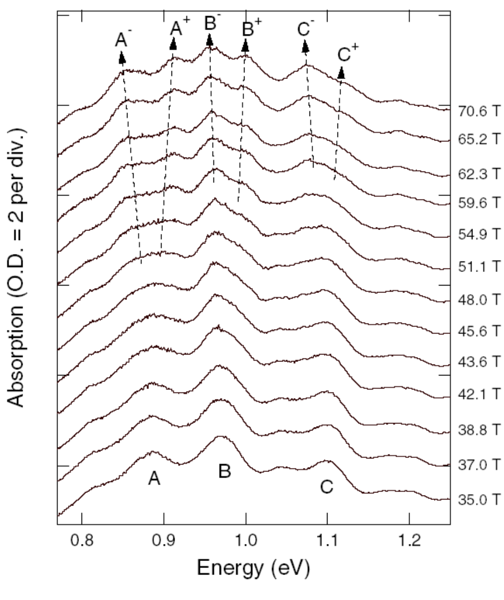


Polarized light absorption spectra of micelle suspended CNT

Semiconductors

Personnel involved:

Permanent: J. Leotin

PhD students: O. Drachenko

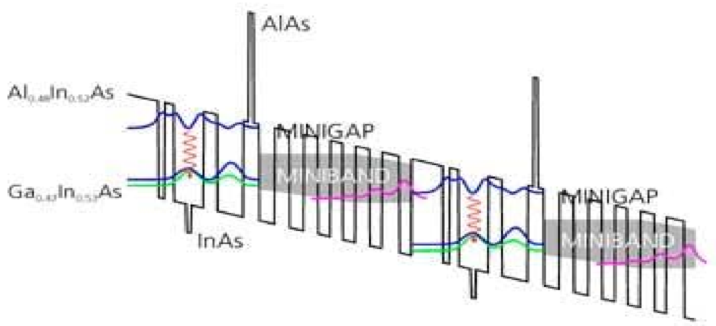
Invited: V. Rylkov (Kurchatov Institute)

Spectroscopie infra-rouge en champ magnétique pulsé

Relaxation inter sous-bandes dans des puits quantiques $In_{0,77}Ga_{0,23}As$/ InAlAs.
Dans ces puits quantiques d'alliages, les modes de phonons émis dans la relaxation inter sous-bandes, du type modes confinés d'interface, modes d'alliages du puits ou de la barrière, sont très mal connus. La résonance magnétophonon inter sous-bandes offre le moyen de les identifier dans une structure de laser à cascade quantique. Elle se traduit par des oscillations en champ magnétique de l'intensité du laser. Les résultats en cours d'analyse montrent que dans cettesrtucture pauvre en gallium, le mode inattendu du phonon LO de GaAs domine dans la relaxation. La structure été élaborée au TU de Berlin par M. Semtiv et al, associé à ces travaux.

Détection Optique de Résonances en champ magnétique pulsé.
Le projet JRA-EuroMagNet se bâtit à partir de la mesure en champ pulsé de variation des spectres de photo-luminescence avec une excitation dans le domaine THz. La détection couvrant la gamme 0,7 – 4 eV est réalisée à l'aide de deux spectromètres multi-canaux rapides. L'excitation dans la gamme 10-100 meV se met en place avec des lasers à cascades quantiques.

Spectromètre compact de Résonance Cyclotron excitée par des lasers à cascades quantiques
Nous avons mesuré la résonance cyclotron des électrons d'une couche mince InSbAs /GaAs excitée par un laser à cascades quantique GaAs/GaAlAs et détectée par un détecteur Si :B à bande d'impuretés bloquée, tous deux placés près de l'échantillon, dans le même cryostat. L'effet d'alliage avec l'arsenic sur la masse effective et la largeur de raie est en cours d'analyse.



Bandstructure of a quantum cascade laser.

Spectroscopie de photoluminescence de boites quantiques auto-organisées InGaAs/GaAs
La spectroscopie de photoluminescence en champ pulsé jusqu'à 73 T est un atout important pour analyser le spectre d'énergie des boites quantiques InGaAs/GaAs. Dans cette expérience, le contrôle de la population des paires électron-trou par la puissance d'excitation optique nous a permis de remplir successivement les couches d'états jusqu'à une population de 12 paires par boite. L'application d'un champ magnétique lève la dégénérescence des couches et permet d'identifier l'état fondamental et les états excités. De plus, elle offre de données pour caractériser les interactions du système électron-trou confinés à 0D.
Nous avons mis en place une spectrométrie rapide fournissant un spectre toutes les millisecondes. La bobine ARMS a permis d'atteindre 73T. La mesure est basée sur le guidage par fibre optique du signal de luminescence excité par une diode laser pulsée vers des spectromètres multi-canaux Si ou InGaAs.
L'analyse des donnés montre qu'un modèle simple de confinement à deux bandes paraboliques pour les électrons et les trous explique étonnamment bien l'essentiel de nos résultats. On retrouve les états de Fock-Darwin d'une particule chargée confinée dans le potentiel parabolique 2D engendré par le champ magnétique, sans signature particulière d'effets de corrélation électron-trou. Les masses effectives ajustées pour les électrons et le trous sont respectivement $0,067m_0$ et $0,341\ m_0$. Le clivage de spin n'est pas introduit ici car il n'est pas résolu dans nos données expérimentales.

Disordered systems

Personnel involved:

Permanent: J. Galibert

Invited: V. Ksenevich (Belarus State University), R. Rosenbaum (Tel Aviv)

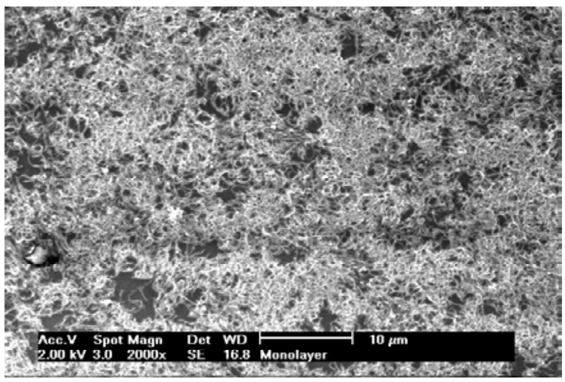
Transport in self assembled metallic nanocristal films .*(J. Galibert, V. Ksenevich)*
We study magneto-transport in self-assembled films of metallic nanocrystals, like Co and Pt, with typical particle sizes of 10 nm and particle separations of 20 nm. We observe indications of weak and strong localisation and Coulomb charging.

Transport in self assembled multi-walled carbon nanotube networks
In the context of an INTAS project, we develop new methods for the preparation of self-assembled multiwalled carbon nanotube networks and we study their optical and transport properties. The participants are

EPFL Co-ordinator	Prof. L. Forró	Institute of Physics of Complex Matter, FBS Swiss Federal Institute of Technology (EPFL), CH-1015 Lausanne Switzerland
LNCMP (CNRS, INSA,UPS)	Dr. J. Galibert	The National Pulsed High Magnetic Fields Laboratory, Toulouse, (LNCMP) France
INP	Prof. S.A.Maksimenko	Institute for Nuclear Problems, Minsk, Belarus
BSU	Dr. V. Samuilov	Belarus State University, Minsk, Belarus
HTMI	Prof. S. Zhdanok	Heat and Mass Transfer Institute, NASB, Minsk,Belarus
NSTU	Prof. O.Kibis	Novosibirsk State Technical University, Novosibirsk, Russia

Extraordinary transport properties of polycristalline bismuth films .*(J. Galibert, R. Rosenbaum)*

The electronic transport properties of a polycrystalline (3420 Å thick) bismuth film have been measured over a wide temperature interval (0.23 K $\leq$ T $\leq$ 292 K) and a magnetic field range (0 T $\leq$ B $\leq$ 25 T). The results for the polycrystalline film are very different and anomalous with respec to those of an epitaxial thin bismuth film. The zero field resistance increases by a factor of five. The magnetoresistance (MR) values in perpendicular magnetic fields have the same magnitude at low temperatures as compared to the MR values at room temperature. The Hall coefficient data in perpendicular fields show oscillations at liquid helium temperatures; there should be no Shubnikov-de Haas oscillations in a polycrystalline bismuth film. The sign of the Hall coefficient at room temperature is positive in small fields and becomes negative in large fields. In contrast, the Hall coefficient is always negative in thick bismuth films. The magnetoresistances in parallel magnetic fields show maxima at intermediate fields followed by decreases at high field values; in theory there should be a small or no MR in the parallel field orientation. Quite anomalous are the large Hall voltages and Hall coefficients in parallel magnetic fields; the parallel Hall data also have oscillations at low temperatures. The magnetoresistance in transverse fields is anomalous and can be explained by strong diffuse boundary scattering at the top and bottom surfaces of the film. Acceptable fits to most of the transport data are obtained using the two-carrier expressions of Pippard and of Fawcett and using the Drude expression.



SEM picture of CNT network

Magnet production, research & development

Personnel involved:
Permanent: O. Portugall, P. Frings, J. Billette

PhD students: S. Batut (starting 1/10/2004)

Eight user magnets have been available for scientific research projects in 2004:
- four 40 T Cu-magnets with 26 mm bore
- two 58 T Cu-Zylon magnets with 26 mm bore
- one 58 T Cu-Zylon magnet with 11 mm bore
- one 58 T Cu-SS (stainless steel) magnet with 11 mm bore

One of the wide bore Cu-Zylon coils and the Cu-SS magnet have failed at the end of 2004 and will be replaced at the beginning of 2005.
The 77 T ARMS magnet has been successfully integrated in the user program until the failure of the coilex in october 2004. A replacement is scheduled for the first half of 2005.
Advanced magnet design activities have been focussed on two basic issues, the improvement of standard user magnets and prototype studies of magnets serving special purposes. Projects aiming at the improvement of standard user magnets are concerned with:
Aging: Advanced computer codes permit reasonably accurate predictions of the maximum performance of a magnet but not of its lifetime. To study the mid- and long-term effect of material fatigue, endurance tests with small model magnets have been performed throughout 2004. Changes in material properties were studied in two ways: by monitoring the resistance evolution of magnets during testing and by dissecting and analysing coils subjected to different long-term treatments. In the latter case the local resistivity and micro-hardness of wire samples as well as visible degradations of the magnet insulation were analysed. (In-house)
Optimized current and reinforcement distribution: Cu-SS wires with different cross section and SS-content are used in the same coil to even out the force distribution. The project makes use of the laboratory's ability to custom-tailor Cu-SS wire. A design based on finite element calculations has been worked out. Production of the first full-scale prototype coil is scheduled for the first half of 2005. (In-house)

Mini coils in different phases of testing. Left : original shape. Center : significant plastic deformation due to magnetic pulse. Right : Overloaded coil

Projects focussing on special purpose magnets are:

Split-coil magnet: The test installation developed for aging studies also provides a useful tool for the design of advanced pulsed magnets serving special purposes. In 2004 this installation was used to test a first split-coil magnet with 11 mm bore and 6 mm radial access, which achieved 29 T before failure. The development of split-coils opens up new possibilities for magneto-optical, x-ray (see also report on the ESRF-project) and neutron scattering experiments. (In-house)
Pulsed dipole magnet: A 250 mm long prototype has been tested up to 9,5 T. The magnet has failed during an attempt to reach 10 T due to a weakness in the external reinforcement shell that is not intrinsically related to the magnet construction itself. This magnet development is part of a research project to investigate the vacuum magnetic birefringence in collaboration with LCAR, Université Paul Sabatier, Toulouse.
Thumb-coils: A 1 kJ generator has been set up that permits the operation of coils featuring bore sizes of 2-4 mm and outer dimensions of typically 20x20 mm. The miniaturization offers a broad range of possibilities including the operation in liquid helium, the fabrication of high-field inserts for coils with 26 mm bore, the generation of oscillating fields in the 20 T range, the use and testing of small samples of advanced wires such as CuNb nano-filamentary wire and the simple testing of different coil-types such as thin-foil or poly-helix magnets. (In-house)

Reinforced conductors

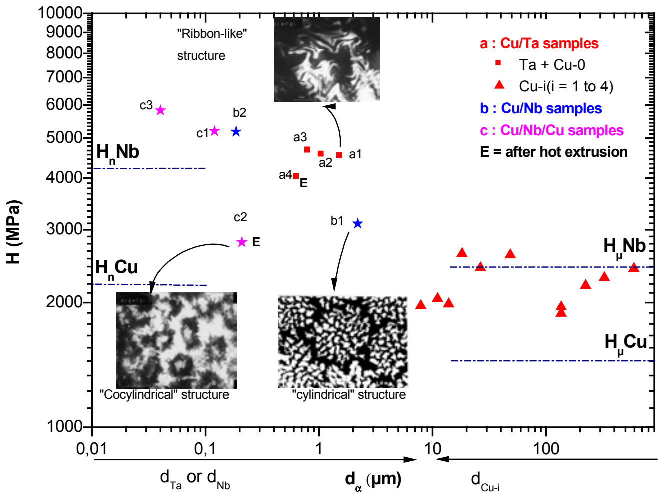
Personnel involved:

Permanent: F. Lecouturier, N. Ferreira, J.M. Lagarrigue

PhD students: V.Vidal

Copper/stainless steel macrocomposite conductors used in the winding of the 60T magnets have been produced in order to insure the availability for the users magnets. Nevertheless, in order to optimize the magnet life, we proposed to study the influence of the drawing process on the aging of the conductors submitted to high stress and low temperature during the magnet operation. For this purpose, we have drawn several batches of Cu_{60}/SS_{40} with drawing strain ranging from 65% to 85% and aging tests will be performed using the mini-coil configuration in the next coming months.

Cu/X (X=Nb, Nb/Cu, Ta) nanofilamentary high strength conductors for high field magnet over 80T are under development. The Cu/Nb nanofilamentary structures has been extensively studied , and led to the optimization of the metal used as reinforcement (Ta) and geometry (Nb nanotubes filled with copper nanowhiskers). Transmission Electron Microscopy observations have been carried out at the LMP (Poitiers), to study the microstructure of the Cu/Ta and Cu/NbCu nanocomposites. Mechanical properties information provided by the nanoindentation technique have been performed and allow for the analysis, in the nanometre scale, of the mechanical properties in terms of size effect. These results are compared to those obtained with the Cu/Nb nanofilamentary wires in the following figure: they evidenced that the more effective strengthening is obtained with the co-cylindrical Cu/NbCu nanostructures.
Nevertheless, theses wires suffer from frequent internal fractures of the hard Cu/Nb or Cu/Ta core brought about by the drawing conditions. In order to obtain several meters of continuous lengths of wires without defect, efforts have been made to study the influence of the drawing conditions (reduction area by drawing pass, die angle, drawing speed.) on the occurrence of the central bursting defects. Several meters (>10 meters) of Cu/NbCu have been obtained in the step with 85^3 fibers without any defect, and rectangular sections have also been successfully obtained. These parameters will be applied to the step 85^4, and depending on the results, we will upgrade or not the billet size.
Through a collaboration with the LMP, we will also investigate the repartition of the elastic and plastic deformation between the copper matrix and the Nb nanowhiskers, and the fracture mechanism at the microscopic level by means of X-ray tensile tests . The results will allow us to optimize parameters for the internal geometry of the wire as well as for the drawing process.



Plot of ultimate tensile strength of composite conductors vs.size of reinforcement component

14 MJ Generator

Personnel involved:

Permanent: P. Frings, B. Griffe, L. Drigo, J. Marquez

Since it was put in operation (2000), the 14 MJ generator has been functioning satisfactorily. During 2004 the main weak spot of this generator, the analogue control of the charging units, has been successfully replaced by a digital version.
The replacement of the analogue control had highest priority because the analogue system has been a source of problems since the beginning and most importantly it has become a big risk for the continuity of the operation after the disappearance of the company that produced the whole system. In case of a major breakdown no possibility of quick repair would have existed, as the spare unit was not delivered in a working state. Another advantage of the conversion to digital control is that it allows to replace about 100 copper wires with one glass fibre cable and to improve the galvanic separation between the control room and the HV room.

The projects in the next year are dictated by the increased utilisation of the generator by an increasing number of outside users. The following projects are foreseen:

- increase of the safety by a further reduction of galvanic connections with the high-voltage room
- increase of productivity by reduction of charging times (possible to gain a factor of two in the most used configuration, after rearranging the chargers) and replacing the electric drives for the power switches by pneumatic ones (this reduces the time to switch boxes or polarity from 2 minutes to 2 seconds)
- implementation of a logging system that will account the number of pulses made by every user and at the same time provide a reliable history of the life of a coil
- various additions and improvements to the control system in order to make it even more user friendly and "fool" proof

The increased use of the installation starts to interfere with maintenance and repair operations and therefore some systematic maintenance period has to be foreseen in the future (style in-house use, availability not guaranteed).

The highest field coils will not only be limited by mecanical constraints, but also by thermal ones. The latter can be alleviated by going to shorter pulses. In the mid-term future, an extension of the generator to allow ~2 MJ short pulses (typically 10 ms) has to be foreseen.

Mobile pulsed field installation ESRF

Personnel involved:

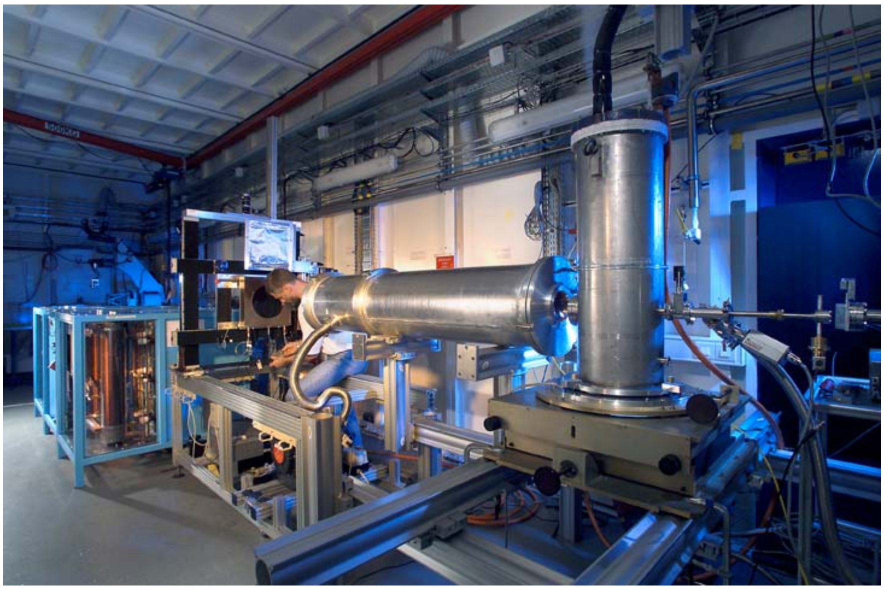
Permanent: P. Frings, J. Billette, M. Nardone, B. Griffe, L. Drigo, J. Marquez

The laboratory has been actively involved in a project to combine pulsed magnetic fields with an intense X-ray source. The expertise available in the laboratory allowed to build a 30 T pulsed magnet, primarily for repetitive use in a cryostat adapted to the requirements posed by X-ray scattering experiments. Moreover, the experience in building a transportable capacitor system for an European cooperation with the University of Amsterdam, allowed us to quickly provide a transportable energy source that fulfilled the strict safety requirements imposed by a large installation as the ESRF. Finally, part of the samples were proposed via a long term visitor of our laboratory.

The experiment, performed by a joint team of the LNCMP, ESRF, CNRS Grenoble and KU Leuven, was a technical success. The magnet and the power supply functioned as foreseen, there was no interference between the pulsed field and the synchrotron electron beam or the detector system. In total more than 250 pulses were done at fields of 20 T and more than 50 pulses at 26 T (the physics did not require to go to higher fields).
The pulse time of the magnet was adequate but, as expected, the duty cycle of the magnet limited severely the time one could obtain spectra at the highest field. One second measuring time at the highest fields requires currently a number of pulses and cooling periods that sums up to approximately 8 hours experiment time.

Even with all these limitations, as is normal for a pilot experiment, we were able to obtain useful spectra at 20 and 26 T. Unfortunately the conclusion of the experiment was that the magnetostriction on the Mn_{12}-acetate sample at 77 K was zero within the resolution of 0.010 Å.

Since the feasibility of this technique has been proven, further experiments are being planned. The experimental conditions will be made more favourable by choosing a more adapted sample, going to lower temperatures and adapting the detector to the required high energy X-rays.
Once these experiments successfully carried out, we will start designing a pulsed field system more tailored to the specific requirements of the ESRF (shorter cooling time, higher charging power, wider access, radial access coil)



Picture of mobile pulsed installation at ESRF. Far left, the generator, right of center the coil cryostat

User facility activities

The LNCMP is operating many magnet sites on which various types of experimental set-ups are available and which are open to the French and international scientific communities. The description of these installations can be found on our web site (www.lncmp.org). Since 2002, scientists who wish to obtain access to the pulsed field installation and the scientific infrastructure around it, must submit an application. The proposals are divided in four scientific themes: *Magnetism, Semiconductors, Metals and Superconductors* and *Magnetic Resonance and Others.* These applications are evaluated by an independent external programme committee twice a year on their scientific merit and feasibility.

During the two sessions of 2004, a total number of 53 applications have been submitted and accepted (25 during the first semester and 28 during the second one). These applications correspond to 879 days asked by and attributed to the users on the 7 available magnet sites. According to the type of magnet used (from 75T-14 MJ to 40T-1.2MJ) the number of shots at the maximum magnetic field value can vary from 3 to 6 per day.

The repartition of the proposals by scientific topic in 2004 was the following:
Magnetism: 13
Semiconductors: 11
Metals and Superconductors: 21
Magnetic Resonance and Others: 8
82.5% of these applications came from external users, and of these, 34% were from French laboratories and 66% from other European or international laboratories.

As the LNCMP has just been recognized as European user facility, starting 2005, the European Community Transnational Access contract (part of the Integrated Infrastructure Initiative EuroMagNET) will allow to reimburse part of the travel and living expenses of external applicants coming from European Community countries and associated ones (Bulgaria, Iceland, Israel, Liechenstein, Norway, Romania, Switzerland).

User facility activities: 2004 proposals list.

(Listed as: Title , affiliation and applicant name. * correspond to 2nd semester proposals.)

Magnetism

1- *High field intergrain tunnelling magnetoresistance in ceramic magnetic oxides.*
Departamento de Fisica Materia Condensada-ICMA
Facultad de Ciencias. Universidad de Zaragoza-CSIC. Pza. San Francisco, Zaragoza 5009, Spain.
Dr Pedro A. Algarabel

2- *High field magnetization studies of highly frustrated antiferromagnets.*
Lab. de Physique des Solides Bat 510, Paris-sud XI 91405 Orsay cedex, France
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4, France
Pr Philippe Mendels / Pr. Jean Marc Broto.

3- *Magnetic phase diagram and magnetization of two 1D $A_4BB'_2O_9$ compounds, $Sr_4CoMn_2O_9$ and $Sr_4NiMn_2O_9$.*
CRISMAT –ISMRA, Université de Caen, France
Dr A. Maignan.

4- *Electron-magnon scattering in ultra-thin magnetic films (Pt / Co (0.8nm) / Pt) and epitaxial FePd ordered alloys films: magneto-transport studies in the paraprocess.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4, France.
Dr B. Raquet.

5- *Influence of the antiferromagnetic domain walls in exchange bias systems.*
CEA Saclay, DSM / DRECAM / SPEC, Orme des merisiers, 91191 Gif sur Yvette Cedex.
Dr Michel Viret.

6*- *High field magnetoresistance in Re-based double perovskites.*

Departamento de Fisica Materia Condensada-ICMA,
Facultad de Ciencias. Univ. de Zaragoza-CSIC. Pza. San Francisco Zaragoza 5009, Spain.
Dr Pedro A. Algarabel.

7*- *High magnetic field saturation of the magnetization of natural and synthetic goethite (γ-FeOOH).*
Laboratoire des Mécanismes de Transferts en Géologie, 14 Avenue Edouard Belin 31400, Toulouse, France.
Lionel Esteban.

8*- *A magnetization study in high magnetic fields on the S=1/2 antiferromagnetic Heisenberg chain copper benzoate* $Cu(C_6H_5COO)_2\ 3H_2O$.
Institut für Metallphysik und Nukleare Festekörperphysik, TU Braunschweig
Mendelssohnstrasse 3, 38106 Braunschweig, Germany.
Dr. A. Wolter

9*- *High field magnetization measurements on Y orthovanadates.*
Departamento de Fisica Materia Condensada-ICMA
Facultad de Ciencias. Univ. de Zaragoza-CSIC. Pza. San Francisco, Zaragoza 5009, Spain.
Dr Clara Marquina.

10*- *Wide angle X-ray scattering (WAXS) in pulsed magnet fields on the molecular magnets* Fe_8 *and* Mn_{12}.
Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Celestijnenlaan 200 D 3001 Leuven, Belgium.
Pr Johan Vanacken.

11*- *Small angle X ray scattering measurements on magnetic field induced phase transitions in* $Pr_{0.5}Ca_{0.5}MnO_3$ *in pulsed magnetic fields.*
Laboratoire de Cristallographie/CNRS, 25 Avenue des Martyrs 38054 Grenoble Cedex, France
Dr Emilio Lorenzo.

12*- *Magnon and electron-magnon scattering in ultra-thin magnetic films (Pt/Co(0.8nm)/Pt) and epitaxial FePd ordered alloy films: magneto-transport under FIR excitation.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4, France.
Dr Bertrand Raquet.

13*- *Low temperature transport and magnetization properties of the misfit Cobalt oxydes.*
CRISMAT – ENSICaen, 6 Bd Maréchal Juin, 14050 Caen, France.
Dr Sylvie Hébert.

Semiconductors

14- *Hall effect in diluted magnetic semiconductor Ga:MnAs.*
Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Celestijnenlaan 200 D3001 Leuven, Belgium.
Pr Johan Vanacken.

15- *Propriétes de transport sous fort champ magnétique de réseaux bi-dimensionnels auto assemblés de nanogouttes métalliques.*
Laboratoire de Physique des Matériaux Electroniques, Université de Bélarus Minsk
F. Skaryna Avenue 4, 220012 Minsk, Belarus.
Dr Vitaly Ksenevich.

16- *High field magnetotransport and magnetooptical studies of narrow gap ferromagnetic semiconductor* $In_{1-x}Mn_xSb$.
Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46
02-668 Warszawa, Poland.
Dr Witold Dobrowolski.

17- *Electron-luminescence inter-sous-bande d'électron 0D dans des lasers à cascades quantiques – Résonance cyclotron.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Pr Jean Léotin.

18*- *Magnetotunneling in the valence band applied to Si/SiGe cascade structures.*
Laboratoire de Photonique et de Nanostructures-CNRS, Route de Nozay, 91960 Marcoussis, France
Dr Ulf Gennser

19*- *Investigation of the scattering mechanisms responsible of the lower lasing level depopulation in strain compensated InGaAs – InAlAs/InP quantum cascade laser, operating at λ ~ 4µm.*
Humboldt-University Berlin (Prof. W. T. Masselink group), Department of Physics/FET
Newtonstrasse 15, D-12489, Berlin, Germany.
Dr Semtsiv Mykhaylo.

20*- *Magneto-optical comparison of the confinement properties of self-assembled InAs/InP quantum wires and quantum wells.*
Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Celestijnenlaan 200 D3001 Leuven, Belgium.
Dr Manus Hayne.

21*- *Magnetotransport in the arrays of mesoscopic and nanoscale low dimensional structures.*
Laboratoire de Physique des Matériaux Electroniques, Université de Bélarus Minsk
F. Skaryna Avenue 4, 220012 Minsk, Belarus.
Dr Vitaly Ksenevich.

22*- *Magneto-optical investigations on InN and InMnN films in high magnetic fields.*
National Laboratory for Infrared Physics, Shanghai Institute of Technical Physiscs
Chinese Academy of Sciences. Yutian Road, 200083 Shanghai, China.
Pr Wei Lu.

23*- *High magnetic field magnetotransport and cyclotron resonance phenomena in novel Ge/SiGe/(001)Si heterostructures and its maximum entropy mobility spectrum analysis.*
Department of Physics, Univ. of Warwick, Gibbet Hinn Road, Coventry, CV4 7AL, UK.
Dr Oleh Myronov

24*- . *Processus optoelectroniques dans les lasers à cascades quantiques*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Pr Jean Léotin.

Metals and Superconductors

25- *Hall voltage and Hall coefficient measurements on polycrystalline Bi films in large parallel magnetic field.*
School of Physics and Astronomy, Tel Aviv University, Ramat Aviv, 69978, Israel.
Pr Ralph L. Rosenbaum.

26- *Hall effect in the field induced normal state of HTSC.*
Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Celestijnenlaan 200 D 3001 Leuven, Belgium.
Pr Johan Vanacken.

27- *Study of the field induced phase transitions and Fermi surface in quasi-two-dimensional organic metals and superconductors by means of magneto-transport measurements under high magnetic field.*
ICREA, Barcelona / ICMAB-CSIC, Campus de la UAB, 08193 Bellaterra, Spain.
Dr Vladimir Laukhin.

28- *Huge quantum oscillations in the magnetoresistance of the quasi-2D organic salt* α*-(ET)*$_2$*TlHg(SeCN)*$_4$ *studied down to very low temperature (20 mK).*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Dr Luc Brossard.

29- *Search for quantum oscillations in 2H-*NbS_2.
Walther-Meissner Institute, Walther-Meissner Strasse 8, 85748 Garching, Germany.
Dr. Werner Biberacher.

30- *High field properties of exotic organic conductor* $(TMTSF)_2FSO_3$.
Ewha Womans University, 11-1 Daehyung-Dong, Seoul 120-750, Republic of Korea
Pr Woun Kang.

31- *Anisotropy of the upper critical fields: temperature dependence of the superconducting coherence length along c-axis and dimensional crossover in high-*T_c *cuprates.*
Superconducting Structure Physics Laboratory, P.N. Lebedev Physical Institute

Russian Academy of Sciences, Leninsky prospect 53, Moscow 119991, Russia.
Pr Dr. Vedeneev.

32- *Etude sous pression hydrostatique de la transition métal-onde de densité de spin induite sous champ dans le sel de Bechgaard* $(TMTSF)_2NO_3$.
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Dr David Vignolles.

33- *Quantum transport in individual carbon nanotubes.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Pr Jean Marc Broto - Dr. B. Raquet .

34- *Electronic transport in individual nanowires.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Pr Jean Marc Broto - Dr. B. Raquet .

35- *The Fermi surface of Bi nanowires.*
Howard University, 500 College St. N.W. Washington, DC 20059, USA
Dr Tito E. Huber.

36- *Experimental investigation of helicon maser in magnetized solid-state plasma.*
Vilnius, Gedeminas Technical University, Electrical Department Taikos 18-11, 2017 Vilnius, Lithuania.
Dr Zigmund Jankauskas.

37- *Electrical transport of doped carbon nanotubes in pulsed magnetic fields.*
GHMFL – MPI/CNRS, 25 Avenue des Martyrs 38042 Grenoble, France.
Dr Vojislav Krstic.

38*- *Probing high-field magnetoresistance in* $SrRuO_3$ *nanometric films: searching for weak localization effects.*
ICREA, Barcelona / ICMAB-CSIC, Campus de la UAB, 08193 Bellaterra, Spain.
Dr Vladimir Laukhin.

39*- *Quantum dissipation in high temperature superconductors.*
Nat. Inst. of Mat. Physics, Str. Atomistilor 105 bis, Comuna Magurele POBox MG-7,Cod 77125, Romania
Dr Viorel Sandu.

40*- *Behavior of the pseudogap in high-Tc superconductors in very high magnetic fields.*
Superconducting Structure Physics Laboratory, P.N. Lebedev Physical Institute
Russian Academy of Sciences, Leninsky prospect 53, Moscow 119991, Russia.
Pr Dr. Vedeneev.

41*- *Hall effect in the field induced normal state of HTSC.*
Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Celestijnenlaan 200 D 3001 Leuven, Belgium.
Pr Johan Vanacken.

42*- *Combination frequencies in the oscillatory spectrum of multiband quasi-two- dimensional organic metals and superconductors.*
Inst. of Problems of Chemical Physics, Russian Academy of Sciences, Chernogolovska 142432, Russia.
Dr Rustem Lyubovskii.

43*- *Pseudogap and SC gap in* $Bi_2Sr_2CaCu_2O_{8+\delta}$: *tunneling spectroscopy in very high magnetic fields.*
Superconducting Structure Physics Laboratory, P.N. Lebedev Physical Institute
Russian Academy of Sciences, Leninsky prospect 53, Moscow 119991, Russia.
Pr Dr. Vedeneev.

44*- *Quantum transport in individual Carbon nanotubes and nano-wires based on nanotubes.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4, France.
Dr Bertrand Raquet – Pr. J.M. Broto.

45*- *Fermi surface study in new quasi-two-dimensional organic metals based on BEDO radical cation salts with the square planar* $Ni(CN)_4^{2-}$ *anions by means of magnetotransport measurements under high magnetic fields.*
ICREA, Barcelona / ICMAB-CSIC, Campus de la UAB, 08193 Bellaterra, Spain.
Dr Vladimir Laukhin.

Magnetic Resonance and Others

46- *High-field electron spin resonance in* η-$Na_{1.286}V_2O_5$ *and* $Na_2V_3O_7$.
L2MP, University of Aix-Marseille III-CNRS, Case 142, Faculté des Sciences de St- Jérôme, 13397 Marseille Cedex 20, France.
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4 , France.
Dr André M. Ghorayeb / Dr. Michel Goiran.

47- *Photoluminescence of carbon nano-tubes.*
Dept. of Electrical and Computer Engineering, Rice Univ., Houston, Texas 77005, USA.
Pr Junichiro Kono.

48- *Study of the effect of a high pulsed magnetic field on the spin crossover complex* $Fe(bpp)_2(BF_4)_2$.
Laboratoire de Chimie de Coordination-CNRS, 205 route de Narbonne, 31077 Toulouse France
Dr Azzedine Bousseksou

49*- *Cyclotron resonance studies of diluted magnetic semiconductors such as* $Ga_{1-x}Mn_xAs$ *and* $Ga_{1-x}Mn_xN$.
Quantum Functional Semiconductor Research Center, Dongguk University
3-26 Phil-Dong, Chung-gu, Seoul, 100-715 Korea.
Pr Im. Taek Yoon.

50*- *High field Electron Spin Resonance and magnetization of single crystals* $La_{1-x}Sr_{1+x}MnO4$.
Leibniz Institute for Solid and Materials Research Dresden, Helmholtzstrasse 20, 01069 Dresden, Gremany.
Dr Vladislav Kataev.

51*- *Development of a high pressure cell in the pulsed field.*
LNCMP, 143 Avenue de Rangueil 31432 Toulouse Cedex 4, France.
Pr Jean Marc Broto – Pr. Jesus Gonzalez.

52*- *Orientation of purple membranes for solid state NMR experiments.(in DC field)*
Institut de Pharmacologie et de Biologie Structurale, 205 route de Narbonne, 31077 Toulouse France.
Pr Alain Milon

53*- *High–field Electron Spin Resonance in* $Na_2Va_3O_7$.
L2MP, University of Aix-Marseille III-CNRS, Case 142, Faculté des Sciences de St- Jérôme, 13397 Marseille Cedex 20, France.
Dr André M. Ghorayeb.

Publications

Publications in international journals

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G.L.J.A. Rikken and P. Wyder
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D. Vignolles, A. Audouard, M. Nardone, L. Brossard, S. Bouguessa and J.M. Fabre
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K. Spencer, F. Lecouturier, L. Thilly and J. D. Embury
Advanced Engineering Materials **6,** 290 (2004)

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J. Y. Fortin, E. Perez and A. Audouard
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R. Bel, K. Behnia, C. Proust, P. van der Linden, D. K. Maude, and S. I. Vedeneev
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Thermal conductivity across the phase diagram of cuprates: Low-energy quasiparticles and doping dependence of the superconducting gap
M. Sutherland, D.G. Hawthorn, R.W. Hill, F. Ronning, S. Wakimoto, H. Zhang, C. Proust, E. Boaknin, C. Lupien, L. Taillefer, R. Liang, D.A. Bonn, W.N. Hardy, R. Gagnon, N.E. Hussey, T. Kimura, M. Nohara, H. Takagi
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R. Rosenbaum, J. Galibert
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Combination frequencies of magnetic oscillations in β″ - $(BEDT\text{-}TTF)_4(NH_4)[Fe(C_2O_4)_3]$ ·DMF,
A. Audouard, V.N. Laukhin, L. Brossard, T.G. Prokhorova, E. B. Yagubskii, E. Canadell
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High-field superconductivity in alloyed MgB2 thin films
V. Braccini, A. Gurevich, J.E. Giencke, M.C. Jewell, C.B. Eom, D.C. Larbalestier, A. Pogrebnyakov, Y. Cui, B. T. Liu, Y. F.Hu, J. M. Redwing, Qi Li, X.X. Xi, R.K. Singh, R. Gandikota, J. Kim, B. Wilkens, N. Newman, J. Rowell, B. Moeckly, V. Ferrando, C. Tarantini, D. Marre, M. Putti, C. Ferdeghini, R. Vaglio, E. Haanappel
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M. Costes, J.M. Broto, B. Raquet, H. Rakoto, M.A. Novak, J.P. Sinnecker, S. Soriano, W.S.D. Folly, A. Maignan, V. Hardy
Journal of Magnetism and Magnetic Materials , accepted for publication

Magnetic anomalies near energy level crossing in $HoPO_4$
J.M. Broto, H. Rakoto, Z.A. Kazei
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Phase transitions and crossover at high magnetic fields in the Jahn-Teller compound $DyVO_4$
A.A. Deminov, Z.A. Kazei, N.P. Kolmakova, J.M. Broto, H. Rakoto
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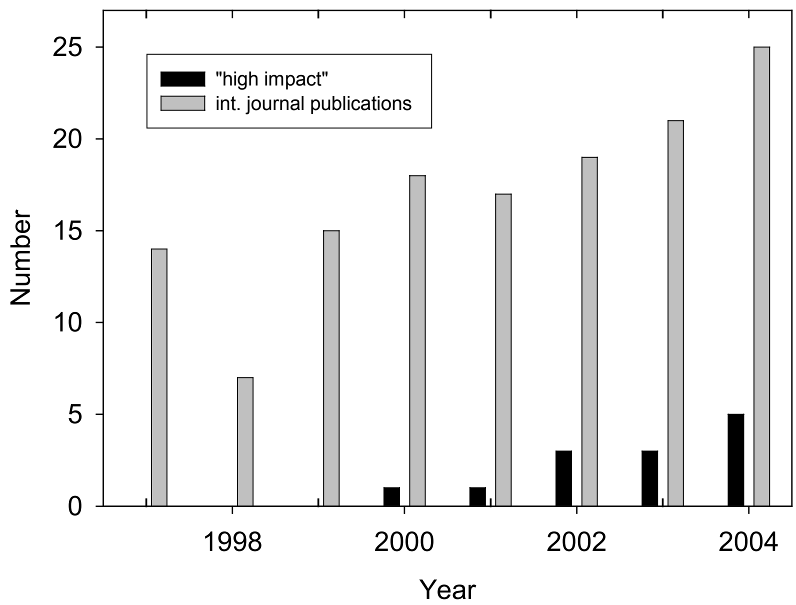
Transverse magnetoresistance behaviors of thin polycrystalline bismuth films.
R. Rosenbaum, J. Galibert
J. Low Temperature Physics, accepted for publication



Overview of LNCMP publications in international journals, and high impact journals (Phys. Rev. Lett., Nature, Science)

Conference proceedings

Perspectives for Cu/SS macrocomposite and Cu/X nanofilamentary Conductors Used in Non-Destructive High-Field Pulse Magnets Under Cryogenic Conditions
F. Lecouturier, K. Spencer, L. Thilly, J.D. Embury
Physica B **346-347C,** 582 (2004)

Experimental analysis of mechanical and electrical aging in pulsed magnets
J.Billette, F.Lecouturier, O.Portugall
Physica B **346-347**, 589 (2004)

The LNCMP: a pulsed-field user-facility in Toulouse
The LNCMP-team
Physica B, **346-347C**, 668 (2004)

Magnetic oscillations in a two-dimensional network of coupled orbits.
A. Audouard, D. Vignolles, C. Proust, L. Brossard, M. Nardone, E. Haanappel, S. I. Pesotskii, R. B. Lyubovskii and R. N. Lyubovskaya
Physica B **346-347,** 377 (2004).

High magnetic field studies of the charge density wave state of the quasi two-dimensional conductor KMo_6O_{17}.
Jean Dumas, Hervé Guyot, Hafid Balaska, Jacques Marcus, David Vignolles, Ilya Sheikin, Alain Audouard, Luc Brossard, Claire Schlenker
Physica B **346-347,** 314 (2004).

Magnetic oscillations in beta"-$(BEDT\text{-}TTF)_4(NH_4)[Fe(C_2O_4)_3]\cdot DMF$: Fermi surface study and frequency mixing.
V. N. Laukhin, A. Audouard, L. Brossard, T. G. Prokhorova, E. B. Yagubskii and E. Canadell
Physica B **346-347,** 359 (2004).

Magnetic oscillations and frequency mixing in a two-band conductor
J. Y. Fortin, E. Perez and A. Audouard
Physica B **346-347,** 373 (2004).

Parallel magnetoresistance of a polycrystalline bismuth film in high magnetic fields
R. Rosenbaum, J. Galibert
Physica **B 346-347**, 291 (2004)

Energy relaxation of magnetically confined electrons in quantum cascade lasers
O. Drachenko, D. Smirnov, J. Leotin, V. Rylkov, H. Page, C. Sirtori
Physica E 20, 503 (2004)

Hall coefficient measurements at high perpendicular magnetic fields in polycrystalline bismuth films
R. Rosenbaum, J. Galibert
Physica B **346-347**, 287 (2004)

Microminiature Hall probes based on n-lnSb(Sn)/i-GaAs heterostructure for pulsed magnetic field applications up to 52T
O.A. Mironov, M. Myronov, S. Durov, O. Drachenko, J. Leotin
Physica B **346-347**, 548 (2004).

Intersubband lifetime tuning by magnetophon resonance in GaAs/GaAlAs quantum cascade lasers, *O. Drachenko, D. Smirnov, J. Leotin, V. Rylkov, H. Page, C. Sirtori*
Physica B **346-347**, 498 (2004).

Study of rapid oscillations in (TMTSF)2FSO3 under pressure and under very high magnetic fields, *W. Kang, Y. J. Jo, Haeyong Kang, Ok-Hee Chung, D. Vignolles, M. Nardone and A. Audouard,*
Accepted for publication in Synthetic Metals.

Magnetoresistance of a Si-MOSFET structure in a parallel magnetic field
J.M. Broto, M. Goiran, H. Rakoto, A. Gold, V.T. Dolgopolov.
Physica B **346-347**, 493 (2004).

Effect of annealing on magnetic and magnetotransport properties of $Ga_{1-x}Mn_xAs$ epilayers.
Kuryliszyn-Kudelska I., Wojtowicz T., Liu X., Furdyna J.K., Dobrowolski W., Domagala J.Z., E.£usakowska, M.Goiran, E.Haanappel, O. Portugall.
Journal of Magnetic Materials and Magnetism **272-276**, 1575 (2004).

High magnetic field study of charge/polaron ordering in $Bi_{1-x}Sr_xMnO$ ($x \leq 0.50$) perovskites
M. Respaud, A. Kirste, M. Goiran, J. Vanacken, J.M. Broto, H. Rakoto, A.E. Carrillo, M. von Ortenberg, M. Hervieu, C. Frontera, J.L. Garcia-Muñoz.
Physica B **346-347**, 70 (2004).

Hall effect and magnetoresistance of $La_{1.875}Sr_{0.125}CuO_4$
J. Vanacken, E. Haanappel, S. Stoobants, T. Wambecq, V. Mashkautsan, C. Proust, L. Rigal, V.V. Moshchalkov
Physica B **346-347**, 334 (2004).

First experiments in fields above 75T in the european « coilin-coilex » magnet
H. Jones, P.H. Frings, M. von Ortenberg, A. Lagutin, L. Van Bockstal, O. Portugall, F. Herlach
Physica B **346-347**, 553 (2004).

Upper critical fields up to 60T in dirty magnesium diboride thin films
C. Ferdeghini, V. Ferrando, C. Tarantini, E. Bellingeri, D. Marrè, M. Putti, P. Manfrinetti, A. Pogrebnyakov, J.M. Redwing , X.X. Xi, R. Felici, E. Haanappel
Proceedings of Applied Superconductivity Conference, Jacksonville (USA) 3-8 octobre 2004 (to be published in IEEE Transactions on Applied Superconductivity 2005)

Conference contributions

3rd Workshop on High Field Techniques in Toulouse, 18-19 September 2004
Large cross-section wires at LNCMP
F.Lecouturier

Post-mortem analysis of pulsed magnets
F.Lecouturier

GDR NEEM : Nouveaux états électroniques de la matière, Aspet 29 juin-2 juillet 2004
Etude magnétique du composé η-$Na_{1.286}V_2O_5$ sous champ magnétique élevé.
*M Costes, M Goiran, J.M. Broto, P. Millet, A.M. Ghorayeb, A Stepanov***.**

Propriétés magnétiques des composés quasi-1D: Sr_3NiIrO_6 et Ca_3CoIrO_6
M.Costes, J.M. Broto, B. Raquet, H. Rakoto, M.A. Novak, J.P. Sinnecker, S. Soriano, W. Folly, M.N. Baibich, Maignan, D Flahaut, S. Lambert

Transition sous champ magnétique intense dans le conducteur quasi-bidimensionnel à onde de densité de charge KMo_6O_{17}
H. Balaska, J. Dumas, H. Guyot, J. Marcus, C. Schlenker, D. Vignolles

I.C.S.P. 2004, Arizona
Intersubband lifetime magnetophonon oscillations in GaAs quantum cascade lasers
O. Drachenko, D. Smirnov , J. Léotin, A. Vasanelli, C. Sirtor,

Congrès SFP – JMC9 – Nancy (Août 2004)
Transition sous champ magnétique intense dans le conducteur quasi-bidimensionnel à onde de densité de charge KMo_6O_{17}
H. Balaska, J. Dumas, H. Guyot, J. Marcus, C. Schlenker, D. Vignolles

JMC9, 30 août - 3 septembre 2004, Nancy
Elaboration, étude microstructurale et caractérisation mécanique par nanoindentation des conducteurs nanofilamentaires Cu/Ta
V. Vidal, L. Thilly, F. Lecouturier

MRS Fall Meeting, 29 november – 3 december 2004, Boston
Size effect on the plasticity of Cu/Nb and Cu/Ta nanocomposite conductors: in-situ TEM and nanoindentation studies
L. Thilly, V. Vidal and F. Lecouturier

Elaboration by severe plastic deformation, microstructural study and mechanical characterization by nanoindentation of new CuTa nanofilamentary wires for use in high field magnet
V. Vidal, L. Thilly, F. Lecouturier

Japan–French meeting on Quantum Complex Systems, Grenoble (july 2004),
The metal-insulator transition in cuprates revisited
C. Proust, M. Sutherland, L. Taillefer, M. Nardone, E. Haanappel, D. Bonn, W. Hardy, R. Liang

International Workshop on Evolution of Quantum Effects from the Nano- to the Macroscale, Cargèse (may 2004),
Test of the Wiedemann-Franz law in hole-doped cuprate around optimal doping
C. Proust, R. Bel, K. Behnia, D. Maude, P. van der Linden, S.I. Vedeneev.

X MegaGauss Conference, Humbolt University, Berlin July 2004.
Magneto-transport phenomena in carbon nanotube under 60T,
G. Fedorov, B. Lassagne, M. Sagnes, B. Raquet, J-M Broto, F. Triozon and S. Roch,

NT'04 : International conference on the Science and Application of Nanotubes, San Luis Potosi (Mexico) July 2004.
Magneto-transport in Double Wall Carbon Nanotubes : Novel features under 60T,
B. Raquet, B. Lassagne, G. Fedorov, M. Sagnes, J-M Broto, F. Triozon and S. Roche,

TNT 2004 "Trends in Nanotechnology", Segovia September 2004.
Magneto-transport under 60T in Double Wall Carbon Nanotubes,
B. Lassagne, G. Fedorov, M. Sagnes, B. Raquet, J-M Broto, F. Triozon and S. Roche

ALFA program HIFIELD :

Summer school Vienna "New experiments in high magnetic fields » 26-28/04/2004
Giant magnetoresistive head in the hard drive, *J.M. Broto*

Magnetic properties study in quasi 1D A'_3ABO_6, *J.M. Broto*

Summer school La Havana « News experiments in high magnetic fields », 18-20/11/2004
Photoluminescence Al2O3 : Cr3+ under high magnetic field
CH Power, J Gonzalez, JM Broto, B. Raquet, J. Léotin

International workshop on Nanomagnetism , La Habana 15-19 /11 / 2004
Quantum dots of Cd0.5Mn0.5Te semimagnetic semiconductor formed by the cold isostaticcpressure method
O. Contreras, Ch. Power, M. Quintero, R. Tovar, E. Quintero, J. González, V. Muñoz-San José, J. M. Broto and E. Snoeck

Magneto-transport in Double Wall Carbon Nanotubes : Novel features under 60T,
B. Raquet, B. Lassagne, G. Fedorov, M. Sagnes, J-M Broto, F. Triozon and S. Roche

Dynamic effects in one dimensional A'_3ABO_6
M.Costes, J.M. Broto, B.Raquet, H.Rakoto, M.A. Novak, J.P. Sinnecker, S.Soriano, W. S. D. Folly, A. Maignan, V.Hardy

Invited Conferences

Int. Workshop on Magnet Technology for Nano and Bio Science Opportunities (MTNBS, Seoul 2004)
The Toulouse pulsed-magnet facility: State of the art and future challenges for nano- and bio-sciences, *O. Portugall* ,

Semi-Mag Conference,Tallahasee august 2004
Optical Detection of the Aharonov-Bohm Effect in Carbon Nanotubes in High Magnetic Fields
J. Kono, G. Rikken, O. Portugall, J. Leotin

GDR NEEM, Aspet (june 2004)
Supraconductivité et instabilité électronique sous champ magnétique intense
C. Proust, A. Audouard, D. Vignolles, L. Brossard, E. Haanappel, L. Rigal

Contributions to books

Conducteurs nanocomposites multi-échelle ultra renforcés pour bobines de champ magnétique pulsé non-destructif supérieur à 60T
L.Thilly, F. Lecouturier
To be published in Nanomatériaux 2

The spin crossover phenomenon under high magnetic field.
A. Bousseksou, F. Varret, M. Goiran, K. Boukheddaden, J.P. Tuchagues.
Topics in Current Chemistry, Vol. 235: Spin Crossover in Transition Metal Compounds III. Springer-Verlag Editors : Gütlich, Philipp; Goodwin, Harold A. (2004).

Magneto-chiral anisotropy in asymmetric photochemistry, *G.L.J.A. Rikken*
in "Chiral Photochemistry", eds. Y. Inoue and V. Ranayamurty, Marcel Dekker 2004.

Organigram 1/1/2005

Director G.Rikken DR1
Deputy O. Portugall IR1

Administration / Secretary
S. Bories Agt T INSA
F. Rougalle T

Technical infrastructure

Generator
J. Marquez IR (until 1/5)
B. Griffe AI
P. Frings IR

Reinforced conductors
F. Lecouturier IR
N. Ferreira AJT
J.M Lagarrigue T
Coils
J. Billette IE

Experimental Support
H. Rakoto IR
G. Ballon AI
M. Nardone IE
L. Drigo IE
NN T (concours 2005)

Informatics
L. Bosseaux T

Machine shop
G. Coffe AI INSA
L. Bendichou Agt T
NN AJT UPS
Welding
J.P. Laurent T INSA

High field science

Scientists
A. Audouard CR
R. Battesti MC UPS
J.M. Broto PR UPS
J. Galibert CR
M. Goiran CR
E. Haanappel CR
V. Krstic CR
J. Léotin PR UPS (until 1/9)
O. Portugall IR
C. Proust CR
B. Raquet MC INSA
L. Rigal MC UPS
G. Rikken DR
D. Vignolles MC INSA
NN PR UPS (concours 2005)

PhD students
S. Batut INSA
E. Perez UPS
B. Lassagne INSA
M. Costes UPS
V. Vidal INSA
M. Mainson

Long term visitors
J. Vanacken PAI Tournesol