NHMFL REPORTS

NATIONAL HIGH MAGNETIC FIELD LABORATORY

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Florida State University • University of Florida • Los Alamos National Laboratory

SCIENTISTS INTEGRATE MAGNET-BASED TECHNOLOGIES

Last year a team of NHMFL, FSU, and FAMU scientists initiated a research program that applies magnet-based technologies to the environmental sciences. There are several unique analytical instruments at the NHMFL that allow novel analysis of environmentally significant processes.

Currently we are focusing on three techniques that hold promise for unraveling some major unanswered environmental and ecological questions. Fourier Transform Ion Cyclotron Resonance (FT-ICR) Mass Spectrometry is used to identify the composition and structure of naturally occurring organic matter. Inductive Coupled Plasma Mass Spectrometry (ICP-MS) is used to determine heavy metal and elemental concentrations. Electron Paramagnetic Resonance (EPR) spectroscopy is used to characterize the binding environment and valence state of transition metals.

This research has been made possible to some extent by a 1996 NSF (Geoscience Directorate) Academic Research Infrastructure (ARI) instrumentation grant that supported the acquisition of a high resolution ICP-MS and a 1996 NSF (Chemistry Division) ARI acquisition of advanced EPR instrumentation. In addition, this July the governing board of the South Florida Water Management District (SFWMD) approved funding for our research on the cycling of phosphorous in the Everglades, as the increased levels of phosphorous in waters draining the agricultural areas north of the Everglades are destroying the natural wetland ecosystem.

Wetlands (marshes, bogs, swamps, sloughs, etc.) are transition zones between dry land and deep water, and these transition zones occur in a wide variety of geographic settings. Natural wetlands have several

EVERGLADES *cont. on page 3*

NHMFL ULTRA-HIGH B/T FACILITY

Open for Users

The Ultra-High B/T Facility, an annex of the National High Magnetic Field Laboratory operated by the University of Florida, has been successfully tested, and is now open for users. This facility provides researchers with the opportunity for studying phenomena at ultra-high values of the ratio of magnetic field to temperature with B/T up to 4. 10^4 T/K.

The system consists of a $PrNi_5$ nuclear demagnetization refrigerator for cooling samples in an independent high field superconducting magnet (17 T maximum field) with moderate homogeneity. The full design field of 18/20 T (for operation at 4.2/1.5 K) is expected to be available in 1998/99 with the replacement of 1 of the 4 Nb_3Sn superconducting coils. The principal magnet was tested using a miniature magnetoresistance probe (0.25 mm Cu wire) and a recently developed 500 MHz NMR probe. The persistent mode field decay was observed to be 1.6 10^{-5} per day. The homogeneity measured with a ^3He NMR probe was found to be 1.8 10^{-5} over a 1 cm DSV at full field. This homogeneity is adequate for a number of condensed matter NMR studies at ultra-low temperatures.

The dilution refrigerator that precools the nuclear refrigerator and sample cell can cool the entire system relatively rapidly, less than

High B/T Facility demagnetization refrigerator is ready for raising the dewar into place.

HIGH B/T FACILITY *cont. on page 7*

From the Director's Desk

Integrating Magnetic Resonance Research

A unique strength of the NHMFL is its ability to support and stimulate interdisciplinary research. Recent issues of this newsletter have reported on engineering advances in the resistive magnets at the NHMFL that make them important new tools for magnetic resonance research activities. The NHMFL's Center for Interdisciplinary Magnetic Resonance offers users a wide range of facilities, some of which, like the 9.4 T ICR magnet system, are state of the art. The cover story of this issue details how three magnetic resonance techniques are being integrated and applied to environmental science—specifically and very importantly, for research and restoration efforts on the Florida Everglades.

More needs to be done, however, as there appears to be a critical national need to integrate magnetic resonance assets across the country. I am pleased to report that preliminary discussions have been held on this subject with the National Science Foundation, the National Institutes of Health, and the Department of Energy. The basis for the dialogue was a white paper, "National Magnetic Resonance Collaboratorium," submitted by the NHMFL in April, 1997. The "Challenge" and "Goals" sections of the NMRC proposal are shared below to facilitate the ongoing discussions. The strategy involves the establishment of a multi-site consortium drawing on existing concentrations of magnetic resonance expertise and facilities at institutions in four geographic areas of the country—West Coast, Midwest, Mid-Atlantic, and Northeast. These regional centers, along with the NHMFL and possibly other centers of excellence, would form the core of the extended user facilities. In addition, cooperative partnerships will be explored with NIH and DoE facilities (such as the Pacific Northwest Laboratory and the NIH-funded National Stable Isotope Resource located at Los Alamos National Laboratory) and other institutions, to ensure the broad participation of the magnetic resonance community.

A responsive collaboratorium will involve the integration of science and technology. Recent advances in computer and connectivity technology provide the

National Magnetic Resonance Collaboratorium

The Challenge

In the fifty-two years since the discovery of nuclear magnetic resonance in 1945, magnetic resonance technologies have demonstrated an enormous multidisciplinary impact on biophysics, materials science, chemistry, geochemistry, biology, and bioengineering. To maintain our prominent position at the forefront of science and engineering, a dramatic new concept for integrating U.S. magnetic resonance assets is demanded by the exponential growth in:

- the cost of state-of-the-art magnetic resonance instrumentation,
- magnetic resonance data sets,
- interdisciplinary research requiring multi-agency collaborations, and
- computation and internet capacity.

The concept proposed herein—the National Magnetic Resonance Collaboratorium (NMRC)—establishes extensive network-based collaborations (a virtual laboratory or "center without walls"); leverages existing investments in faculty, facilities, and equipment by sharing instrumentation; and offers exceptional new educational opportunities. As the term "collaboratorium" implies, "collaboration" and "laboratory" are merged into a vital new entity. The NMRC will prepare the United States for the competitive challenges close at hand, and will lay a framework within which the United States can lead multidisciplinary magnetic resonance research and development into the 21st century.

The Goals

Magnetic resonance spectroscopy, including nuclear magnetic resonance, electron magnetic resonance, and ion cyclotron magnetic resonance mass spectroscopy, is rapidly becoming the backbone of modern biological and chemical sciences. The goal of the NMRC is to develop the needed interfaces and infrastructure leading to a network-based national science and technology initiative. There is a critical need within the United States for a major investment in magnetic resonance capacity at the highest fields to respond to opportunity to implement the concept of a virtual laboratory. The NHMFL in cooperation with the regional centers and the private sector will develop state-of-the-art capabilities using the internet to provide remote access to specialized user facilities and to promote the advance of magnetic resonance science and technology.

We believe that the NHMFL may be uniquely positioned to spearhead the NMRC. Among other things, we develop the most advanced magnet technology worldwide, novel magnetic resonance modeling and simulation technology, and U.S. industrial leadership in magnetic resonance technology and applications. We also possess a strong multidisciplinary magnetic resonance science program, and operate in a multi-institutional environment—responding to science, technology, and educational challenges. We look forward to the continuing discussions and hosting an NMRC workshop later this year.

Jack Crow, Director and Co-Principal Investigator, FSU
Don Parkin, Co-Principal Investigator, LANL
Neil Sullivan, Co-Principal Investigator, UF

the challenges within the biological and chemical sciences. The specific goals of this collaboratorium are:

- to simulate science and new science opportunities through greater connectivity,
- to design the tools and interfaces to support network-based collaborative research through shared instrumentation,
- to provide access to the most advanced magnetic resonance instrumentation and analysis software,
- to facilitate the gathering and analysis of magnetic resonance data in support of the creation of new knowledge with broad tangible benefits to society,
- to establish a private sector-institutional consortium to advance the U.S. competitive position in magnetic resonance instrumentation and applications,
- to establish a virtual laboratory on the internet for the training of undergraduate and graduate students in magnetic resonance techniques,
- to establish a national mentorship program for under-represented groups, and
- to enhance access to educational materials through the use of the worldwide web.

EVERGLADES *cont. from page 1*

important functions in our environment including providing support and habitat for a large variety of species and influencing the flow and quality of (drinking) water; wetlands are the primary "custodians" of fresh waters. The "purifying" aspect of wetlands has been documented for a long time, but their importance in maintaining water quality and species diversity is just now being recognized. In a recent article in the journal *Nature* the "per-hectare-services" that wetlands provide to society are estimated to be the most valuable of all terrestrial ecosystems, and these services are estimated to be an order of magnitude more valuable than the services provided by tropical rainforest. The growing awareness of the importance of wetlands has resulted in large scale projects to restore wetlands, as well as programs to build artificial "treatment" wetlands. Most wetland restoration and construction projects, however, are designed using simple mass balance through box models that do not incorporate realistic ecosystem mechanisms and processes within a box or include energy and/or transport from one box to the next.

Our research is aimed at developing methods for determining the processes and mechanisms responsible for element and energy cycling in wetlands and the resulting drastic differences between the chemistry of water entering a wetland and that leaving it. Wetlands are dynamic entities and are the result of constant change that makes recognition of a quasi "steady-state" difficult. Stability of flora and fauna in natural wetlands is only achieved after several decades, and methods are required to judge whether an impacted wetland is indeed on its "road to recovery." Understanding the chemical processes and mechanisms occurring in a wetland is of vital importance for restoration of a wetland to its unperturbed condition or for optimization of the cleaning capacity of an artificial wetland. We hope that by understanding the cycling of elements at a *fundamental molecular level* at the bottom of the foodchain, we can identify early indicators of the direction in which a wetland is progressing from its quasi steady-state. Improvement or decline in the health of a wetland ecosystem can thus be detected early, long before the effects are manifested in the fish and fowl higher up the foodchain.

An example of the lack of molecular science currently included in wetland protection is the regulation of environmentally significant substances in fresh water. Virtually all these regulations are based on the total amount of that substance dissolved in the water regardless of its form and association. Dissolved organic matter (DOM), however, plays a dominant role in the chemistry of pore waters in fresh water wetland ecosystems. Studies of acidic lake sediment have shown

EVERGLADES *cont. on page 4*

Dirac II Experiments Conducted at Los Alamos

The world's leading scientists in ultra-high magnetic fields gathered in a remote canyon at Los Alamos National Laboratory (LANL) in June to experiment on some of the most powerful magnets that have ever existed on Earth, but for only a few millionths of a second. The "Dirac II" series of four shots approached fields at the extremes of 850 tesla using explosively driven generators. Most of the scientists were probing the unusual electronic states of superconductors, semiconductors, and quantum Hall devices in ultra-high magnetic fields. "We're measuring phenomena never measured before," commented physicist Laurence Campbell, director of the NHMFL Pulsed Field Facilities at LANL.

On the firing site from the left: Max Fowler (Los Alamos), Fritz Herlach (Leuven), Noboru Miura (Tokyo), Michael von Ortenberg (Berlin). In the background are three members of an Australian Broadcasting Company TV team.

The pioneering Dirac experimental campaign began as a collaboration with Russian and American scientists to strengthen scientific ties and cooperation. A workshop held at the NHMFL in mid-1994 with scientists from LANL and Russia focused on the types of experiments that may be feasible in some of the highest magnetic fields ever achieved by man. Most of the experiments use a Russian compression-flux generator, called an MC-1, the only such machine that can create such high magnetic fields and still have space inside for experiments. There were six shots during the first Dirac series in the spring and summer of 1996; another series of shots (Dirac II) was conducted this year; and Dirac III is planned for 1998.

After weeks of preparation, researchers from Australia, Belgium, Germany, Japan, Russia, and the United States joined LANL researchers in delicately positioning the samples and sensors inside the generator or large pulsed magnet surrounded by over thirty pounds of explosives that are meticulously arranged to create a perfect uniform implosion. Inside the cavity of the pulsed magnet are cascades of concentric tubes of copper that confine the flux and make the magnetic field compression more uniform. Lastly, the cryostat is fitted into the last cascade and the samples are chilled with liquid helium.

Below the experimental apparatus in a concrete bunker of three-foot concrete walls, scientists and engineers are busily checking out the massive banks of high-speed electronics that will capture the data in about 70 millionths of a second. Once the test site and bunker are secure and each scientist confirms that they are ready for firing, the countdown begins and everyone intently watches video monitors. The explosion is being recorded from cameras positioned 125 yards away in Ancho Canyon and sent back to the bunker. Then the blast reverberates through the bunker and a large reddish yellow fireball fills the video screen for several seconds. The implosion has a force equal to more than 300 hand grenades going off at the same time; only a few shattered pieces of the device remain at the test site.

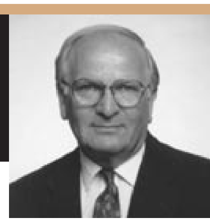
Within the last one or two microseconds of the experiment, the pressures within the generator or pulsed magnet reach nearly three million atmospheres or practically the pressure of the Earth's core. This is all the time the scientists have to measure the samples' electrical resistance and related properties at these record levels—an enormous challenge within itself. This issue's "From the Chief Scientist's Desk" is devoted to some of the data obtained from Dirac II by NHMFL physicist James Brooks.

EVERGLADES *cont. from page 3*

that cations in the pore water are balanced mainly by organic anions. In an acidic freshwater as much as 80% of the total anions in a wetland could be accounted for by DOM. DOM serves several important functions in the pore water of freshwater wetlands by acting as a pH buffer, and as substrates for microorganisms to facilitate energy (carbon) and nutrient cycling. Furthermore, naturally-occurring organic matter in general, and humic substances in particular, have the ability to absorb, bind, and/or complex environmentally-significant substances such as pesticides, polychlorinated biphenyls (PCBs), polyaromatic

EVERGLADES *cont. on page 10*

From the Chief Scientist's Desk



As the NHMFL science activities grow in strength and breadth, we will highlight one research area in each issue of these REPORTS to give a sense of important advances in our research and our scientific capabilities. It is indeed a difficult task to select from such a rich set of achievements, yet we hope to cover our programs over a cycle of six to eight issues. This quarter we feature the remarkable experiments of the Molecular Conductor Research Group, concerning the existence of the quantum Hall effect in a weakly three dimensional solid, whose band width in the third direction is smaller than the Landau level spacing. In addition they discuss preliminary optical reflectivity data at ultra high magnetic fields, demonstrating a high degree of reproducibility under these most unfriendly conditions. Thus, this work exhibits both fundamental scientific insight and a high level of technical achievement.

R. Schrieffer

Low Dimensional, Low Electron Density Materials in "Low" (30 T) and "Ultra High" (800 T) Fields

James Brooks

A main interest of the Molecular Conductor Research Group at FSU/NHMFL is the connection between truly two dimensional electronic systems and layered, bulk crystalline materials. The former can be realized in the two dimensional electron gas (2 DEG) of a GaAs/GaAlAs structure, and the latter is manifested in highly anisotropic (layered, conducting) molecular crystalline materials. Can one observe a quantum Hall effect in a bulk crystalline material, and if so, what features are in common with the 2 DEG. This question has been asked recently from the molecular conductor point of view in a study of the integer Hall effect in the so-called spin density wave state of an organic conductor.[1] Here the answer is yes, there is quantization of the Hall plateaus, but they are linked to the field induced spin density wave gaps in the electronic band structure, and universal scaling[2,3] of the Hall plateau temperature dependence is not obeyed. The same effect has been observed in a 40 layer GaAs/AlGaAs multilayer system[4] where a warped cylindrical Fermi surface behavior is observed, a well known property of a quasi-two dimensional metallic system. Recently, there are reports of the quantum Hall effect in a true, quasi-three dimensional organic conductor metal,[5] and in a charge density wave material.[6]

Magnetic Fields Below 30 T

In this regard, we are studying GaAs/AlGaAs 200 layer quantum wells at the NHMFL, fabricated at Sandia National Labs. We are using a combination of facilities, such as the Millikelvin Facility, tilting probes, and 30 T resistive magnets. Our measurements are focused on the effects of parallel and perpendicular fields with respect to the layers on the temperature scaling behavior of the quantum Hall transitions, and on evidence for quasi-three dimensional electronic structure. Theoretical work is being carried out in conjunction with Z. Wang at Boston College. Some *very* preliminary results of this work are shown in Figure 1 for one of the samples studied so far. The data is very rich in content. The temperature dependence gives information on the universal character of the Hall effect behavior in quasi-three dimensions, the combination of angle and field dependence yields information and on tuning of the quasi-three dimensional electronic structure, and the crossover (as noted) is a field induced metal-to-insulator transition which is independent of temperature. The fact that the n = 2 Hall plateau is equal to $h/400e^2$ to within a fraction of a percent tells us that all 200 layers participate in the transition.

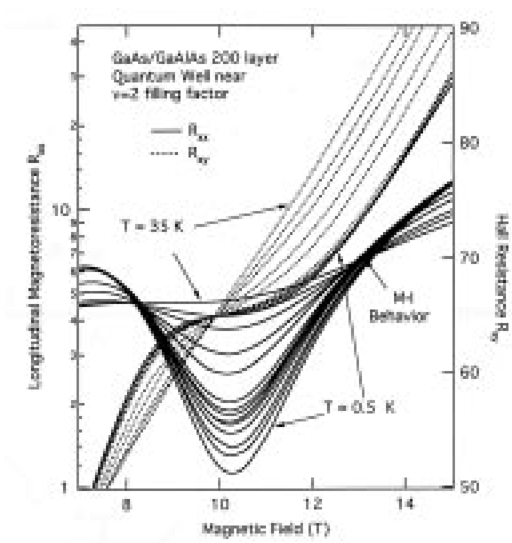


Figure 1. Temperature and field dependence of the n = 2 quantum Hall transition in a 200 layer quantum well structure in a tilted field of 30 degrees. Metal-to-insulator behavior at higher fields is also noted.

LOW & ULTRA HIGH *cont. on page 6*

LOW & ULTRA HIGH *cont. from page 5*

Magnetic Fields Up To 820 T - Dirac II

Another main interest in our group is the quantum limit, and what happens to these systems in extremely high magnetic fields. With the advent of the Dirac II series of dynamic field experiments at Los Alamos this June (see page 4), the materials used in the project above became relevant in a completely new regime, and our group had the opportunity to try some new experiments. Our previous attempts to study quantum limit effects in molecular conductors in magnetic fields up to 800 T by standard electronic transport measurements are described in the *NHMFL 1996 Annual Report*, and in Los Alamos preprint LA-UR 96-3472. This year we decided to measure optical reflectivity at liquid nitrogen temperature (75 K). We had to come in from the bottom of the magnet, just below the liquid helium cryostat, and we could only study two samples per shot. A diagram of our approach is given in Figure 2. Here we used two optical fibers, one for transmission, and one for receiving the light, which was from a 810 nm laser. Hence we simply recorded the light reflected from the sample into a very fast detector filtered at 820 nm.

The results of the experiments which survived the extreme conditions of the pulse are shown in Figure 3. and 4, a $NbSe_2$ sample and two GaAs/GaAlAs 200 layer quantum well samples. The field can be measured in two ways. The first is the so-called B-dot coil in which the EMF induced in a single winding of 1 mm^2 area is measured and our data is plotted vs. the integrated signal from such a coil. We show in Figure 3 the results of such a method, along with our control optical trace. Note that the magnetic field really does not take off until the last 10 microseconds. The experiment is over when the shock wave hits the sensors, just beyond 70 microseconds, at which time the "B-dot" coil breaks and bright light is introduced into the receiver optical fiber. The other way to measure the field is by Faraday rotation, a simple optical measurement which uses the rotation of the polarization of light by quartz in a magnetic field. Figure 4a shows the Faraday rotation data, and Figure 4b shows quantum well and $NbSe_2$ signals from three different runs, along with the control signal from the fourth run with no optical excitation. The clean nature of the optical signals under such extreme conditions is impressive.

Discussion & New Opportunities For Ultra High Field Theory and Experiment

Why did we put low electron density, low dimensional materials in the Dirac experiments? Because at magnetic fields of 800 T the magnetic quantization energy becomes comparable to the electronic energy (Fermi energy, band energy, etc.) and one might expect profound changes in their properties. In fact, at this scale of energy, 75 K is quite cold. Why did we study optical reflectivity? Because it was a simple first step in the use of "photonics" to provide high signal to noise

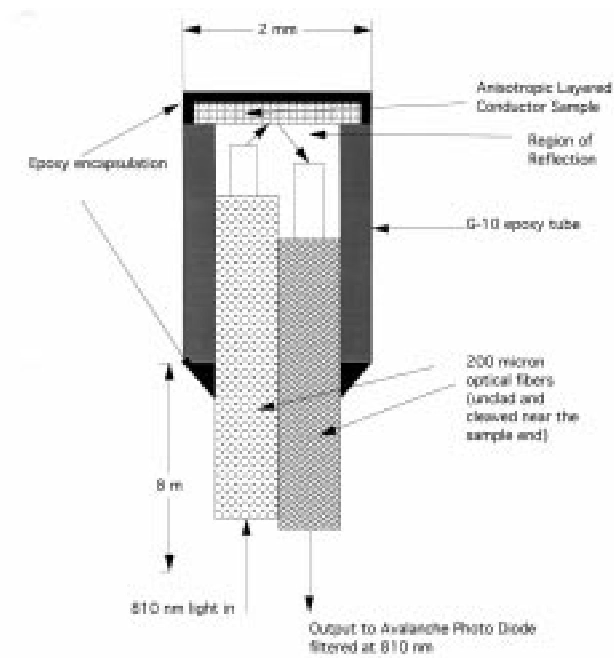


Figure 2. Schematic of reflectivity experiment. The unit is placed in a small cylindrical package along with the Faraday and B-dot sensors axially in the MC1 generator directly below the He-cryostat tail in flowing liquid nitrogen.

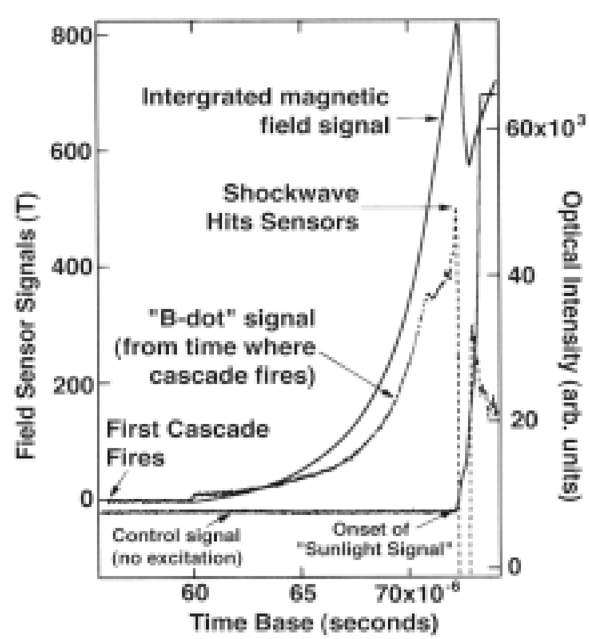


Figure 3. Time dependence of the "B-dot" sensor and control signal. When the shock wave hits the center region at about 72 microseconds, the "B-dot" coil is destroyed and the remaining optical receiver fiber sees very bright light.

in an environment where it is often difficult to obtain information about one's sample. We were excited by the reproducible, oscillatory nature of the quantum well data, and also by the drop of reflectivity above 200 T in the $NbSe_2$ sample. Work is now underway to compare the known electronic structure of these materials with the energy scales (photon energy, magnetic energy) with the data.

Thus it seems there are new opportunities in ultra high field physics. It may be better not to think about how to extend low energy scale problems into the regime of 1000 T class experiments, but to think about new kinds of condensed matter physics at these larger energy scales - 100 K, near infrared, 1000 T, etc. where materials with bandwidths on the scale of 50 meV should really start to feel these effects. Thus, even simple theoretical questions like "what does the band structure of these systems look like at 800 T?" need to be addressed. And second, experimental questions like "how can we use the highly advantageous photonics-based instrumentation to get at the physics?" deserve consideration.

This international research activity involves a broad collation of participants and institutions, including: J.S. Brooks, L. Engel, S-Y Han, (FSU/NHMFL); Z. Wang, B. Zhang (Boston College); J.A.A.J. Perenboom (Univ. of Nijmegen); W. Lewis, B. Marshall, S. Gallegos, D. Devore, M. Grover, G. Leach (Bechtel); C.H. Mielke, D. Rickel, W. Lewis, D. Clark, M. Fowler, J. King, L. Tabaka (LANL/NHMFL); J.A. Simmons, M.J. Hafich, J.L. Reno (Sandia National Labs); summer interns J. Cothern (Gilford College), J. Detwiler (Occidental College), E.C. Clark (Clark Univ.); R.G. Clark (UNSW Group); N. Miura (ISSP Tokyo Group); O. Tatsenko (Sarov Russia Group). This research is funded by NSF-DMR-95-10427; DE-AC04-94AL85000; and the NHMFL.

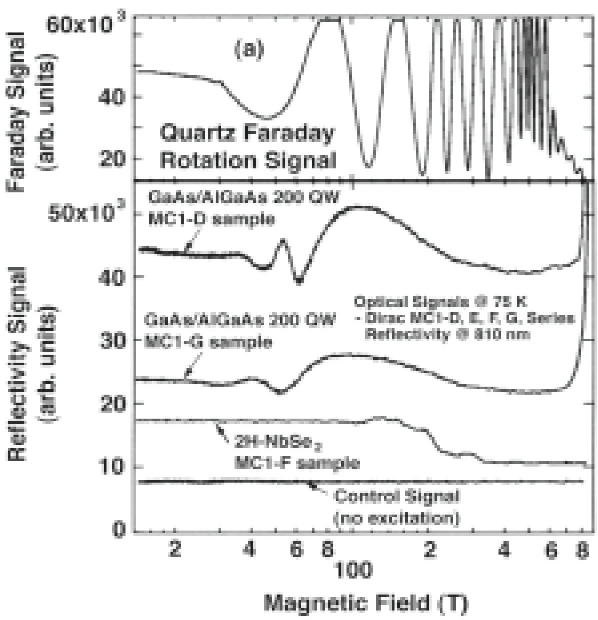


Figure 4. (a) Faraday and (b) GaAs/GaAlAs, $NbSe_2$, and control signals. Note the similarity between GaAs/GaAlAs signals for completely different runs. Note also the drop by 50% in the reflectivity of the 2H-$NbSe_2$ above 200 T, and the very flat control signal over the entire field range.

[1] S. Valfells, *et al*., Phys. Rev. B **54**, 16413 (1996).
[2] H. P. Wei, *et al*., Phys. Rev. Lett. **61**, 1294 (1988).
[3] L. Engel, *et al*., Phys. Rev. **B 43**, 6828 (1991).
[4] H. L. Störmer, *et al*., Phys. Rev. Lett. **56**, 85 (1986).
[5] N. Harrison, *et al*., Phys. Rev. Lett. **54**, 9977 (1996).
[6] S. Hill, *et al.,* to be published. (1997).

HIGH B/T FACILITY *cont. from page 1*

50 hours from 4 K to 12 mK in 8 T (the maximum field of the demagnetization magnet).

The nuclear demagnetization stage consists of 5 moles $PrNi_5$, in the form of 52 bars (9.0 cm length x 1.0 cm width x 0.64 cm thickness) soldered with pure indium to copper strips (57.2 cm length x 0.32 cm thickness x various width: 50 moles total). The nuclear refrigerator meets the design cooling capacity of at least 10 nW at 1 mK. In the first demagnetization cooling, the system was successfully cooled below the Neel transition of ^{3}He (T_N = 0.934 mK) with a residual field of 6 kG. The temperatures were measured using a ^{3}He melting pressure thermometer. The heat leak was determined to be less than 10 nW at both 1 mK and 20 mK, with no significant field-dependent heat leak at 20 mK up to 15 T. We believe that temperatures below 500 µK will be attained easily in the next run and will be followed with a Pt NMR thermometer.

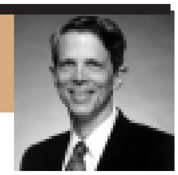
Some of the experiments planned with users in the near future include quantum Hall effect studies; determination of the upper critical fields for ordered phases in solid ^{3}He; and transport measurements for polarized dilute ^{3}He-^{4}He liquid mixtures.

Dewar being lifted into position around dilution refrigerator.

For further information, potential users may contact J.S. Xia at 352-392-8869; jsxia@phys.ufl.edu.

Attention Users

Bruce Brandt
Director, DC Field User Programs



The assistance provided to NHMFL users by the DC and Pulsed Magnet Facilities staff has proven to be critical to efficient, effective research. This is even more true when special equipment like a laser, far-infrared spectrometer, dilution refrigerator, or magnetometer must be used. Such equipment requires a local physicist to develop and maintain it, and to train users.

The DC Facility in Tallahassee has benefited greatly from several able scientists who have built up our instrumentation and helped users while working as postdoctoral fellows. Thomas Schmiedel (visible optics), Yongjie Wang (infrared optics), Murali Chaparala (cantilever magnetometry) and Christian Wolters (magnetometry) are well known to users. Some of these pioneers have moved on and others are preparing to do so. We have therefore moved to replace them with permanent "instrumentation physicists," whom I would now like to introduce.

First to arrive will be Yongjie Wang, who hasn't far to travel. Yongjie has developed the Tallahassee far-infrared magneto-optics instrumentation into a reliable facility. He has also pursued his own research on high field spectroscopy of semiconductors, recently focusing on resonant electron-phonon interactions in GaAs/AlGaAs quantum well structures.

Xing Wei received his undergraduate degree from Peking University and his Ph.D. from the University of Utah, where he studied fullerenes, conducting polymers, and light-emitting diodes made therefrom. He has been a Director's Postdoctoral Fellow at the Los Alamos National Laboratory since January, 1995, studying low-dimensional correlated electronic materials. His technical expertise includes time-resolved photo absorption and photo luminescence, optically detected magnetic resonance, and Raman spectroscopy. While Xing has not used the facility in Tallahassee, he has been developing a probe that will allow spectroscopy of low-dimensional materials in the 20 T superconducting magnet in Los Alamos. Xing expects to arrive in Tallahassee in early October.

Early October is also when Donavan Hall will be coming to Tallahassee from Baton Rouge, Louisiana. He will have finished his Ph.D. work with Roy Goodrich, some of it done at the NHMFL in Tallahassee and Los Alamos, and will be taking over user support in the area of magnetic measurements. Donavan is familiar with the magnetization measurement techniques used at the NHMFL. He already has begun developing with Roy Goodrich a new SQUID detector for transport and magnetic measurements in the 33 T resistive magnet. It relies on a field cancellation coil developed by the NMR Magnet Development Group and has been tested and used to 32 T. We are looking forward to further development of this technique in addition to those already available to users.

Chautauqua 1997

The NHMFL offered its second Chautauqua Short Course for College Teachers in mid-June. This year's three-day course, entitled "Who needs magnetic fields?," was taught by members of the laboratory faculty and staff and focused on magnetism in science and technology. Laboratory Director Jack Crow led the program with an overview about the critical importance of magnetic fields to research and technology, including their implications for quality of life enhancements and economic development.

Dr. Crow was followed by Associate Professor Justin Schwartz (head of the NHMFL's HTS Magnets & Materials group), who gave an overview on superconductivity, and Professor Steven Van Sciver (interim director of NHMFL Magnet Science and Technology), who led a discussion on cryogenics. The sixteen participants of the program then explored the laboratory with an in-depth tour of the research facilities. At the end of a busy "Day One," smaller groups were formed so that participants could focus on one of three subtopics—Physics, Engineering, or Biology & Chemistry—for the remainder of the course. Participants also devoted considerable time to discussing and examining new teaching strategies and developing resource materials to be used in courses at their home institutions.

The Chautauqua annual series of courses, sponsored by the National Science Foundation, offers specifically designed learning opportunities for undergraduate college teachers of science. The NHMFL Chautauqua course provided a setting for college teachers to learn about the advances in science and technology promoted through the lab; to interact and discuss research and teaching with top scientists and scholars; and to examine and develop strategies to incorporate these new understandings and advances into their curriculum.

The sixteen participants came from community colleges and universities across the nation, including Tulsa Community College, OK; Gonzaga University, WA; and Jacksonville University, FL. In a post-program evaluation, the participants rated the course as having a good to excellent overall value, and all indicated that they would recommend the course to a colleague. As one participant wrote, "[The course] provided a great vision of future applications of high magnetic fields and also state of the art facilities."

This article was contributed by Sam Spiegel, director of NHMFL K-12 Educational Programs, 850-644-5818, spiegel@magnet.fsu.edu.

NHMFL-EURUS Technologies Partnership Update

The NHMFL established its first on-site partnership with EURUS Technologies in October 1996. The company moved into new facilities in Innovation Park in March 1997 and the pace of activities throughout the period has been extraordinary. EURUS General Manager John Romans shares some of the highlights.

With barely enough time to catch our breath, the vision shared by EURUS and the NHMFL—that collaborative development of HTS technologies would drive accelerated technological innovation—is rapidly becoming a reality.

Beginning with the record-setting, pre-delivery testing of the 12.5 kA HTS power lead built for CERN, there have been numerous technological advancements and joint EURUS-NHMFL accomplishments, including:

- Development of three new power lead designs, with ratings from 10 A to 20 kA (Figure 1)
- Reduced contact resistance in the SL Series™ power leads by an order of magnitude (Figure 2)
- Improved quality assurance and production procedures for the fabrication of HTS power leads
- Established characterization codes and testing programs for ongoing material/product development
- Submittal of several SBIRs with NHMFL personnel focusing on higher performing HTS materials and improved production processes
- Initiation of a long length high voltage HTS transmission cable demonstration program with the lab, local utilities, and other industry partners.

It should be noted that the only "negative" event was the departure of Dr. Patrick Henning, who was "on loan" to us from the NHMFL and provided us with invaluable assistance in establishing the characterization codes and testing programs mentioned above. Pat, whose postdoctoral advisor was none other than NHMFL Director Jack Crow, earned his Ph.D. in October, 1996, and he moved on to new endeavors at Brookhaven National Laboratory this spring. We found this ironic, since he relocated to Long Island, NY—the place from whence we came! Dr. Richard Hodges joined us from the University of Birmingham, England, in April.

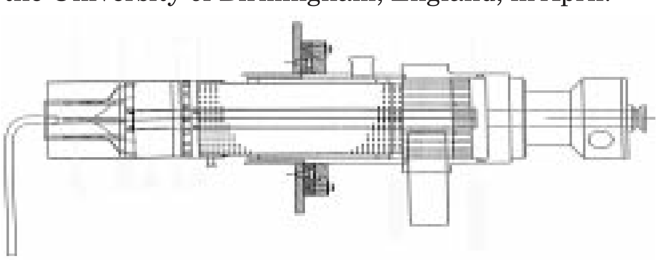


Figure 1. Schematic design for multi-kA class SL Series™ HTS power leads (drawing by NHMFL magnet designer Steve Kenney).

Immediate Benefits of Partnership

The accelerated integration of HTS technology into commercially viable products has not only enabled EURUS to respond more rapidly to industry demands, but it has also positioned EURUS to better service the increasing power demands of the NHMFL.

Demonstrating the mutual benefits of such accelerated product development, EURUS has recently completed an assessment of the laboratory's helium and power consumption rates in an effort to significantly reduce operating costs by integrating HTS power leads into several magnet systems at the laboratory. These comprehensive lead systems have demonstrated the ability to dramatically reduce helium burn-off, enhance run times, and make user support easier on operating personnel.

Looking Ahead

While an aggressive pace has been set for the technical development and ongoing commercialization efforts of HTS technology, EURUS is confident that the relationship established with the NHMFL will continue to facilitate technological breakthroughs at a rate faster than ever envisioned. EURUS has been honored to work with such an extensive group of dedicated scientists and engineers and is convinced that a model for success has been seeded here at Innovation Park.

For further information on the NHMFL-EURUS Technologies partnership see the Summer and Fall Issues of NHMFL Reports. John Romans may be contacted at 850-574-1800, romans@magnet.fsu.edu.

Figure 2. Rendered drawing of improved termination design for SL Series™ power leads (original drawing by NHMFL magnet designer Steve Kenney).

EVERGLADES *cont. from page 4*

hydrocarbons (PAH), and heavy metals. The effect of binding to organic matter on the bioavailability of chemicals is a particularly interesting—but poorly understood—phenomenon. Most compounds and especially heavy metals are most easily absorbed by living organisms (bioavailable) in their ionic form. It is therefore extremely important to know the association of metals or compounds with DOM in the different environments. In addition, to truly understand the bioavailability, one also needs to know the consumption rate of the organic matter that ties up the metals, pesticides, etc. DOM is mainly consumed by microorganisms like bacteria, which will result in changes in speciation and liberation of organically complexed components in their ionic and more bioavailable form. The bioavailability of substances can thus vary dependent on the microbial populations present in the water, soil, and sediment. Despite the tremendous importance of DOM in freshwater ecosystems, little is known about its identity, properties, function, and dynamics. Most chemical models of the freshwater systems are still based on inorganic constituents and overlook the importance of organic constituents in acidic aquatic ecosystems. Our approach has been to understand the physiochemical identities and properties of DOM in freshwater wetland ecosystems at a molecular level. Although pore waters are an important part of the total system, we at present concentrate on the water column as sampling of this water, especially in larger quantities, is far less complicated.

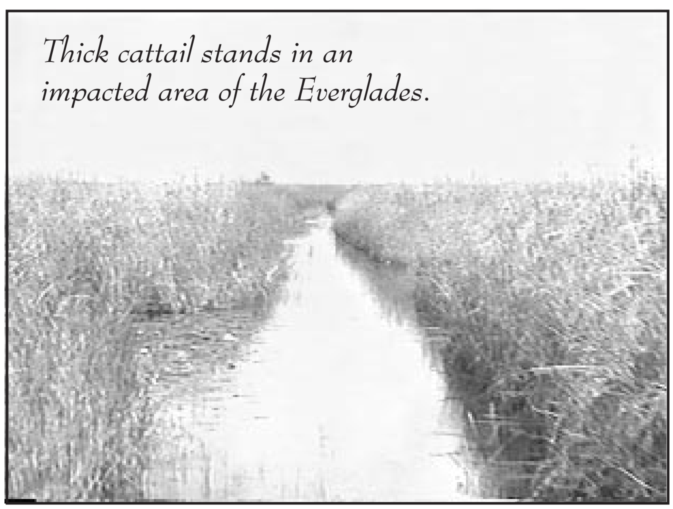
New Research Activities with South Florida Water Management District

An example of our studies is collaborative research we just begun with the SFWMD on the cycling and sources of phosphorous (P). The interests of the SFWMD in P-cycling are several. Most importantly, they are mandated to preserve the Everglades and are required to reduce the levels of P in the waters that enter the Everglades to levels that do not alter the natural conditions. The natural P-levels are below the detection limits of their analytical techniques, thus regulation of the P at these levels and the design of treatment of the waters to achieve those levels is a difficult to achieve for them. The techniques available at the NHMFL and FSU will allow the characterization of the P sources, as well as P-cycling at low levels. Additional importance to the identification of the P-sources comes from the passage of a November 1996 referendum establishing "polluter pays" principle in Florida.

Phosphate has historically been a limiting nutrient in the oligotrophic Everglades. Waters that drain agricultural lands and enter the northern part of the Everglades, called the Water Conservation Areas

Unimpacted Everglades. White areas are periphyton communities.

(WCAs), are known to contain elevated levels of P, but the exact source of this P has not been fully determined. It may be due to direct application of fertilizers, from leaching of the organic-rich, peat-like soils in the agricultural areas that have been oxidized from aerial exposure, or most likely, from some combination of sources. Unperturbed Everglades wetlands with low phosphate concentrations are typified by extensive sawgrass marsh communities interspersed with an attached and floating periphyton mat in the relatively non-vegetated sloughs (shown above). The unperturbed periphyton communities are composed of calcareous mats of cyanobacterial-diatom assemblages. With increased P loading into the Everglades, both the periphyton and aquatic vascular plant communities have responded with a shift in species composition and biomass. At the high P-end of the spectrum the calcareous mats are replaced by non-calcareous filamentous green algal mats with lower biomass and sawgrass meadows are replaced by thick cattail stands



Thick cattail stands in an impacted area of the Everglades.

up to eight feet tall (shown above). As one moves to lower P concentrations the cattail stands become less dense and less tall and in the unaffected areas where the sawgrass is dominant large areas of open water

EVERGLADES *cont. on page 11*

exist. Cattails respond rapidly to P supply, have high growth rates and retain most of the P in the leaves and roots. Therefore, cattail stands have shorter turnover times, higher litter production rates, and higher decomposition rates, compared to sawgrasses, and the P loading leads to increases in organic carbon loading to the sediments which results, among others, in increases in total phosphorus, total organic carbon, and decreases in reduction potential. It is thus likely that the cattail stands will reach a steady-state condition rapidly and then loose their ability to remove dissolved P resulting in the expansion of the cattail areas to the further downstream areas. These changes in the P cycling are brought about by significantly enhanced growth of sediment microorganisms, particularly the anaerobes, in response to this enhanced organic carbon input. In addition, P loading leads to increases in denitrification, sulfate-reducing activities, and methanogenesis, which are all signs of increased organic carbon cycling in the sediments. This is apparent in the peat oxidation rates where cattail-dominated, P-impacted areas have sediment peat oxidation rates of 1.1 cm/yr, which is four to five times higher than the peat oxidation rates of sawgrass-dominated sediments.

Furthermore, the disappearance of the calcareous floating mat associated with the increased P-input reduces co-precipitation of P with calcium. Total P in the sediment pore waters also increases ten-fold in the P-enriched regions, adding an additional P reservoir. Most of the sedimentary P is likely to be organic phosphorus in origin because of the observed increase in organic carbon loading to these sediments. P ionically or covalently bound to these complex organic biomolecules (e.g. cattail and periphyton detritus) and geomacromolecules (e.g. humic and fulvic acids) will require re-mineralization by heterotrophic microorganisms before it can be utilized by higher plants. This sedimentary organic P is the largest P reservoir and its turnover time will be a critical factor controlling the extent (and rate) to which elevated P will migrate deeper into the WCAs and the Everglades National Park through a series of macrophyte uptake-bacterial regeneration cycles. Each regeneration cycle will release dissolved organic phosphorus (DOP), which will be transported downstream until the DOP is hydrolized and taken up by plants. This suggests we may see a moving P "plume" in these areas with time as the organic P reservoirs (both sediments and water column) are slowly remineralized by the microorganisms and the DOP moves downstream. Furthermore, this suggests that phosphate "problem" will continue long after the inorganic phosphate loading requirements established by the Everglades Forever Act of 1994 are met.

The unique aspect of our research is the combination of the most modern "conventional" chemical analysis; microbiological assays and sampling techniques; and several novel magnet-based analytical techniques. For example, Capillary Electrophoresis (CE) sorts compounds based on their mass/charge ratios. By carrying out a CE separation of organic compounds followed by FT-ICR-MS, ICP-MS will identify the organic compound that an element (P, metal) is associated with. By duplicating the CE experiment coupled with an ICP-MS will provide a quantitative measurement of the amount of that element with a specific compound. This will ultimately allow determination of binding constants for the organic molecules with P or a metal. Determining the change in speciation of P along the P-gradient in the Everglades in combination with the measurement of changes in speciation in incubation studies will provide information on P-cycling and the bioavailability of the different organo-phosphate complexes. For metals, the speciation can be further defined with EPR spectroscopy. EPR provides information on the valence state and binding environment of magnetic and paramagnetic elements and can identify the location of the metal atom on the complex organic molecule.

The application of this research not only lies in the Everglades or natural wetlands, but these studies on the cycling of elements can also be applied to constructed wetland, which are designed for removal of contaminants, nutrients, etc. Understanding at the molecular level will allow improved designs of constructed wetlands. The long-term goal of our research is to build a predictive model of ecosystem behavior and health and to determine early indicators of ecosystem "health." Future collaboration with the "sensor" group at the Center for Materials Research and Technology at FSU is anticipated with the goal to develop sensors for field measurement or constant monitors of these "early " indicators.

The environmental research group comprises L.-C. Brunel (NHMFL); W.T. Cooper (FSU, Chemistry); N. Dalal (NHMFL and FSU, Chemistry); Y.P. Hsieh (FAMU, Wetland Ecology Program); W.M. Landing (FSU, Oceanography); A. Marshall (NHMFL and FSU, Chemistry); V.J.M. Salters (NHMFL and FSU, Geology); Y. Wang (FSU, Geology and NHMFL).

This article was contributed by Vincent Salters, who may be contacted at 850-644-1934, salters@magnet.fsu.edu, for further information.

29th Annual Southeastern Magnetic Resonance Conference (SEMRC)

October 30 - November 1, 1997
University of Florida
Gainesville, Florida

Deadline for abstracts and advance registration: September 15, 1997

SEMRC will feature invited and contributed papers and posters in NMR, MRI, EPR, and ICR, including time-resolved and multidimensional spectroscopies; high magnetic fields; and applications in material sciences, physics, chemistry, biology, and the medical fields. Invited keynote speakers are Michael Mehring (University of Stuttgart, Germany), Hans Thomann (Exxon Corp.), and Warren Warren (Princeton University).

Abstracts for all presentations and posters, which will be reproduced and bound for distribution to conference participants, are requested by September 15. Advanced registrations (payable to the Univ. of Florida Foundation by check or money order) are also due by September 15. On-site registration will be available at increased fees.

For further information on registration, accommodations, transportation, and the Companion Program, contact SEMRC, Lori Clark, University of Florida, Department of Chemistry, Box 117200, Gainesville, FL 32611-7200; 352-392-4654; *lori@chem.ufl.edu;* (fax) 352-392-0872.

Alexander Angerhofer (*alex@chem.ufl.edu*) and C. Russell Bowers (*russ@physical27.chem.ufl.edu*) are the organizing committee chairs.

Physics of Manganites, Ruthenates, and Related Materials

November 9-11, 1997
NHMFL
Tallahassee, Florida

A small workshop will be held at the NHMFL to share information about the physical properties of Mn- and Ru-based transition metal oxides and to discuss science and technology opportunities in this area. Small informal meetings such as this one are consistent with the NHMFL mission to develop an in-house science program and to promote collaboration among scientists and engineers working in areas related to magnetism and magnet development. The workshop has been limited to thirty invited participants.

8th U.S.-Japan Workshop on High-T_c Superconductors

December 8-10, 1997
NHMFL
Tallahassee, Florida

The NHMFL will host the eighth workshop in this series between members of the Japanese and U.S. science communities that explores the latest innovations in high temperature superconductor research. The series is co-sponsored by the Japanese, and this year's co-chair is Professor K. Tachikawa from Tokai University. Discussion topics include HTS coil for high field use; bulk synthesis, structures and applications; thin films; vortex structure, critical current, and AC loss; new materials and characterization.

Attendance is principally by invitation. For further information, contact conference co-chair Justin Schwartz at *schwartz@magnet.fsu.edu*

VIIIth International Conference on Megagauss Magnetic Field Generation and Related Topics (Megagauss VIII)

October 18-23, 1998
NHMFL
Tallahassee, Florida

Megagauss VIII is the next meeting in a series that began in 1965 in Frascati, Italy. The scope of the conference is to provide the latest results on the generation of very high magnetic fields at the megagauss level and higher, and to present up-to-date highlights of state-of-the-art research in extremely high magnetic fields. Principal topics will be the generation of multi-megagauss fields, the production of non-destructive fields up to a megagauss, the handling of extremely high power in the terawatt range at high energy density, and the application of ultra-high fields in technology and science.

The meeting is intended to combine technological and scientific aspects of generation and use of megagauss fields. Researchers actively involved in ultra-high field studies, engineers building these advanced devices, and young engineers, scientists and students who want to get acquainted with this new and promising area of ultra-high magnetic fields should plan to attend.

The First Announcement for Megagauss VIII was released in April 1997; the Second Announcement, calling for papers, will be released in September, 1997. For details and deadlines, and to get on the mailing list for further information, contact conference coordinator Ysonde Jensen, 850-644-0566; *megagauss@magnet.fsu.edu*; (fax) 850-644-0867.

Physical Phenomena at High Magnetic Fields-III (PPHMF-III)

October 23-27, 1998
NHMFL
Tallahassee, Florida

Once every three years, the NHMFL hosts PPHMF—a major conference for which it is the sole sponsor. PPHMF-II in 1995 attracted 189 participants from universities and laboratories around the world. PPHMF-III expects to bring together a similar congregation of experts to discuss recent advances in areas of science and applications in which high magnetic fields play an important role. The program will include invited and contributed papers as well as posters, covering a broad range of materials and phenomena, including semiconductors, magnetic materials, superconductivity, organic solids, the quantum Hall effect, chemical and biological systems, and the technological use of high magnetic fields.

Please note the following dates and deadlines:

April 15, 1998	Pre-registration and abstract deadline
May 15, 1998	Second announcement and abstract acceptance notification
September 1, 1998	Early registration deadline
September 25, 1998	Manuscript deadline

For further information and to get on the PPHMF-III mailing list, contact the conference coordinator, Mary Layne, 850-644-3203; *layne@magnet.fsu.edu*; (fax) 850-644-5038.

Random Observations

Wallace S. Brey, an important member of the NHMFL extended family at UF, will be honored on the occasion of his 75th birthday. In recognition of his extensive contributions to modern nuclear magnetic resonance and his role as the editor-in-chief of the *Journal of Magnetic Resonance* from 1969 to 1996, the University of Florida will hold the Wallace S. Brey Symposium on November 2. Invited speakers include E. Raymond Andrew, William W. Brey, Richard W. Briggs, Naresh Dalal, Stanley J. Opella, Katherine N. Scott, Edward O. Stejskal, and Charles Watkins. For more information, contact Russell Bowers, UF Department of Chemistry, P.O. Box 117200, Gainesville, FL 32611-7200; 352-846-0839, *russ@physical27.chem.ufl.edu*.

Alan G. Marshall received the 1997 Maurice F. Hasler Award at the Pittsburgh Conference on March 16. The award is sponsored by Fisons Instruments and administered by the Spectroscopy Society of Pittsburgh. The Hasler Award, which is given in alternate years, recognizes major achievements in spectroscopy that offer significant potential for application. Dr. Marshall is the co-inventor (with Melvin B. Comisarow) of Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometry, an ultrasensitive analytical technique that is used to investigate complex chemical mixtures such as crude oil and molecular structures such as proteins. More than 200 FT-ICR systems have been installed worldwide. Professor Marshall joins a distinguished list of award winners that includes a Nobel Prize winner and four members of the National Academy of Sciences.

Marshall and the activities of his research group were prominently featured in the cover story, “Florida Magnet Lab Attracts Attention,” of *Chemical & Engineering News*, March 17, 1997. *Analytical Chemistry News & Features* has likewise reported the group’s activities recently: “Electrons get cool” (May 1, 1997, p. 278 A) discussed a new approach for producing low-energy electrons by using the Penning ion trap of an FT-ICRMS instrument; and “Breaking the record” (June 1, 1997, p. 336 A) reported a new mark for high molecular mass, unit-resolution mass spectrum, by using the 9.4 T FTMS instrument at the NHMFL to measure the molecular mass of chondroitinase I and II (112,508 and 111,713 Da, respectively) with unit resolution and 3 Da accuracy.

Adriana Moreo, associate professor of physics at FSU and a theorist with the NHMFL Condensed Matter/Theory Group, has been elected Member-at-Large to the Executive Committee of the Division of Computational Physics of the American Physical Society.

1997 NHMFL Summer Minority/Women Research Program is wrapping up this year’s internships as presstime approaches. This program brings undergraduate women or members of ethnic minority groups to the laboratory for two months to work alongside scientists on projects that relate to the students’

Random Observations *cont. on page 14*

research interests. Eighteen students participated in this year's program, and a full report on their experiences will appear in the Fall Issue of *NHMFL Reports*. We are pleased to pass along at this time, however, a wholly unsolicited "thank you" received from Jenny Magnes, who was a member of the internship class of 1996. Jenny's mentor was instrumentation physicist, Eric Palm, but she obviously had great learning experiences and interactions with other members of the Instrumentation and Operations group headed by Bruce Brandt.

Jenny writes to Bruce on June 16:

> *This is a thank-you-email to you and the staff of the NHMFL. In great part, thanks to the opportunity given to me last summer and your letter of recommendation, I have been accepted in a Ph.D. program at University of Delaware and am currently working on my own research project here at Argonne National Lab.*
>
> *The summer internship last year helped me a great deal in building my own picture of the physics field and deciding on the direction in which I would like to continue to pursue in my career... Furthermore, I have been able to share the impressions gained in Tallahassee with many students, physicists, and professors. Professors seem to benefit from this information by being able to pinpoint the weak and strong points in their lesson plans.*
>
> *I would like to assure you on how important the [internship] program can be for many students, such as myself, as well as for the professors at the home-based universities. It appears to me that by permitting undergraduate and graduate students to participate in active research, like is being done [at the NHMFL] and here at Argonne, everyone involved can benefit.*
>
> *Thank you again for last summer's experience.*

Thank *you*, Jenny, and best wishes to you and all our outstanding summer interns—past, present, and future—for continued success.

UF Faculty Win Important NIH Grant

Principal investigator Paul J. Reier, UF Department of Neuroscience, was recently awarded a five-year grant for \$3.38 million from the National Institutes of Health for new research on cellular repair of spinal cord injuries. A critical part of this Program Project Grant is the Magnetic Resonance Imaging (MRI) Core Project, which will be directed by Thomas H. Mareci.

Mareci, an associate professor of biochemistry and an NHMFL faculty member at UF, will team with Dr. Ben Inglis, Dr. Ed Wirth, Xeve Silver, Beth Bossart, and Wenhua Ni-Xu to perform *in vivo* serial MRI exams that will provide important dynamic views of the spinal cord injuries and repairs of the individual animals studied in the project at UF. Each MRI time point has been carefully selected to obtain specific information that will help to (a) determine the severity of spinal cord injury, (b) guide the transplant or vehicle injections, and (c) determine transplant viability at key treatment points. The MRI group will use the 4.7 T magnet system in the Center for Structural Biology at UF to provide a diagnostic service to each subproject of the Program Project.

In addition, the group is already investigating the potential of MR microscopy for providing detailed three-dimensional images of the injury or transplant site in selected postmortem spinal cord specimens. Since these data will be acquired on the 14 T magnet system in the Center for Structural Biology in a time-efficient and cost-effective manner, they will assess the accuracy and reliability of MR microscopy for measuring several important morphological parameters (e.g., lesion and/or transplant volume). Partial funding for the purchase of this magnet system was provided by the NHMFL, along with funding from the Division of Sponsored Research at UF.

Mareci indicated that by using the 14 T magnet system, "we will acquire three types of MR images for each postmortem cord specimen: (a) images with near-isotropic voxels, (b) images with very high in-plane resolution, and (c) apparent diffusion tensor (ADT) images. All three sets of images can be acquired in a single overnight session and each set has unique advantages for measuring specific tissue parameters. These images will be compared to correlative histological sections. This comparison will include measurements from a 3D image visualization to determine how accurately MR microscopy can illustrate lesion volume, transplant volume, and host-graft apposition, as well as white matter sparing in the adjacent host spinal cord. These MR micrographs demonstrate anatomical detail at a resolution rivaling low- to medium-magnification light microscopy, but MR microscopy methods (e.g. diffusion mapping) provide a unique view of this tissue."

The NHMFL is enormously proud of the laboratory's multi-faceted educational programs, and we regularly note that they span K-12 through postdoctoral. For nearly two years, however, *NHMFL Reports* has overlooked reporting about the most critical component of our educational programs: the activities, experiences, and contributions of the postdoctoral fellows of the laboratory.

A postdoctoral position is the next educational step in the career of a young scientist. He is provided opportunities and more independence in order to pursue his or her independent research activities. By incorporating "postdocs" into our research and development activities, we are, in essence, developing our future user program. These outstanding individuals are the next generation of significant drivers of science and technology.

At the same time our postdocs are gaining research experience, the NHMFL can address the specific needs of the laboratory. In order to maximize the facilities and human resources of the laboratory, we often hire postdocs with specific educational skills for specific purposes. This has proven to be very successful, as evidenced by the work of the postdocs in the Instrumentation and Operations group, who were the principal innovators behind the cantilever beam development and new magneto-optics and visible optics instrumentation, which have become important enhancements to user services (see "Attention Users" for further details).

The management of the laboratory must be careful, however, as the needs of the lab are extensive. It would be easy to overload our "best and brightest" young scientists with assignments, so we try hard to maintain a good balance.

To expand educational and research opportunities, the NHMFL would like to initiate an international exchange program. This, we think, would best be done with postdocs. Such a program would broaden the exposure of NHMFL facilities to the international community and vice versa. To this end, the NHMFL is pursuing the establishment of a European-U.S. Scientific Foundation, which would support four European postdocs to the NHMFL and four U.S. postdocs to Europe.

Without further delay, we are pleased to introduce—and publicly thank—the postdoctoral fellows currently affiliated with the NHMFL. Even a cursory review reveals the remarkable breadth of their contributions and educational experiences, and the bright future ahead for magnet-related science and technology.

Bruce C. C. Amm.
Advisor: Steven Van Sciver; MS&T, Δ-B. Bruce is presently involved in two closely related areas of study. The first is pancake coil fabrication from surface-coated high critical temperature $Bi_2Sr_2CaCu_2O_x$ (Bi2212) superconductor. The second is the study/characterization of the mechanical properties of Bi2212 and how strain affects its superconducting properties.

Bertrand Baudouy.
Advisor: Steven Van Sciver; MS&T, Cryogenics. Bertrand is working on two different, but closely connected, experimental subjects: the study of superfluid helium flow at high Reynolds number in the Liquid Helium Flow Facility; and the study of the hydrodynamical characteristics and the cavitation effect on a liquid helium centrifugal pump (which is used in the first experiment). Bertrand is also investigating the heat transfer equation applied to superfluid helium in the turbulent regime for different configurations such as steady-state 2D and 3D, transient 1D (not semi-infinite media), 2D and 3D.

Scott Ekern.
Advisor: Alan Marshall; CIMAR, FT-ICR. Scott's research focuses on three areas: photodissociation studies of proposed interstellar polycyclic aromatic hydrocarbon cations; fluorescence detection of ions trapped in an ICR; and electrospray ionization of biological molecules.

Mark R. Emmett.
Advisor: Alan Marshall; CIMAR, FT-ICR. Mark is a neuropharmacologist with an extensive background in biological mass spectrometry. He is establishing biochemical/biomedical applications for FT-ICR mass spectrometry and is collaborating with other labs for biological analysis by FT-ICR. He is interested in using FT-ICR in the study of endogenous cytokines (growth factors) produced by brain tumors; specifically, highly aggressive and untreatable gliomas. The endogenous active forms of the cytokines produced by gliomas are unknown, and FT-ICR is being used to identify them. This information is critical for subsequent work toward development of a treatment for these brain tumors. In the near

future Mark will advance to a new position at the NHMFL: Director of Biological Applications in the FT-ICR group.

Alan Freeman.
Advisor: S.J. Blackband; UF Neuroscience/Center for Structural Biology. Alan's interests involve project exploration of the brain activation detected by functional magnetic resonance imaging (fMRI) during auditory stimulation. The research group is comparing the fMRI responses of a group of dyslexic volunteers to those of a normal control group. He also supports other fMRI groups at UF interested in the motor and language cortical areas. Alan is developing the application of current density imaging with MRI in the spinal cord, and it is hoped that this will provide a sensitive technique to examine damaged and diseased spinal cords and their response to therapy.

Michael A. Freitas.
Advisor: Alan Marshall; CIMAR, FT-ICR. Michael joined us in June, making him one of the newest postdocs at the NHMFL. His research activities will focus on the development of two-dimensional FT-ICR for the analysis of complex mixtures and exploring gas phase conformations of peptides and proteins using hydrogen/deuterium exchange reactions.

Riqiang Fu.
Advisor: Alan Marshall; CIMAR, NMR. Riqiang is working on the development of new techniques in the field of liquid-state and solid-state NMR spectroscopy, and their applications to physics and chemistry.

Claudio Gazza.
Advisor: Elbio Dagotto; CM/T. Claudio's research centers on quantum magnetism and strongly correlated electron systems. He is presently focused on different minimal models in low dimension for quantum spins and electrons problems of current interest. In particular, he is using numerical techniques like the density matrix renormalization group and Monte Carlo.

Wilhelmus J. Geerts

Wilhelmus J. Geerts.
Advisors: Jeff Childress and Steve Pearton (UF/Materials Science/ NHMFL) and Bruce Brandt (NHMFL/Operations). Wim has worked on several projects in Gainesville and Tallahassee, including electric transport properties of the nitrides; magnetic properties of Fe/Al_2O_3 multilayer and granular materials; and magneto-optical (MO) properties in high fields and at low temperatures. Most of the work he did at UF. In May, 1997, he moved to Tallahassee to develop the MO probe in a user facility. This fall, Wim will join the Materials Physics Department at SouthWest Texas State Univ. in San Marcos, where his research will focus on the optic, electric, and magnetic properties of ultra thin films and multilayers.

Zachary Ha.
Advisor: Robert Schrieffer; CM/T. Zachary studies novel quantum phenomena in low dimensions using exact method, conformal field theory techniques, and numerical methods. Examples include spin chains, one-dimensional metals (Luttinger liquids), and 2D frustrated spin systems. The 2D spin systems are also closely related to the topic of high temperature superconductivity.

Stephen Hill.
Advisor: Jim Brooks; CM/ T, Molecular Crystals Group. Stephen has developed techniques to measure the microwave conductivity of metals and superconductors in high magnetic fields. He uses these techniques specifically to measure magneto-transport on small samples and for magnetic resonance measurements such as cyclotron resonance and electron paramagnetic resonance. Stephen is leaving the NHMFL this summer to become an assistant professor of physics at Montana State Univ. in Bozeman.

Jun Hu.
Advisor: Robert Schrieffer; CM/T. Jun has done research on electron gas in nonuniform magnetic fields, the quantum dot system, manganite materials, and type-II superconductors. In the near future, Jun will advance to a research associate position at the Univ. of Maryland at College Park.

Yongmin Kim.
Advisor: Laurence Campbell; Pulsed Field Facility, NHMFL at Los Alamos. Yongmin's main interests are the magneto-optical properties of semiconductor heterostructures such as doped

and un-doped GaAs-AlGaAs quantum wells, AlGAAs-GaAs, and other higher band gap semiconductors. He is also interested in magneto-transport experiments for these semiconductor systems.

Stephen T. Kinsey.
Advisors: Timothy Moerland (FSU Biology) and Bruce Locke (FSU Chemical Engineering); CIMAR, NMR. Stephen's work centers around three areas. (1) Diffusional processes and intracellular reaction kinetics in living muscle tissue (sponsored by NIH postdoctoral fellowship and the American Heart Association). (2) The use of magnetic resonance imaging to measure rates of transdermal water and drug mobility across skin and the extent to which electric fields enhance this process (sponsored by the Whitaker Foundation). (3) The use of NMR to examine the structure and electrophoretic properties of gel media (sponsored by NASA). He will be leaving the NHMFL in August for an assistant professor position in biochemistry at the Univ. of North Carolina at Wilmington.


Stephen T. Kinsey

André Luiz Malvezzi.
Advisor: Elbio Dagotto; CM/T. André conducts numerical studies of electronic models applied to low dimensional systems. In particular, techniques such as Lanczos Method and Density Matrix Renormalizaton Group (DMRG) are applied to the investigation of electronic and magnetic properties of Hubbard-like models in one and two spatial dimensions.

George B. Martins.
Advisor: Elbio Dagotto; CIMAR, EPR. George's main interest is the numerical study of static and dynamic properties of one and two dimensional spin systems, including chains (gapped and non-gapped), ladders (two or more legs), and cuprate materials (doped and undoped). An interesting point of these studies has been the effects caused by the introduction of non-magnetic impurities on these systems, mainly the enhancement on short range order.

Charles H. Mielke.
Advisor: Alex H. Lacerda; Pulsed Field Facility, NHMFL at Los Alamos. Charles is involved in pulsed high magnetic field experiments ranging from the capacitor-driven 60 T coils to the explosively-driven flux compression generators extending to 850 T. Most of his measurement expertise lies in transport properties at low temperature, although he is presently involved in magnetization studies and optical reflectivity experiments. He studies Fermi surfaces in organics, 2DEG systems, unconventional metals, and heavy fermion compounds—all in the highest fields available.

Eduardo Miranda.
Advisor: Bob Schrieffer; CM/T. The focus of Eduardo's work has been on strongly correlated electronic systems, specifically the class called heavy fermion materials, which contain elements from the rare earths or actinides, such as Cerium or Uranium. These materials have a wide array of behaviors, ranging from superconductors to insulators. The main challenge in studying these systems, he says, is to learn how the strong interaction among the electrons, which is thought to be essential to their understanding, can lead to such myriad behavior. He is also involved with questions of how deviations from stoichiometry and/or crystalline order affect the low temperature behavior of these systems. Eduardo will leave the NHMFL this summer to become an assistant professor at the Univ. of Campinas.

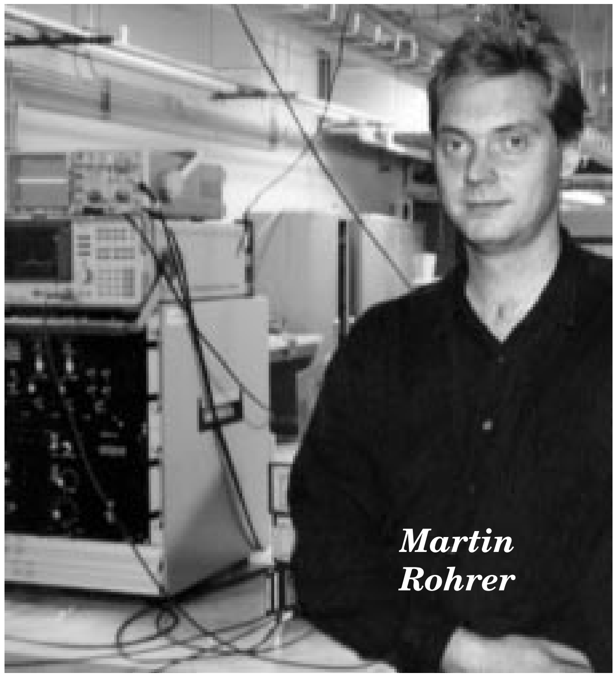
Thomas Palm.
Advisor: Peter Fajer; CIMAR, EMR. Thomas uses fluorescence energy transfer between labeled sites on the muscle proteins Troponin C, actin, and myosin to measure inter- and intramolecular distances at various stages of the contractile cycle. These

experiments show which rearrangements the proteins undergo during muscle contraction and relaxation.

Luca Pardi.
Advisor: Louis-Claude Brunel; CIMAR, EMR. Luca's research interests center on the magnetism of exchange coupled systems; molecular-based magnetic materials; low dimensional magnetic materials; large spin molecules; and high nuclearity spin clusters. He is leaving the NHMFL this summer to assume new responsibilities at the Institute of Atomic and Molecular Physics in Pisa, Italy, where he will be working on the development of a high frequency–high magnetic field electron paramagnetic spectroscopy project.

Martin Rohrer.
Advisor: Louis-Claude Brunel, CIMAR, EPR. Martin conducts experiments in high field/high frequency EPR and ENDOR (Electron Nuclear Double Resonance). He also has designed a suitable microwave resonance cavity for the existing multifrequency high field EPR spectrometer in order to enhance its sensitivity by a factor of approximately 100. This is extending the capabilities of the spectrometer to allow for the measurement of more diluted and lowly concentrated radical systems, such as specific biological spin systems. His first applications of the cavity have demonstrated the successful gain in sensitivity and will serve as the required construction platform for further extensions concerning quasi-optical microwave-propagation to the cavity and additional sample irradiation by radio frequency to complete ENDOR capability.

P.V.P.S.S. Sastry.
Advisor: Justin Schwartz; MS&T, HTS Magnets and Materials. Sastry's research and development activities focus on three areas: the synthesis and characterization of Hg-Ba-Ca-Cu-O superconducting materials; the influence of superconductor-metal interfaces on the microstructure and superconducting properties; and the fabrication of Bi-Sr-Ca-Cu-O superconductor wires and tapes.



Martin Rohrer

Thomas Schmiedel.
Supervisor: Bruce Brandt; I&O. Thomas's research concentrates on high magnetic field measurements of optical and electronic properties of semiconductors. Presently he is studying ZnMnSe and GaAs Quantum well systems to measure spin interactions of electrons with manganese in the host lattice, as well as electron effective masses in different symmetry points of GaAs and Landau level anomalies. Thomas developed the visible optics facilities of the laboratory, which have become very important new tools for users.

Victoria Soghomonian.
Advisor: Timothy Cross; CIMAR, NMR. Victoria is investigating the stabilization and temporal and spatial characterization of resistive magnets for high field biological NMR experiments. She is also developing instrumentation and novel experimental methods for solid state NMR and biological NMR in magnetic fields 20 T and above.

Zhiyan Song.
Advisor: Timothy Cross; CIMAR, NMR. Zhiyan is probably the newest postdoc at the NHMFL, arriving in early July. A year ago he defended his Ph.D. thesis in the Division of Physical Chemistry at Stockholm Univ., where he worked for Prof. Malcolm Levitt, a very well known solid state NMR spectroscopist and for Prof. Allan Rupprecht, a biophysicist known for his work on oriented fibers of DNA. His thesis title was "Conformational Transitions and Molecular Order in Wet-Spun Oriented DNA." At the NHMFL, Dr. Song will help to implement and develop solid state NMR techniques to characterize high resolution three dimensional structures of membrane proteins using oriented samples.

Mohammad Reza Vaghar.
Advisors: Hans Schneider-Muntau and Yehia Eyssa; MS&T, Pulsed Magnets. Reza works in the area of stress analysis to derive new formulations for analysis of cylindrical coils with high magnetic fields. He also develops computer codes that can be used for magnet design and development. Reza started at the NHMFL as a research assistant in May 1992 and was the first

student at the NHMFL to earn his master's degree (working under the direction of H. Garmestani and D. Markiewicz).

Yongjie Wang.
Supervisor: Bruce Brandt; I&O. Yongjie conducts infrared magneto-optical studies of semiconductors. In addition, Yongjie has taught thermodynamics at FAMU and has been enormously important to the development of the far-infrared magneto-optics instrumentation at the NHMFL (see "Attention Users" for further information).

Christian H. Wolters.
Advisors: Justin Schwartz, MST, HTS; and Bruce Brandt, I&O. During his position under Dr. Schwartz (March, 1994, to August, 1996), Christian conducted materials research in the field of high temperature superconductors and developed procedures for the synthesis of HgReBaCaCuO superconductors and metal sheathed superconducting wires. Under Dr. Brandt (August, 1996, to present), he has developed user instrumentation in the field of magnetometry. He was also involved with the design and experimental setup of the high field VSM (vibrating sample magnetometer), the cantilever beam magnetometer and AC susceptometer. Christian recently accepted a position in private industry with Tencor (Milpitas, CA) as a senior systems engineer.

Li-Ye Xiao.
Advisor: Steven W. Van Sciver; MS&T, ΔB/Cryogenics. Li-Ye's research focuses on the stability of high Tc superconducting magnets, and the characterization of high Tc superconducting tapes for magnet applications.

Seiji Yunoki.
Advisor: Elbio Dagotto; CM/T. Seiji is involved in the theoretical study of strongly correlated electronic systems.

Christian H. Wolters

Zhongqi Zhang.
Advisor: Alan Marshall; CIMAR, FT-ICR. During Zhongqi's tenure with the NHMFL, he set up the biochemistry sample preparation lab and the online LC-MS systems. His research activities focused on the study of protein high-order structure and dynamics by protein-hydrogen exchange and FT-ICR mass spectrometry. He also developed software for mass spectral data analysis. This summer, Zhongqi will start a new position in private industry with Amgen, Inc., in Thousand Oaks, CA.

Cherian Zachariah.
Advisor: Arthur Edison; UF Biochemistry and Molecular Biology/Center for Structural Biology. Cherian's interests involve the determination of the three dimensional structures of neuropeptide precursor proteins using NMR spectroscopy. Cherian and others in Dr. Edison's lab will also be determining the structures of the different peptides when bound to the receptor, both in solution and when expressed in Xenopus oocytes using TRNOE NMR spectroscopy.

CIMAR – Center for Integrated Magnetic Resonance
CM/T – Condensed Matter/Theory
I&O – Instrumentation & Operations
MS&T – Magnet Science & Technology

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