The UMD Physics Newsletter

"going where no newsletter has gone before"

Issue No. 1 ***Spring 1996*** ***Editor: J.R. Hiller***

All-Class Reunion

Don't miss the UMD all-class reunion on July 26 and 27, 1996. The department will have an open house from 1:30 to 3:30 PM on Friday, July 26, with a reception in room 241 of Marshall W. Alworth Hall. Hope to see you there!

Inside this issue

Jordan Steps Down as Department Head

On June 1 of last year, Tom Jordan stepped down as department head, after spending 11 years at the helm. Those years saw many changes and challenges both for UMD and for the department, and we were fortunate that Jordan was willing to take the lead during that time. He succeeded Howard Hanson, who had served even longer, and was succeeded by John Hiller.

While Jordan was Head, the department expanded its research effort in condensed matter physics, added an emphasis on computational physics, expanded the graduate program, and survived the retirement of Gordon Likely. He also had the unfortunate task of guiding recovery from the loss of Don Olson. The expansion of the graduate program was supported by additional teaching assistantships made necessary by the increased enrollment in service courses. Some of the increase in enrollment was driven by new engineering programs that began operation at the time Jordan became Head. At that same time, the department became part of a new college on campus, the College of Science and Engineering. Recruiting of graduate students became a worldwide effort and brought a distinctly international flavor to the program.

Freed from the responsibilities of department head, Jordan has been able to devote more time to teaching and research. He has become the primary instructor for the liberal arts course, Ideas in Physics, that Likely once ruled so well, and has developed new content for the graduate mechanics course that adds nonlinear chaotic dynamics in a fundamental way.

Large Lakes in Our Future

Everyone knows that there is a large lake not far from UMD, but what many may not know is that a new physical limnology institute, called the Large Lakes Observatory, has started in its home on the lower campus. A member of the institute with a joint position in Physics, Elise Ralph, was hired this year and will arrive in January 1997. Searches for additional joint physics faculty will be conducted in the next few years. The director of the institute, Tom Johnson, and two new faculty associated with the Geology Department have already arrived.

This is an exciting opportunity for expansion in research activity and for broadening of the curriculum. We hope to see increased involvement of undergraduates in research and greater variety in the research interests of graduate students. It is, of course, in an area that has seen work before at UMD, by both Michael Sydor and Johnson. Its return has renewed Sydor's interest in remote sensing.

The next issue will bring details of Ralph's research program and of the outcome from the next search.

Outstanding TA of 94-95

Jennifer Adelman was selected as the Outstanding Graduate Teaching Assistant of the 1994-95 academic year. She received a plaque at the annual TA Fiesta, sponsored by the College of Science and Engineering, and a one-year membership in the AAPT. She is now completing her thesis on the modeling of orbital debris under the direction of Greg Ojakangas.

Name this Newsletter!

It needs a catchy name. Think of a good one and send it in. You can use the info mailer on page 5, or the information form on the web page.

Alumni Make Good Recruiters

Your experiences at UMD show that the physics programs have unique qualities of value. If you encounter a high school or college student who would benefit from similar experiences in learning and research, have them contact us or pass along their name and address. We'll be happy to send out information about our programs and arrange for application materials.

Find Us on the Web

The department has a home page at http://www.d.umn.edu/physics. There you will find links to many secondary pages with information about the undergraduate and graduate programs and faculty activities. Check it out and tell us what you think!

Gift Funds

The department has two gift funds. One is a general Development Fund, with which we may soon offer an annual award of recognition to an accomplished undergraduate physics major. The other is the Donald Olson Memorial Scholarship Fund, to which many of you have made donations; it is used to provide a research scholarship for a student at an early stage in his or her studies. If you are able to make a donation to either fund, it will be much appreciated. Please send it to the Development Office, 315 Darland Administration Building, UMD, 10 University Drive, Duluth, MN 55812 earmarked "Physics Development Fund" or "Olson Memorial Fund."

Catch Up with Past Grads

Nancy Smith, M.S. '92

In 1989 I took a job for a few months - just to make some money - for Cyprus Northshore Mining, who had bought and were reopening the old Reserve Mining plant (also known as The Company That Dumped Their Tailings in Lake Superior). How time flies: I've passed my 6th anniversary there, and am happily ensconced as an environmental engineer (golly! I'm using my degree!) for the company, now named Northshore Mining. Given the reputation of the facility and the complexity of this operation, it's an interesting, varied and sometimes frustrating job. I find myself cracking open a (shudder) chemistry book about as often as I rely on my computer, electronics and data analysis skills.

In my off hours, I still teach flying in airplanes and gliders, fly my own airplane (last year's acquisition), sail, kayak, hunt, fish or snowshoe, depending on the season. I also get together with other musicians on Thursday nights for old-time music jams at Sir Ben's tavern. (Come on down, y'all!) Occasionally I'm home long enough to weed the flower bed, paint the house (1992 acquisition) or pay bills. My 'family' now comprises two cats and a dog, all rescued strays and first-class buddies, but to the Census Bureau I'm still a household of one.

Greg Ojakangas, B.S. '82

I received a B.S. in Physics and Geology from UMD in 1982, and an M.S. (1985) and Ph.D. (1988) from Caltech in Geophysics and Planetary Science, respectively. My doctoral work was on the coupled thermal and dynamical histories of the Galilean Moons of Jupiter, and my post-doctoral work at the University of Arizona was primarily on the development of a new mathematical model describing the dynamics of planetary rings. I spent three years as an orbital debris scientist at the Johnson Space Center (JSC), and I continue research in orbital debris modeling with support from JSC. I am also continuing research with the Lunar and Planetary Institute in Houston (where I have had visiting scientist appointments twice), on the thermal and orbital histories of moons of Saturn. I worked for Phillips Petroleum in three-dimensional seismic processing as an undergraduate summer employee in 1981 and 1982.

Recently I have had a teaching position in the Geology department at UMD and for the past two years have been a member of the Graduate Faculty in Physics. I have involved several undergraduates and graduate students in various space science research projects since I initiated UMD's involvement in the NASA Minnesota Space Grant Consortium three years ago.

Dale Heikkinen, B.A. '60

After graduation from UMD, I went to the University of Iowa in Iowa City, IA in the fall of 1960 with the intention of going into space physics under Professor James Van Allen. At the end of my first academic year, I and about 4 other first year graduate students were enticed to switch to Nuclear Physics. We were amenable because at that point in the space physics program your advancement towards a degree was dependent upon the successful launch of the instrument you may have helped build (i.e. build for master's degree and analyze data from instrument for Ph.D.). Many of the launches were unsuccessful in those early days and several of us opted for what we felt was a more certain path towards a degree. Low energy nuclear physics was also a popular and interesting field at that time.

During the summer of 1961, I became a research assistant in nuclear physics under Professor R.R. Carlson. My masters degree research was done on a 400KV Cockroft Walton type accelerator. The work involved the angular correlation of gamma rays emitted in the reaction of protons with ^{22}Ne. I received my masters degree in August of 1962 and proceeded directly on to work on my Ph.D.. My Ph.D. work involved the study of the ^{6}Li + ^{12}C reaction using a Li beam from the newly installed 5.5 MV Van de Graaff accelerator. During the course of this work our lab had the distinction of developing the first on-line computer data acquisition system for a low energy nuclear physics laboratory. I was granted a PhD in June 1965 and spent the summer of 1965 at Iowa as a post-doc.

Beginning in September 1965, I accepted a position as a post-doc in the nuclear physics group of the physics department at Stanford University. My wife Gloria and I lived in Menlo Park, CA and, even though we were only 1/2 mile from the San Andreas fault, the climate provided a great deal of compensation. Access to the Stanford Medical School was also an added benefit for our youngest daughter who was born deaf-blind as a result of German measles during Gloria's pregnancy. This was our first extended time away from the mid-west.

My work at Stanford involved the use of a 9MV Tandem Van de Graaff accelerator. I continued on in the work on heavy ion reactions by looking for radiative-capture gamma rays from heavy-ion induced reactions. We were successful and actually the first to see these in such reactions. I also was involved in the work on isospin forbidden reactions involving both charged particle and gamma ray decay. At that time isospin topics and the early investigations of heavy-ion reactions were the popular topics in nuclear physics. I spent 3 years at Stanford from 1965-68.

In September of 1968, I accepted a position at Lawrence Livermore National Laboratory in Livermore, CA. This involved a move of some 45 miles to the other side of San Francisco Bay, but also to another microclimate of the Bay Area because we are over a range of hills from the bay. The Livermore Valley can have hot days (>100 deg) but the nights are almost always cool enough to require a sweater. While the Livermore Valley is not as famous as the Napa Valley located some 75 miles to the north, we consider our wines (especially the whites) to be equal to or in some cases better than those from Napa. We have some 15 wineries located within a 15-20 minute drive.

At Livermore, I spent approximately the first 20 years in the experimental Nuclear Physics Division of the Physics Department. The first 10 years involved a continuation of low energy nuclear physics research

using a cyclotron and then a cyclo-graaff (a combination of a cyclotron and Van de Graaff). After that, and because of my extensive experience with accelerators, I joined the Rotating Target Neutron Source-II (RTNS-II) project as accelerator physicist and Deputy Facility Manager. This project utilized the most intense source of accelerator-produced 14 MeV neutrons to investigate neutron-induced radiation damage to materials of interest to the fusion energy program of DOE. This facility became an international facility in 1982 when the government of Japan joined in a 50% share of the support and utilization of RTNS-II. This was a very enjoyable period with many lasting friendships made with Japanese colleagues and numerous trips to Japan. In 1987 the DOE decided to shift emphasis from basic research on neutron-induced radiation effects to engineering/applied research using a fast neutron high flux reactor at Hanford, WA. This resulted in the shutdown of RTNS-II. Needless to say, it was a disappointment to LLNL personnel and the Japanese alike. During 1972-73, I spent a year at the University of Jyvaskyla in Jyvaskyla, Finland as a visiting associate Professor of Physics. In 1986, I spent 3 months at Los Alamos National Laboratory as a guest scientist.

In 1988, I rejoined some former colleagues in starting what is now known as the Center for Accelerator Mass Spectrometry (CAMS). We are now part of the Environmental Programs Directorate of LLNL and the center is a Research Institute of the University of California. The primary purpose of the center is, as the name indicates, accelerator mass spectrometry in diverse fields ranging from biology, archaeology, geo-climatology to cosmology. The isotopes used are H, Be, C, Al, Cl, Ca, Ni, and I. CAMS processed over 15000 samples for AMS during FY1995. The other area of research at CAMS is Ion Beam Analysis(IBA). This is the area in which I concentrate my efforts. Macro- and micro-beams of light and heavy ions are used for studies in materials science, biology, non-proliferation and environmental programs. The combined IBA and AMS capabilities make the Center a unique facility.

A Sampling of Student Research Projects

Fang Chen and Zhenzeng Tang, M.S. '96

A scanning tunneling microscope (STM) provides a way to examine surfaces with atomic resolution and can be used to study superconductivity at low temperatures. When a sharp metallic tip is placed within a few atomic diameters of a surface and a voltage applied, a small electric current flows via quantum mechanical tunneling. Observing changes in the current while sweeping the tip over the surface shows the surface topography. The scanning tip of the STM is connected to a piezoelectric tube which can expand or contract under a driving voltage. Studying the response of the piezoelectric material used in the STM as a function of frequency and temperature is crucial for stable operation.

The frequency and temperature response of the piezoelectric tube can be measured using either a relative calibration method or an absolute calibration method. A previous graduate student, Liqiang Tao, did work on the relative measurement method. Our work focussed on the absolute measurement of the displacement of the piezoelectric tube. The absolute calibration method is based on a frequency modulation (FM) technique. In this method, AC signals are applied to the piezo. A tunnel-diode oscillator (TDO) is located near the end of the piezo. The TDO contains a circuit (an LC tank circuit) that consists of an inductor and a capacitor. When the piezo contracts and expands, the inductance of the LC circuit will vary, and therefore change the resonant frequency of the LC circuit. This frequency modulated signal will then be detected and demodulated by a phase locked loop (PLL) FM detector. The output signal of the PLL was measured by a computer-controlled lock-in amplifier. Our goal was to test the method at room temperature, then the low temperature experiments would be carried out.

During two and half months in the summer of 1995, Chen first built the TDO using a germanium back diode, operating at 12MHz, and a tuned amplifier. Then he modified an existing PLL-based FM demodulation circuit to our needs. Each functional circuit was built separately and shielded. After all the parts of the system were tested individually, they were put together. Using this system, the frequency modulation of the TDO was successfully demodulated by the PLL. The measurement instruments included a lock-in amplifier, a frequency generator and a frequency counter, which were successfully controlled by computer using software provided by Tang. The measurements of frequency responses of the piezoelectric tube under room temperature were then carried out. While the system operates properly, the initial results have been less than ideal due to noise. Efforts are still underway to improve the resolution of the circuit.

Brian Edgar, B.S. '96

My summer research in Physics during the summer of 1995 consisted of two projects. One project would be better described as a computer science project. I identified and copied several satellite images from 9-track computer compatible tape to 8mm digital quality videotape. The contents of at least 60 9-track reel-to-reel tapes fit on 1 8mm tape! During the summer, Professor Sydor collected water samples at sites that were simultaneously “photographed” by satellite. By collecting and testing a few representative samples, he hoped to correlate water properties with the satellite data. Once a correlation is established, some patterns in a body of water can be observed without sampling every $(80\ m)^2$ by simply examining satellite data. For the second part of my summer research, I tested water samples collected by Professor Sydor. With the help of Professor Howard Mooers in Geology, I used a laser particle counter to measure the sizes of suspended particles in the samples. We found that the total cross-sectional area occupied by suspended solids in, say, a cubic centimeter of water correlated very well with remote sensing reflectance.

UMD Physics Club 1995-1996 School Year in Review

by Amanda Thralow

In early fall 1995 electrons were held (difficult task) for officer positions within the club. The four valence positions of president, vice-president ,secretary and treasurer were filled by Amanda Thralow, Brian Edgar, Thomas Holecek, and Charlie Mann respectively. John Hiller, the new Physics department head, also became the new Physics club advisor.

After the initial electron meeting the club toyed with several energy states and activity ideas for the year. Items of discussion included building and selling chaotic pendulums crafted by one of the physics club members, Troy Gehrett. (Troy later replaced Thomas Holecek as secretary.) The chaotic pendulum is still in the manufacturing phase and should go on sale next year.

Another idea that came up was to take tours of interesting physics experiments. Places to visit that were mentioned were the Soudan Underground Research Site, Large Lakes Observatory, Fitger's Brew House and Fermilab. So far the Physics club quantum tunneled up to the Soudan Underground Research Site in November, dropped down to the ground state to visit the Large Lakes Observatory on UMD's lower campus in March, and observed high energy smashing at Fitger's Brew House in April. Visiting Fermilab in Chicago is just a matter of picking the date, relatively.

The Soudan Underground Research Site is located in the Soudan Underground Mine State Park, where the DNR preserves the oldest iron mine in Minnesota. Their experiments focus on three major topics: the stability of matter (nucleon decay), the nature and interaction patterns of the cosmic rays, and the particles called neutrinos. These experiments take place in one of a handful of deep underground physics laboratories located at sites around the world. The lab is on the 27th level down into the mine. The ride on the mine shaft elevator down to the laboratory was worth the trip alone.

The Large Lakes Observatory, located right here in Duluth, was well worth giving up the photon to make the short trip. The Large Lakes Observatory mission is to use an integrated systems approach to study large lakes of the world. They are focusing on the physical processes in large lakes, and will collaborate with more biologically oriented programs at other limnological** centers in the U.S. and abroad.

The Physics club also has a web page (http://www.d.umn.edu/physics/physclub.html) on which is a picture of the majority of the members and Dr. Hiller, the club advisor. (The helmets were to protect their hairdos' from the effects of the wind while quantum tunneling.) The members are standing in front of the Soudan Underground Research Site headframe which is directly above the mine shaft which leads down to the Soudan Laboratory. The picture was taken after our tour in November.

A last item of business that the club pursued this year is a club-designed T-shirt. The club quantized and came up with several ideas for what was to be written on the shirt and then the ideas were voted upon. The club decided upon two quotations by two gurus of physics. The quotations are as follows: "Everything should be made as simple as possible, but not simpler," Albert Einstein; and "In science there is only physics; all the rest is stamp collecting," Ernest Rutherford.

And on that note the physics club wishes a wonderful summer to all whose retinas are absorbing the reflection of photons off this newsletter!

**To save you from running to your dictionary, limnology is the science that deals with the physical, chemical and biological properties and features of fresh waters, especially lakes.

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In Memory of ...

Robert Pittman, who passed away in November 1995. He completed his M.S. at UMD in 1994 and was in the Physics Ph.D. program at the University of Illinois-Chicago.

Spring 96 UMD Physics Newsletter Response Form

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Send your reply by one of the following means:

- mail to Department of Physics, UMD, Duluth, MN 55812 .
- e-mail to jhiller@d.umn.edu.
- web page form at the URL http://www.d.umn.edu/physics/response.html.

Thanks!! We'll enjoy hearing from you!