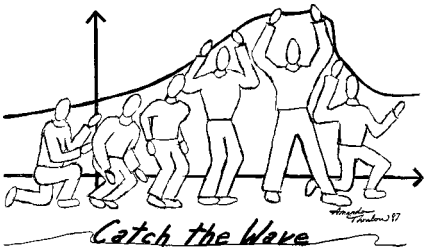

The Wave Packet

The UMD Physics Newsletter

Issue No. 3 ***Spring 1998*** ***Editor: J.R. Hiller***

Another New Faculty Member...

We have a new member of the physics faculty, Meng Zhou, who came to Duluth this January from La Jolla, California. He was an assistant research scientist at Scripps Institution of Oceanography, UCSD. He holds a joint appointment between the Department of Physics and the Large Lakes Observatory, the new physical limnology institute.

Meng was brought up in Shanghai, China. He received his bachelor's degree in applied mathematics/fluid mechanics from Tsinghua University, Beijing, where he wrote his bachelor's thesis on nonlinear turbulent boundary layers. He went to the graduate school of Academia Sinica. His master's thesis is a study of the nonlinearity of the bottom drag of currents in coastal oceans. He came to the United States in 1986, and obtained his Ph.D. degree in physical oceanography at the State University of New York at Stony Brook. His doctoral thesis investigated the salt water intrusion in the Lower Hudson River by observations, analytical methods and numerical modeling. His analysis of the stability of nonlinear gravity currents led to the understanding and prediction of changes of the interface between fresh water and salt water during tidal periods in estuaries and rivers. Meng also worked with Dr. Peter B. Kahn, the former chair of the Department of Physics, SUNY at Stony Brook, to carry out numerical computations for one of Dr. Kahn's books (Kahn 1989: Mathematical Methods for Scientists & Engineers - Linear & Nonlinear Systems). After Stony Brook, Meng went on to the Scripps Oceanographic Institution, first as a post-graduate researcher and later as an assistant research scientist.

Though he has a very theoretical background in physics, mechanics, mathematics, and physical oceanography, Meng has great interest in observational oceanography. He has been in both the Arctic and Antarctic oceans, the California Current region, and on a transect from Ponape, Micronesia to Guam. He has used drifters to study ocean surface currents, eddy production, and heat balance in the Canary Basin, north Atlantic, and the Gerlache Strait, Antarctic. He has also used CTDs (which measure conductivity/salinity, water temperature, and depth) and Acoustic Doppler Current Profilers to study the seasonal variation of circulation in northern Norwegian fjords, and optical particle counters to count sizes and abundance of particles in water.

Meng also has an interest in biology and has worked on mathematical descriptions of animal aggregation behaviors and population dynamics. He has three current projects: to model circulation and krill aggregation in the Gerlache Strait in Antarctic, to measure zooplankton abundance in the Southern Ocean Project of the international Joint Global Ocean Flux Study, and to model circulation and zooplankton population dynamics in the California Current region. He is planning to develop projects for Lake Superior to study the interaction between physical forces and plankton.

...and a New Boat

In September the Large Lakes Observatory obtained a "new" boat for use on Lake Superior, an 87-foot former fishing trawler made available through the federal ocean fisherman buy-out program. The steel-hulled boat once fished the waters of the North Atlantic, operating from Portland, Maine as the Fairtry. Renamed the Blue Heron, it is now in the Fraser Shipyards of Superior, Wisconsin for a new paint job and outfitting with research gear. Much of the cost has been borne by a $250,000 grant from the Legislative Commission on Minnesota Resources. Once the work is complete, the Heron will function as both a research lab and a classroom for the faculty of the Observatory and their students.

Wolz Outstanding TA of 96-97

Bill Wolz was selected as the Outstanding Graduate Teaching Assistant of the 1996-97 academic year. He is now in a third year as GTA and is finishing his M.S. thesis under the supervision of Professor Sydor.

Awards go to Thralow

Amanda Thralow (BS '97) received both of the 1997 awards for undergraduates, the Outstanding Academics Award and the Outstanding Research Award. The academic award goes to the graduating senior with the highest GPA. The research award recognizes the best research project completed by a physics major. For now, the nature of each award is permanent entry of the name on a plaque. The plaques were purchased with funds from the department's Development Fund and are displayed on the third floor of Marshall W. Alworth Hall. When the Fund becomes large enough, its earnings will be used to make monetary awards.

A description of Amanda's project was given in the previous issue of the newsletter. See Wave Pack. **2**, 3 (1997). After graduation, she continued at UMD in the Physics M.S. program.

Inside this issue

A Sampling of Student Research

Qingyan Chen, MS '98

My work in the scanning tunneling microscope (STM) lab primarily involved building a raster generator circuit in conjunction with an STM of conventional single piezoelectric tube design, and developing an imaging system for acquiring and displaying the data related to the vertical (z) motion of the STM tip.

The STM images surfaces with atomic resolution by scanning a sharp wire probe over a surface. The distance between surface and probe tip is small enough to permit electrons to tunnel quantum mechanically between the two. Applying a voltage between the probe and surface produces a continuous tunneling current, which decreases exponentially with distance between surface and probe tip. The probe is moved in three dimensions by the piezoelectric element. Images are obtained by using a feedback loop to maintain constant current by raising and lowering the probe over the surface as it moves laterally. The feedback signal provides the image information.

The raster generator produces two voltage ramps to drive the x and y piezoelectric segments of the STM. It aims at relieving the computer that acquires the data from the STM of the task of positioning the STM tip during a scan. Previously Dr. Maps built a raster generator with discrete TTL logic devices. This time we have used programmable logic devices (PLDs) instead. The layout of the circuit is much more compact and is easily interfaced to a commercial video frame grabber for image acquisition. Two 10-bit counters connected to digital-to-analog converters (DACs) are used for producing x and y ramps, respectively. The 10-bit counters are each constructed from two PLDs. Another PLD is used to synchronize the operation of the x and y counters. The digital outputs from the counters serve as inputs to the DACs. The voltages to the piezoelectric segments are then produced by multiplying the voltages from the DACs with dc voltages that set the range of the scan in the x and y directions.

The imaging system consists of a PC, a video frame grabber, and some interfacing circuits. I configured the frame grabber hardware for slow-scan mode and wrote a simple program to initialize the frame grabber and get it ready for image acquisition. Finally, I designed a PLD to generate the timing inputs for the frame grabber. A standard video monitor connected to the frame grabber displays the image being digitized. A complete image can be acquired in roughly two seconds.

For testing purposes, I have used a function generator to simulate the input signal to be digitized from the STM. The frame grabber can only accept voltage within a narrow range so a signal-conditioning front-end was built that compresses the original signal into this range. Most of the experiments I have carried out involved testing the circuit and solving problems encountered. Although every part above works as expected now, the noise in the ramps produced by the raster generator is still a problem. Effort is underway to reduce the noise and build a permanent circuit board.

Brent Barnstuble

Olson Memorial Scholarship recipient

Remote sensing has a wide range of applications. Countries monitor each other's activities remotely by employing satellites and spy planes. Exploring the depths of space requires that observations and data collection be done remotely, and relieves mankind from having to endure extreme environments first hand, such as on Mars. The Earth can be viewed from above and its interconnections can be seen on a global scale via satellites. They can provide some of the answers to many of the environmental concerns raised in the past fifty years. One element that is essential to our very existence is water and the quality of our supplies. The seas, the lakes, the rivers, and the groundwater on our planet are all connected and each affects the other. The importance of these resources provides ample reason to investigate inherent optical properties of the particulates suspended in water, such as dissolved organic material (DOM) and inorganic material (*e.g.* red clay). Remote sensing is such an efficient way to collect a vast amount of information that ways to decipher and understand what the data means are worthwhile.

We undertook the challenge of trying to relate *in situ* measurements of radiance above and below the water to remote sensing reflectance (RSR), thereby determining if inherent optical properties of water could be measured remotely. When measuring remote sensing reflectance, one is actually measuring a combination of the reflectance due to the particulates (RSR) and due to the air-surface interface ($RSR_{surface}$) which is dependent upon many variables, such as aerosol scattering, observation angles (polarization effects), and surface roughness to name a few. Satellites and planes measure the total RSR, and get a "muddied" picture due to surface effects. One must take these surface effects into account and subtract them from the total reflectance in order to obtain a true spectrum representing the optical properties of the suspended particulates. Our methodology for trying to quantify and understand surface reflectance was by submerging a probe 4 cm below the surface and then measuring the reflectance (RSR_{probe}). The difference between RSR_{total} and RSR_{probe} should reveal the effects of the surface and correct data measured remotely. This difference, the residual signal (RSR), is related to the suspended particulates by the following equation: $RSR = RSR_{total} - RSR_{surface} = Cbb/(a+bb)$, where C is a constant and bb and a are optical parameters of the particulates. Modern instrumentation allowed us to obtain values for a, bb (AC9 meter), and RSR data (spectrometer). By collecting and analyzing all this data we could then determine if $RSR_{surface}$ could be quantified to a reasonable extent, thereby determining whether the optical properties of water can be measured remotely.

This was a team effort by Bill Wolz, Amanda Thralow, Professor Michael Sydor, and myself. My own contributions included collection of lake water samples for Bill and Amanda to use, spectrometer measurements out on the lake, and processing of raw spectral data to reformat the data files. Through many hours a data interpretation performed by Professor Sydor, many insights were gained about the nature of the air-surface interface. The optical parameters bb and a were purposely varied over a wide range so our results would be general and applicable to many situations. For example, data collected from the Gulf of Mexico and North Carolina showed a remarkable resemblance to the data from Lake Superior. The interrelations among the optical parameters were worked out and linear fits were obtained but the details are much too lengthy to include here. Overall, however, our research yielded nice general results, leading us to the conclusion that the surface effects can be reasonably quantified,

implying that the optical parameters can be estimated from RSR_{total}, and in particular, the ratio of bb/a within 20% can be determined.

I am in debt to Professor Sydor for taking me in and spending valuable time with me. He made last summer invaluable to me and hopefully there is more to come.

Catch Up with Past Grads

James Gilbert, MS '93

After graduating with a M.S. in Physics from UMD in the spring of 1993, I retained a one-year instructor position through the Department of Chemical Engineering. My responsibility was teaching and recitating the Engineering Mechanics sequence. Following my UMD experience, I accepted a physics teaching position with a private college preparatory school in Oklahoma City named Heritage Hall.

Heritage Hall is currently in its 30th year. I am currently in my 4th year at Heritage Hall and was appointed Head of the Science Department after my second year. Our school is one of the two nondenominational prep schools in Oklahoma City. We are a tuition driven institution with enormous patron and parental support. Our student body is approximately 700, ranging from grades K - 12. The academic school is divided into three parts: Lower (grades K - 4), Middle (grades 5 - 8), and Upper (grades 9 - 12). Our campus is very attractive with wonderful facilities to accommodate academics, sports, and extra curricular activities.

I have been actively involved in redeveloping and enhancing our science curriculum over the last few years. Our Upper School science curriculum includes three physics courses: Introduction to Physics (freshman), Applied Physics (Junior) and calculus-based Honors Physics (Senior); three Chemistry courses: General Chemistry (Junior), Honors Chemistry (Junior/Senior), and Advanced Chemistry (Senior); three Biology Courses: General Biology (Sophomore), Environmental Science (Junior/Senior), and Advanced Biology (Senior). Our Science Department has been very aggressive in campaigning for continued instructional upgrades in the classroom. The implementation of more multimedia teaching tools, flex cams, large screen TVs, laser disc players, and better computers & software are currently becoming a reality.

It is an exciting time for our school right now, and I am having fun being part of it. I keep quite busy with everything, including sponsoring our Physics Club, filming our school's football games, and participating in many school related meetings. I have also been teaching night classes (two days/week) and a summer class at one of the local community colleges for the last two years. In my spare time, I enjoy listening to music, attending concerts, being with my dogs, and I still am an avid follower of the Green Bay Packers!

John Sorensen, BS '72

Upon receiving my Masters Degree in Physics from Central Michigan University in 1974, I became an instructor at the physics department at Northern Michigan University. While at NMU I had the pleasure of knowing the Ralph family which included little Elise Ralph. I was recently surprised to meet grown-up Elise who is now a member of the UMD Physics Department.

I enjoyed working at NMU but the lure of an exciting career with the National Security Agency took me to the Washington D.C. area. NSA was a great place to work with opportunities that included an unforgettable tour of duty in Hawaii. Although the work was fascinating, it was not enough to convince me to continue living in the crowded East. So when a job opportunity of doing environmental research with Dr. Sydor arose at UMD, I took it.

Since then I have been affiliated with UMD's Physics, Chemistry, and Archaeometry Departments working on topics such as remote sensing, acid rain, and environmental mercury contamination. I am also the operator of the Laser Raman Spectroscopy System housed by the Physics Department.

My family, which includes my wife Diane and two daughters, Amber (18) and Kara (15), enjoy living in Duluth, where we can be near our extended families. One of our favorite activities is traveling/camping out West.

Computational Physics Lab Upgraded

The Computational Physics Laboratory has been upgraded to Pentium workstations and a Novell Netware server. All workstations have direct Ethernet connections that have become popular for web browsing by graduate students. The more useful pieces of software include Mathematica 3.0, Gnuplot, MathCAD, Hummingbird X-windows support, and Absoft FORTRAN/C/C++ with Lapack subroutine libraries. The Novell server provides print service and central storage for some software and help files, as well as facilities for workstation disk reconstruction.

Funds for the upgrade were allocated by the College of Science and Engineering and totalled nearly $17,000. An additional $2000 was spent on a Linux-based web server that contains course materials. This server and the Novell server are housed in the back area of the lab. (Yes, Ron B., it used to be your office.) All of the old terminals from the front area have been retired after many years of faithful service.

On the Light Cone in Lutsen

Last August the Department and the Minneapolis Theoretical Physics Institute hosted the 8th International Workshop on Light-Cone QCD and Nonperturbative Hadronic Physics in Lutsen, Minnesota. Hiller was the chair of the organizing committee. The site was selected for its spectacular surroundings on the North Shore of Lake Superior. The Village Inn & Resort provided the housing and meeting space. Over the two weeks a total of 67 physicists from 12 countries participated, with a peak attendance near 50 early in the second week.

The main focus of the workshop was on the use of light-cone coordinates in the study of quantum field theories, particularly the theory of the strong interactions, quantum chromodynamics (QCD). In these coordinates the direction in space-time along which a system evolves is taken to be on the forward light-cone. This is roughly equivalent to working in a frame boosted to infinite momentum, *i.e.* to the speed of light. Relativistic dynamics then has some useful properties that can simplify calculations.

A series of such workshops has been organized by various physics departments and institutes since 1991. Past sites included Aspen and Telluride, Colorado; Ames, Iowa; and places in Italy, Poland, and France.

Directory of Faculty ...

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Todd O'Bey
Laboratory Services Coordinator
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In Memory of ...

Donald Graham (MS '79), who passed away in 1997.

Alumni Visits

Several alumni have stopped by, including James Engholm (BS '91), Neal Jahren (BA '88, MS '90), Kambiz Khoso-Shahroudi (BS '85), Andy Mattson (BS '94), and Don McLish (BS '68). Darrin Johnson (MS '90) has been around quite a bit because in addition to being the physics instructor at Duluth's Marshall School, he has been teaching a course each quarter for us.

If you're ever in the area, please stop in. With some advance planning, we can arrange a chance for you to speak about your work, or other topic of interest.

Web Directory

Several alumni have asked for a directory they could use in contacting other alumni. We have made a start on such a directory on the UMD web server, linked to the department home page at http://www.d.umn.edu/physics. The list of names is short because we haven't included anyone without prior permission. If you are not already included, but would like to be, please send a short e-mail note or include an answer to the directory question on the response form.

Career Contacts

Several alumni have volunteered to act as resources for career information that might help current students or other alumni. They include Curt Anderholm (BA '59), Brian Edgar (BS '96), James Engholm (BS '91), Matt Evans (MS '92), James Gilbert (MS '93), Neal Jahren (BA '88, MS '90), Charles Marttila (BA '74, MS '76), Steve Nicholas (BS '91, MS '93), Bryce Schumm (BS '93), and Jeffrey Stein (BA '76). A web page with contact information is linked to the "career" section of the department home page. If you are willing to be a resource for career information, please indicate this on the response form or send e-mail to jhiller@d.umn.edu.

Gift Funds

Gifts to the Physics Development Fund and the Donald Olson Memorial Scholarship Fund may be sent to the Development Office, 315 Darland Administration Building, UMD, 10 University Drive, Duluth, MN 55812. If you have questions or would like further information regarding a gift of any type to the Physics Department, including estate planning, please call our Development Officer, Steve Johnston at 218-726-6995.

Lost Addresses

Several alumni did not get the previous newsletter, because we no longer have a current address. If anyone knows a current address for someone on the list below, please send it in or have the person get in touch. Thanks!

Darrell Anderson, BS '78
James Anderson, BA '50
Mark Bergman, BS '71, MS '73
David Bergum, BS '69
Alfred Bolger, BS '60
Wai Ang Chan, BS '75
Richard Clapper, BS '74
George Clock, BS '73
Bernard Coffin, BS '50
Samuel Eshete, MS '88
Richard Finstad, BA '70
Angus Gillis, BS '57
Gary Grann, BA '63
Henry Grieser, BA '48
Robert Hayes, BA '58
Charles Hill, BA '55
Robert Hill, BA '52
Judith Holmbeck, BA '68
Lloyd Horton, BA '51
James Johnson, BA '54
McRae Johnson, BA '50
Wallace Johnson, BA '50
Michael Jones, BA '69
John Kennedy, MS '89
Mary Kiiskinen, BS '68
John Koivisto, BS '66
John LaLonde, BA '79
Brian Maron, BA '65
John Miller, BA '59
Ali Motahamelian, M.S. '82
William Mularie, BA '61
Yaseen Murayed, BS '85
Richard Neenan, BA '50
Charles Nelson, BA '58
Gerald Nelson, BA '60
Wesley O'Brien, BA '56
David O'Connor, BA '61
Timothy Olson, MS '87
Richard Peterson, BA '70
Roger Pilon, BA '63
Mylan Radulovich, BA '61
Steven Sandstrom, BA '72
Eric Soderstrom, BA '83
Frederick Stewart, Jr., BA '59
Liqiang Tao, MS '92
Victor Tiensuu, BA '47
Paul Town, BS '49
Dale Wick, BA '59
Stephen Wong, BA '50
Ronald Ylatupa, BS '60