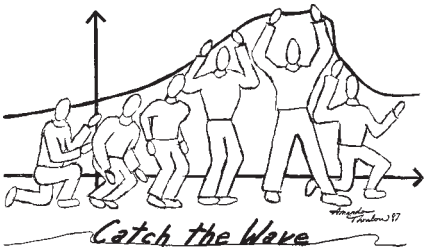


The Wave Packet

The UMD Physics Newsletter

Issue No. 7 ***Spring 2002*** ***http://www.d.umn.edu/physics/newslett/newslett.htm*** ***Editor: J.R. Hiller***

Zhou Departs
Wolz Stays On

After three years as an Assistant Professor in Physics, with a joint appointment in the Large Lakes Observatory, Meng Zhou decided to focus on oceans and took a position at the Boston campus of the University of Massachusetts. He reported there last Fall, and searches were launched for short-term and long-term replacements. For the current year the Department was fortunate to hire Bill Wolz as an Instructor, to replace not only Zhou but also Bo Casserberg during his Fall sabbatical. The search for the tenure-track replacement was broadened to accept applicants with backgrounds in biological as well as physical limnology. That search is still underway.

While at UMD, Zhou was able to obtain a considerable amount of funding. Although most of it was for continuation of his work on oceans, he did undertake projects on Lake Superior, including supervision of Shawn Putnam in the development of a towed instrument package [Wave Pack. **5**, 3 (2000)]. He also supervised a Physics graduate student, Ryan Dorland, in addition to students in the Water Resource Sciences program. Ryan joined Professor Zhou at UMass-Boston after finishing his Physics MS at UMD; his project involved studies of circulation, temperature, and plankton distributions in Lake Superior [Wave Pack. **6**, 6 (2001)]. This interdisciplinary nature of Zhou's work is behind the broadening of the search for a replacement.

Recent BS recipients Todd Barnacle (left) and Chris Lavelle (right) waiting with Professor John Hiller for the Spring Award Lunch. Todd and Chris, along with Shawn Putnam, graduated from Physics in 2001.

CSE Academy

The College of Science and Engineering has begun the process of forming an Academy of distinguished alumni and friends of CSE. The Physics Department's first nominee is Howard Hanson, who guided the Department for over 30 years as Head and was a faculty member from the very beginning of the Department. Professor Hanson will be inducted along with nominees from other departments this September, as part of the UMD Homecoming celebration.

Each year the Department will nominate one or two persons for this honor. Although this year's choice was easy to make, we expect that future nominations will be harder to determine, because information is difficult to come by. The guidelines that we've established are that the nominee be someone who has attained a level of professional success and of scientific leadership that would be associated with being a full professor in academe, a GS-15 (or military equivalent) in government service, or a team leader in an industrial laboratory setting.

We do have enough information about some alumni to form a list of potential nominees; however, the list is almost certainly incomplete, and we could use your help in finding worthy additions. The newsletter response form has been augmented to provide space for entering a nomination. Also, e-mail, to jhiller@d.umn.edu, is another easy route. Please send nominations before the end of the calendar year.

UMD Alumni Scholarships

Scholarships will be awarded by UMD to non-resident, non-reciprocity students who have a parent or a grandparent who graduated from UMD. Recipients of this scholarship will pay current Minnesota resident tuition rather than non-resident tuition rates. The scholarship is renewable if the recipient remains in good academic standing (i.e., a 3.0 gpa) and is making normal progress toward a degree. Additional details can be found at http://www.d.umn.edu/sss/admissions/discover/TuitionWaivers.html.

Inside this issue

Honors and Awards

The **Outstanding Graduate Teaching Assistant** for 2000-2001 was **Bill Wolz**. This was his second such award. Bill completed his MS with Professor Sydor at the end of that summer and is now a temporary instructor in the department.

Chris Lavelle received the **Outstanding Research Project Award** and the **Outstanding Academics Award** for 2000-2001. His project [Wave Pack. **6**, 6 (2001)] dealt with remote sensing of coastal waters. Chris finished his BS that spring and is now at the University of Indiana as a graduate student. **Daniel Gastler** was awarded the **Olson Scholarship** for 2001. This funded part of his work on the Super-Kamiokande neutrino detector in Japan. He is completing his first full year as a Physics major at UMD. **Andrew Clough** received the first **Hanson Scholarship**, which funded his participation in work on the same detector. Andrew has just finished his Junior year. Dan and Andrew wrote a description of their project for this issue of the Wave Packet.

Professor Howard Hanson and the first Hanson Scholar, Andrew Clough.

Outstanding GTA, Bill Wolz.

Lois Olson and new Olson Scholar, Daniel Gastler.

Chris Lavelle, winner of both undergraduate awards, being congratulated by Professor Hiller.

Gift Funds

Gifts to the Physics Development Fund, the Donald Olson Memorial Scholarship Fund, and the Howard Hanson 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 us or the College's new Development Officer, Tricia Bunten, at 218-726-6186.

Alumni Visits

Several alumni have stopped by, including Steve Nicholas (BS '91, MS '93) who gave a seminar last spring on "An Overview of Medical Physics," Joe Wivoda (BS '90, MS '92), Mark Debe (BA '69) who joined the new Industrial Advisory Board for the College, Peggy Chun (BA '69), and Neal Jahren (BA '88, MS '90). Al Friebe, who did a research project some years back, also visited. A couple of us again met up with Allen Anway (BA '63) at the judging for the Northeastern MN Regional H.S. Science Fair.

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.

The Water Column

by Brian May

Research on physical limnology (i.e., the physics of lakes) is alive and well in the physics department. We are currently three faculty with limnological interests: Mike Sydor, Elise Ralph and Brian May.

While others have chosen to focus on the large-scale circulation dynamics (up to 500 km scales for Lake Superior), my recent research has involved making measurements at the smallest scale of fluid motion (about 1 mm). Since arriving at UMD, I've been making temperature micro-structure measurements in an effort to infer levels of turbulent mixing in Lake Superior. These measurements are made with a temperature profiler (SCAMP) that samples at 100 Hz as it free-falls through the water column. Under the assumption that the dissipation of micro-scale temperature variations by molecular diffusion equals the production by turbulence, the level of mixing can be estimated at the time and location of any given profile. To date, measurements have been obtained at a wide variety of locations (e.g., western, central and northern Lake Superior), at various times of the year, and with a wide range of external forcing (e.g., wind). The most notable result so far is the observation of a dramatic seasonable variation in turbulence activity (i.e., high mixing in spring and fall, low mixing in summer). This arises both from variations in wind forcing and seasonal changes in the thermal stratification. Developing a predictive model of turbulent mixing in Lake Superior is next on the list of things to do.

Limnology is an interdisciplinary field and I've been actively linking my research with other limnologists in our local community. Together with Meng Zhou and other members of the Large Lakes Observatory, I have been involved in a project to study the effects of physics on the abundance and productivity of zooplankton. Two cruises last summer involved making measurements of temperature, circulation and turbulence as well as measurements of phytoplankton, zooplankton and fish abundance in western Lake Superior.

This summer promises to be a busy one with new instrumentation set to arrive. The primary instrument (Triaxus) is a towed vehicle from which a host of physical and biological measurements will be made. The Triaxus platform is much like a box-kite (roughly 1 m by 1 m by 1.5 m) that will fly through the water behind our research vessel. Computer-controlled flaps will allow the vehicle to undulate both vertically and horizontally. Initially, on-board instrumentation will include a CTD for temperature, conductivity and oxygen measurements, transmissometer for estimating suspended sediment concentration, fluorometer for estimating phytoplankton concentration and optical plankton counter for estimating zooplankton concentration.

Physics colleagues Mike Sydor and Elise Ralph have also been busy studying the dynamics of large lakes. Dr. Sydor continues his studies relating remote-sensing measurements of reflectance to in-situ concentrations of inorganic suspended solids, dissolved organic matter and phytoplankton pigment. He maintains active collaborations with colleagues at the Naval Research Laboratory at Stennis Space Center, Mississippi. While long-time student Bill Wolz successfully defended his thesis, WRS graduate student Yuhu Yan has recently arrived to begin work on satellite remote sensing. For Dr. Ralph, the NSF-funded project KITES (Keweenaw Interdisciplinary Transport Experiment in Superior) is beginning to wrap up. Her most recent work has involved analyzing the temperature and velocity characteristics of eddies in Lake Superior. Amazingly, these eddies extend throughout the lake basin over all periods of the year and thus appear to be a fundamental part of the lake's physical structure.

Catch Up with Past Grads

First some updates before moving on to this year's featured graduates: Danny Dale (BS '93) accepted a position as Assistant Professor in the Physics & Astronomy Department at the University of Wyoming and Robert Mitchell (MS '90) has been awarded tenure and promoted to Associate Professor in the Geology Department of Western Washington University. Congratulations to both!

Mark Debe, BA '69

I graduated in 1969 with a double major in physics and mathematics. That summer I married Janet Devorak (UMD chemistry), and we moved to Milwaukee, Wisconsin, where I attended graduate school in physics and surface science at UWM, and Jan finished her degree in medical technology. I received my Ph.D in physics from UWM in 1974, and we moved to England with our first child, Derek, where I did post-doctoral work at the University of Liverpool with Prof. David King for two and a half years. This included the position of temporary lecturer in the Dept. of Physical, Organic and Industrial Chemistry for our final year, as well as birth of our daughter, Andrea.

Still thinking of an academic career, I accepted a tenure-track position at the University of Texas, San Antonio, for the '77-78 academic year, teaching physics and electronics. The opportunity to move back to Minnesota and work in the corporate research laboratories of 3M Company was realized in May 1978, and I have been happily challenged ever since. The strong physics grounding I received at UMD and the specialization in surface science and thin films at UWM prepared me well for work at 3M Co.

Among the more memorable activities of my career at 3M include being principal investigator for two microgravity experiments flown on the space shuttle orbiter in

the mid 80's, and the discovery and development of a nanostructured thin-film technology platform which has resulted in well over two dozen US patents. Using this technology I started a program on proton exchange membrane fuel cells in 1995. The decision was made in 1999 to significantly expand this program, and this new business development effort is now a major growth opportunity for 3M. Currently I am a Staff Scientist and research manager in the fuel cell components program and principal investigator for two U. S. Department of Energy government contracts for fuel cells.

Jan and I live in rural Stillwater, Minnesota, where we enjoy a big garden and country living in general, while trying as much as possible to visit our children, who now have embarked on their own careers in California and Tennesee.

Matt Evans, MS '92

Ten years have flown by since I was at UMD. My journeys took me from Duluth to UW-Milwaukee where I studied scanning tunneling microscopy (STM) of metals on silicon. Mainly I studied the initial nucleation of atoms on the silicon surfaces and the associated structures and bonding. After graduate school I did a post-doc at the University of Minnesota-Twin Cities in the Materials Science department. There I studied metals on gallium arsenide. More metals, more semiconductors, and more STM.

Currently I am an assistant professor at the University of Wisconsin-Eau Claire. This involves the normal teaching/meetings/service of any university position. As the chair of my department says every time I threaten to quit because we are both here at 10pm grading, "You can't quit. Slaves can only be bought and sold!" Funny guy.

The nice thing about teaching at Eau Claire is the support for undergraduate research. In the past 2 1/2 years I have traveled with different students to Michigan State University to work for 2 weeks for my old PhD advisor and to the University of Minnesota (Southern Branch) for the past 2 summers to work in the Chemical Engineering and Materials Science department. This has allowed me to continue to do research without having any of my own equipment.

The research I have been doing involves characterizing the growth of thin magnetic films, like Co and Fe, on semiconductors. Yes, metals on semiconductors. These layers have become very important in the formation of tunneling barriers between ferromagnetic thin films and semiconductors. The barriers are critical to select the type of tunneling effects occurring across their structure, and the threshold for turning quantum tunneling on and off. The performance of such magnetic heterostructures, or spintronic devices, depends critically on the properties of the interface layer between the magnetic/nonmagnetic thin films and the substrates. We find that the films that form are very dependent on the growth temperatures and the thickness of the films. We are looking at both the structural characteristics of the surface, with STM, and the chemical nature of the films, with x-ray photoelectron spectroscopy (XPS).

Currently I am working with two other professors to install a STM and a XPS in an ultrahigh vacuum system here in Eau Claire. We hope to get them up and running this summer, and eventually link them together to look at the same surface with multiple techniques. Perhaps a metal on silicon-carbide system.

I hope I never tire of students breaking concrete bricks on my chest as I lie on a bed of nails.

William Mularie, BA '61

I entered the UMD physics program in the fall of 1956 with the help of an Alworth Scholarship. Professor Howard Hanson was the department head. I recall the first Freshman physics lecture had standing room only, with about 150 physics and engineering students. After the first quarter there were a lot of seats, the majority of the students deciding that they wanted to be liberal arts majors.

In 1958 a defining event occurred when the Soviets orbited "Sputnik," which caused a national fervor for the support of science and engineering. After a few years at 3M I entered the full time graduate program in the Electrical Engineering department in Minneapolis. At that time, the Department was masquerading as EE, but the majority of the faculty and department head were physicists. Solid state, lasers and the newly emerging Surface Science were being carried out in EE. The Physics department was excellent but focused upon low temperature, atmospheric, mass spectroscopy, etc. which were of lesser interest to me.

My Ph.D. thesis (1971) was "Photoemission from Si(100)-Cs", under Professor W. Peria. My first post-Ph.D position was in the Physics Group at the Research Institute for Advanced Studies. I did some theoretical work (optical scattering) and experimental (quantum optics and material sciences).

I was employed over 30 years in the private sector, retiring from the 3M Company in 1996. I was a co-founder and director of the National Media Laboratory and the Board of Directors of the National Storage Industry Consortium, served as Director and General Manager of the CAT-ARC division of the Perkin-Elmer Corporation. I have been active in several new business ventures and have acted as an independent business consultant for several Fortune 500 corporations.

Upon retiring from 3M Corporation, I spent 5 years as a Senior Executive Service government employee. First as Deputy Director for Science & Technology (S&T) for the National Imagery and Mapping Agency, as Office Director for the Information Systems Office of the Defense Advanced Research Projects Agency (DARPA) and a short term in the S&T Directorate of the Central Intelligence Agency.

I have just taken a post as CEO of the Telework Consortium (www.telework consortium.org) in Herndon,Virginia. We are planning demonstration projects for high bandwidth optical communication infrastructure to homes and businesses. Recent activities include guest lecturer at the Wharton Global Leadership Series on "The Internet and the Global Corporation," the Wharton North American Forum and the Department of Defense Kerr Panel on Remote Sensing.

Lastly, the free advice section for physics undergraduates: "A physicist can always be retrained to something useful". I would suggest, in fact, that this is a reasonable career path: every 3-5 years, find a new area which interests you, then, * Learn * Contribute, and * Get out and move on! Physics is Truth ! My very best to a great public institution.

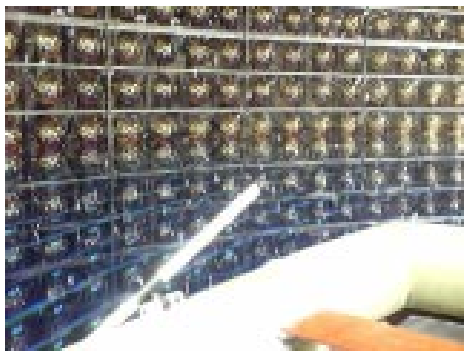
Student Research Projects in Japan

Andrew Clough and Daniel Gastler

With the introduction of Professor Habig to the faculty last year, a new area of research was opened up for students. Through Professor Habig, we became involved in neutrino research with Super-Kamiokande. Andrew started last Spring with a UROP to search for point sources of astrophysical neutrinos, and Dan started last summer with the upgrade to the Super-K detector. After five years of continual operation, it was time to replace the photomultiplier tubes (PMTs) which had stopped functioning for various reasons since 1996.

Last summer, we spent five and a half weeks in Japan helping to replace PMTs. Our participation was supported by the two department scholarships, the Olson Scholarship (awarded to Dan) and the Hanson Scholarship (awarded to Andrew). Super-K is a 40 m high, 40 m in diameter cylindrical water Cherenkov detector. The detector is actually separated into two parts, an inner and outer detector. The inner detector has roughly 11,000 PMTs that are 20 inches in diameter and face inwards. The outer detector has almost 2,000 smaller PMTs (eight inches in diameter) that face outwards. The American part of the Super-K collaboration is in charge of the outer detector, while the Japanese are in charge of the inner detector. About 200 outer detector PMTs had to be replaced.

Andrew's work was on top of the detector, where the entrance to the detector is located. The first thing that needed to be done on top was to put different connectors on the new PMTs. Even with two other people working on replacing the connectors, it took over a week to replace all of the new PMT's connectors. After that task was completed, Andrew spent most of his time near the entrance to the outer detector bringing new PMTs to be sent down and taking care of the old PMTs that were sent up.



Banks of PMTs line the wall of the inner detector. In the foreground, a raft floats on water that will eventually fill the detector.

Dan (left) goes for a gondola ride.

Andrew (foreground) works on PMT connnectors.

Dan spent most of his time in the actual detector. There Dan assisted in the replacement of the outer detector's PMTs. This was done while in inflatable rafts and consisted of removing the old PMT, waterproofing the high voltage connectors and installing the new PMT. The other area where Dan worked was repairing the reflective Tyvek linings on the walls of the detector.

Unfortunately, as the detector was being filled with water, one of the inner detector PMTs imploded, destroying most of the PMTs that were below the water level at the time (2/3 of the PMTs were destroyed). We will be going back this summer to help rebuild Super-K, and with a protective shell for the inner detector PMTs that contains the destruction to any PMT that breaks, hopefully there will be no other problems with the detector after it is rebuilt!

Sorensen now Research Fellow

John Sorensen (BS '72) has joined the Physics Department staff as a Research Fellow working under Michael Sydor in an Environmental Physics Laboratory. The equipment was recently moved from the old Research Lab Building, as part of phasing out the Archeometry Lab run by George (Rip) Rapp until his recent retirement. The Laboratory is equipped with two main analytical systems. The first is an atomic absorption spectrometer, which is used for analyzing total mercury concentrations (inorganic + organic forms). The second is a combination of three sophisticated instruments that work together to achieve the analyses of organo-mercury forms. This system consists of a headspace sampler, for presenting the sample in vapor form for analysis; a gas chromatograph (GC), which separates chemical species by sending them through a capillary column, whereby each compound exits the column at a different

time; and an atomic emission detector for specific quantification of each element as it exits the GC.

Current work is in two areas of environmental science: mercury contamination and hydrodynamic/water-quality modeling of the St. Louis River estuary. The work on environmental mercury contamination began in 1987 with Rapp and with Gary Glass of the EPA, as part of a state funded grant where the goal was to answer two questions: 1) What is the source of the mercury contamination in fish from Minnesota lakes? and 2) Why are mercury levels in fish sometimes significantly different between lakes that are located in the same area? The study documented that the overwhelming source of mercury to lakes is through precipitation. It also showed that lake-to-lake variabilities in fish mercury levels are a result of differences in lake chemistry (such as pH and organic carbon content) that affect the rate of mercury accumulation in fish tissue (bioaccumulation). Although inorganic mercury dominates the mercury forms found in precipitation and lake water (accounting for approximately 99% of the total), the rate of mercury bioaccumulation depends mainly on the amount of organo-mercury compounds (e.g. methylmercury chloride) present in the water. This is because of the strong bond that exists between organo-mercury and tissue protein. The result is a toxin very difficult for the body to eliminate with about three orders of magnitude more bioaccumulation potential than inorganic forms. Thus, current research often centers around methylmercury levels and factors (biotic and abiotic) affecting its production.

Mercury research efforts currently in progress are as follows:
1) Methods are being developed for measuring trace amounts of methylmercury in water, sediments, and tissue. For example, the amount of total mercury in precipitation is typically 5 to 20 ng/L (ppt). A decade ago, most laboratories could only achieve a detection limit of 200 ng/L total mercury. The methods used in this laboratory now result in a detection limit of about 0.03 ng/L of methylmercury.
2) A cooperative project between the Environmental Physics Laboratory and the National Park Service, investigating possible correlations between lake water level fluctuations and mercury bioaccumulation, is expected to begin soon. Preliminary evidence suggests that high fluctuations in water levels increase mercury levels in fish. If this observation can be rigorously verified, it would result in a simple tool whereby mercury levels in fish can be reduced in many reservoir systems.
3) Examination of relationships between methylmercury in sediment and fish mercury levels.
4) Development of techniques to reduce methylmercury contamination in lakes by either reducing rates of methylmercury formation or converting organo-mercury species to less toxic inorganic forms.

The modeling of the St. Louis River estuary is aimed at understanding the distribution of contaminants. Because of the numerous contamination incidents that have occurred within the estuary in the past (e.g. mercury discharge by paper mills, and tar and chemical dumping by steel mills), preparations are now underway for cleanup at selected sites. In so doing there is concern over how the cleanup process(es) will result in redistributing old buried toxins throughout the estuary as they are disturbed during those efforts. The magnitude of such redistribution can only be estimated through computer modeling of the hydrodynamics (how water currents change with time) and subsequent material transport (water quality modeling).

As it turns out, the hydrodynamics of the estuary are quite complex. They are influenced by the flow of the St. Louis River and various Lake Superior oscillation modes called seiches. Seiches may be thought of as tides, but instead of occurring every 12 hours, they occur at intervals determined by the lake's geometry. Time periods of 1.9, 2.2, 3.0, 3.8, 4.9, and 7.9 hours are observed in addition to the 12.0 and 12.4 hour normal tide modes. The amplitudes of the seiche oscillations are driven by weather events. The combination of all of the seiche modes together results in complex currents that can be extremely large. For example, Mr. Sorensen noticed on one occasion that, while collecting samples from a boat, he was swept upstream by the incoming seiche in spite of being anchored about 6 km upstream from the lake.

In 1980 Professor Sydor and Kirby Stortz (BS '72, MS '78) adapted a Dynamic Estuary Model to simulate water movement within the estuary. Since then Sorensen has added several features and is currently applying the model as part of the preparations for a specific cleanup effort.

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Spring 2002 UMD Physics Newsletter Response Form

Name:_____

Address:_____

Phone:_____

E-mail:_____

Employer:_____

Title:_____

Do you wish to be added to the alumni web directory?_____

(The URL is http://www.d.umn.edu/physics/contact/alumni.htm.)

Are you willing to serve as a career information resource for physics students?_____

(The current list is at http://www.d.umn.edu/physics/career/alum-res.htm.)

Would you like to be featured in the next newsletter?_____

My nominee for the CSE Academy is _____because:

_____

_____

Tell us about yourself:_____

_____

_____

_____

Send your reply by one of the following means:

- mail to University of Minnesota Duluth, Department of Physics, 371 MWAH, 10 University Drive, Duluth, MN 55812.
- fax to 218-726-6942.
- 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!

Lost Addresses

If anyone knows a current address for someone on the list below, please send it in or have the person get in touch. Thanks!

James C. Anderson, BA '50
Wai Ang Chan, BS '75
Charles W. Hill, BA '55
Lloyd L. Horton, BA '51
James D. Johnson, BA '54
Wallace E. Johnson, BA '50
Michael R. Jones, BA '69
Kambiz Khosroshahroudi, BS '85
Nagi Keung Lee, BA '71
Peter C. Lukens, BS '90
John A. Miller, BA '59
Mohd I. Mohdyusof, BS '86
Yaseen S. Murayed, BS '85
Charles C. Nelson, BA '58
Gerald D. Nelson, BA '60
Wesley J. O'Brien, BA '56
Timothy S. Olson, MS '87
Lawrence W. Pirila, BA '66
Anthony K. Quick, BS '92
Mylan Radulovich, BA '60
Frederick C. Stewart, Jr., BA '59
Haichuan Tan, MS '96
Charles A. Turcotte, BA '50
Dale O. Wick, BA '59
Stephen Wong, Jr., BA '50