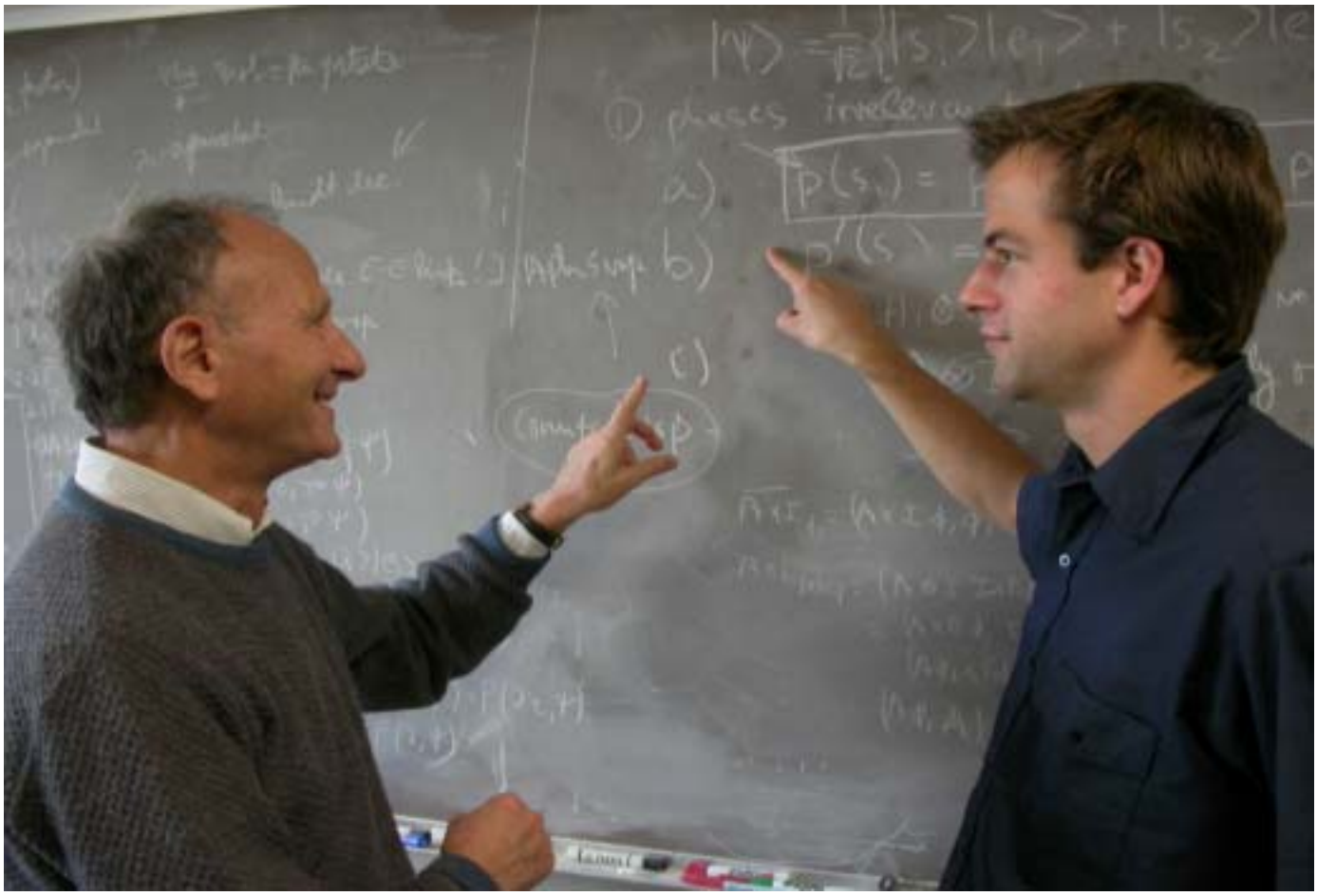
UNIVERSITY OF WASHINGTON
PHYSICS
VOL. 13, WINTER 2004

SPEAKABLE AND UNSPEAKABLE IN QUANTUM MECHANICS



Philosophy Professor (and new Physics Adjunct Professor) Arthur Fine discusses a subtle quantum-mechanical issue with Physics graduate student Max Schlosshauer.

University of Washington Physics Department at a glance:

WWW home page: http://www.phys.washington.edu

Main Office: C121 Physics Astronomy Building
(206) 543-2770, FAX (206) 685-0635

Mailing Address: Department of Physics, University of Washington
Box 351560, Seattle WA 98195-1560 USA

yearly: (typical recent figures)

BS degrees granted…….. 55
MS degrees granted……..14
PhD degrees granted…….15

Undergrad. courses taught …..56
Graduate Courses taught …….50

As of December 2002:

Major research directions:

Astrophysics, Atomic Physics Experiment, Condensed Matter Experiment, Condensed Matter Theory,Gravity Experiment, Nuclear Physics Experiment, Nuclear Physics Theory, Particle Physics Experiment, Particle Physics Theory, Physics Education

Professors ……..…….44
Associate Professors ……7
Assistant Professors …….6
Postdoctoral Associates….. 26

Emeritus faculty ……...…..…..19
Adjunct & Affiliate faculty.….33
Physics Majors …….……..…290
Graduate Students…….…..….208

To inquire about various options of supporting the Department and/or the University, please see http://www.supportuw.washington.edu
or call 1-877-UW-Gifts

UNIVERSITY OF WASHINGTON
P H Y S I C S

This newsletter is published for alumni and friends of the University of Washington Physics Department. The online version of the Newsletter is maintained at www.phys.washington.edu/news/ and contains many live WWW links complementing the articles. We invite your comments, complaints, compliments and contributions.

DavidG.Boulware,Chair
chair@phys.washington.edu 206-543-2770

Vladi Chaloupka, Faculty Editor
vladi@u.washington.edu 206-543-8965

LETTER FROM THE CHAIR

Greetings,

I am pleased to be able to report that even in these financially difficult times, our teaching activities continue with great success. During the past year we graduated 78 students with Bachelors degree. This number is up from 53 the previous year. Our undergraduate program is one of the largest in the country with our students going on to work for private employers, government, national laboratories, and pursuing their studies in physics as well as other fields. We also awarded 13 PhD's at the same time. Karsten Heeger's PhD thesis, *Model-Independent Measurement of the Neutral-Current Interaction Rate of Solar ^{8}B Neutrinos with Deuterium in the Sudbury Neutrino Observatory*, was awarded the prize for best dissertation this year by the American Physical Society.

Last year at this time I wrote about the pending shortfall in state funding of the University. As a result of that shortfall we will be facing a difficult biennium and can only hope that the next biennium will turn out to be an improvement. The cuts in state funding have been partially compensated by tuition increases, but the College of Arts and Sciences still had to take a 5% cut. This is resulting in fewer Teaching Assistants, fewer faculty, and reduced operating funds. To accommodate these cuts we have had to offer fewer courses and are less able to recruit graduate students.

The news is not all bad however. Alexander Lindsey endowed a Graduate Fellowship, the Chisholm Fellowship, last fall, and Professor Henley has committed to the endowment of the Henley Fellowship; each fellowship corresponds to a $100,000 donation. These gifts are helping with addressing one of our most serious problems: recruitment and remuneration of graduate students, and we need more of such fellowships! We have for some years had the Baumgartner Fellowships which we have awarded this year to Steven Matz, Michael Shimogawa, and David Syphers. The Young Fellowship this year went to Eric Thrane, while Michelle Leber received the first Chisholm Fellowship.

This Fall we will be welcoming Assistant Professor Mina Aganagic, a new member of the Particle Theory Group working on string theory. She comes to us from Harvard University where she held a post-doctoral position. She will greatly strengthen our connections with the Department of Mathematics, and will move us into a leading position in string theory.

It is with much regret that I report that Professor Christopher Stubbs has resigned his position here to accept a position at Harvard University.

Assistant Professor Paula Heron in the Physics Education Group has been promoted to Associate Professor — we are looking forward to her contributions for many years now. The accomplishments of Associate Professors Aurel Bulgac and Martin Savage, both members of the Nuclear Theory Group, were recognized by their promotion to Professor.

Professor David Thouless retired this summer after twenty-three years on the faculty. He is a member of the National Academy of Sciences and a recipient of many prizes including the Wolf Prize. These awards recognized his work on the Kosterlitz-Thouless transition, and on the quantum Hall effect.

Many of you may recall John Stoltenberg who for twenty years worked supporting the upper division laboratories. He and his wife died in an automobile accident while bicycling in Alberta this summer. We, and the students, will deeply miss his gentle, thoughtful presence.

Our glass blower, Bob Morley, has retired. He made essential contributions to many of the experiments over the years, and the Department will miss him and his skills.

Despite the budget crises the Department will be searching for a new faculty member this year. We will be undertaking a very broad search looking in experimental atomic physics, condensed matter physics, and theoretical astrophysics. Unfortunately, we are likely to be able to make but one appointment.

In closing please accept my personal thanks for your continued friendship and support.

Sincerely yours,

David B. Kaplan

NOBEL PRIZES 2003

In parallel with ever increasing specialization, various Science disciplines tend also to overlap and to influence each other. This is reflected in Nobel Prizes awarded this year. As Robert Park points out in his inimitable way (see http://www.aps.org/WN/WN03/wn101003.html) , the Medicine award went to a chemist and a physicist, while the Chemistry prize is shared by two medical doctors.

The Physics Prize, too, has an interdisciplinary element. It is shared by Alexei Abrikosov (Argonne National Laboratory), Vitaly Ginsburg (Lebedev Institute, Moscow) and Anthony Leggett (University of Illinois) for theories of superconductivity and superfluidity. However, as much of the contemporary condensed matter theory, the work has profound applications also in theoretical particle physics and in cosmology.

Both superconductivity and superfluidity are rare examples of quantum mechanics being important on the macroscopic scale. At the same time, these phenomena have a large variety of practical applications. In addition, the theoretical methods used in this field - phase transitions, study of quantized vortices, topological considerations and others - became important in other, seemingly disconnected parts of theoretical physics.

David Thouless Retires.

Professor David J. Thouless retired in Summer of 2003 after twenty-three years on the faculty. He has been a towering figure in the field of theoretical condensed matter Physics, member of the National Academy of Sciences and winner of the prestigious Wolf Prize. An international celebration of his work at UW few years ago was attended by just about everybody who is anybody in this field, with many Nobel laureates and present and former colleagues giving talks and lectures.

It is a clear testimony of the stimulating atmosphere in our Department that, in the Preface to his latest book on Topological Quantum Numbers in Nonrelativistic Physics, David Thouless writes:

"The issue was brought sharply into focus for me in 1980, when [UW Physics Nobel laureate, experimentalist] Hans Dehmelt asked me how the quantum Hall effect could possibly be used to determine the fine-structure constant …. Dehmelt's question is one of the unifying themes of the book …"

We hope that David will stay actively involved in the Department for many more years as Professor Emeritus, and continue to share with us his mastery of theoretical physics, his experience and wisdom.

SPEAKABLE AND UNSPEAKABLE IN QUANTUM MECHANICS

The title of our cover story is taken from the title of a collection of articles on the foundations of Physics by the late John Bell, who contributed so much not only to the substance of our discipline, but also to its style and class. Just look at the introduction to his paper on *Bertlmann's Socks and Nature of Reality*:

The philosopher in the street, who has not suffered a course in quantum mechanics, is quite unimpressed by Einstein-Podolsky-Rosen [EPR] correlations. He can point to many examples of similar correlations in everyday life. The case of Bertlmann's socks is often cited. Dr. Bertlmann likes to wear two socks of different colours. Which colour he will have on a given foot on a given day is quite unpredictable. But when you see that the first sock is pink you can already be sure that the second sock will not be pink. Observation of the first, and experience of Bertlmann, gives immediate information about the second. There is no accounting for the tastes, but apart from that there is no mystery here. And is not the EPR business just the same?

Well, the EPR business is not the same, and Bell proceeds to explain the issues with his legendary lucidity, wisdom and wit. In another article, he laments that

... current interest [in questions of foundations of quantum mechanics] is small. The typical physicist feels that they have long been answered, and that he will fully understand just how if he ever can spare twenty minutes to think about it.

The recent appointment of UW Philosophy Professor Arthur Fine as Adjunct Professor of Physics is a clear evidence that our Department, while pursuing excellence in many technical fields of physics theory and experiment, has not lost concern with the fundamentals. Professor Fine is a widely known and highly respected philosopher of science in general, and of physics in particular. He is one of the very few philosophers who understand in detail and in depth the technical issues under discussion. In fact, he has been able to contribute not only to the interpretation of physics theories and experiments, but also to the Physics discipline proper, in papers published in Physical Review Letters, Physical Review and Physics Letters. His interests are quite broad, ranging from foundational aspects of Quantum Mechanics, through various aspects of thermodynamics and chaos, to developments in modern Field Theory.

Professor Fine is perhaps best known for his contributions to the understanding of the issues connected with the Bell inequality. The story goes back all the way to Albert Einstein, who contributed so much to the development of Quantum Physics, yet never accepted its more radical implications. In 1935 Einstein, together with Boris Podolsky and Nathan Rosen (therefrom the famous acronym EPR), wrote a paper on *"Can Quantum Mechanical Description of Physical Reality be Considered Complete?"*. There, while accepting the undeniable success of Quantum Mechanics, EPR argued for the necessity of a more complete, more "sensible" theory. For many years, the issue remained into the domain of Philosophy of Physics until in 1964 John Bell produced his famous Bell Inequality which is obeyed by a wide class of "more sensible" theories, but violated by Quantum Mechanics. This brought the problem in the domain of experimental physics, and experiments soon proved that the inequality is in fact violated. In the words of David Mermin:

The point is no longer that quantum mechanics is extraordinarily (and, for Einstein, unacceptably) peculiar theory, but that the world is an extraordinarily peculiar place.

continued on Page 6

Professor Fine is already supervising a Physics graduate student on his way to a PhD degree. As a "warm-up" to his thesis research, Max Schlosshauer just finished (and submitted to Reviews of Modern Physics) a review of the issues of decoherence. This is a direction of research which is attempting to reconcile the apparent classical aspects of the world with the underlying quantum nature. The infamous Schrodinger cat scenario is a much abused but still valid example of these issues. We should point out that modern developments are changing this field from esoteric "philosophizing" to research of considerable practical importance for quantum computing, cryptography using "entangled" quantum states etc.

Max's PhD thesis will not be the first one at UW Physics on the subject of fundamental issues in Quantum Mechanics. As we briefly mentioned in the Winter 2003 Newsletter (in the article celebrating the remarkable accomplishments of our Nobel Laureate Hans Dehmelt), the famous "quantum telegraph" scheme was initially highly controversial, exactly on account of the quantum measurement issues. Professor Dehmelt was not discouraged, and the rest is history. However, the controversy needed a theoretical resolution, and Bodin Dresevic, a student of professor Lowell Brown, undertook a detailed study of the issues and successfully defended the resulting Thesis.

An article on foundations of physics would not be complete without mentioning the work of Professor John Cramer. The index of his columns for the Analog Magazine (http://www.npl.washington.edu/AV) shows the breadth of his interests (and reading the columns themselves shows the depth ...). Although he is "officially" an experimentalist, he has worked on a number foundational issues - he is the principal proponent of the "Transactional Interpretation of Quantum Mechanics."

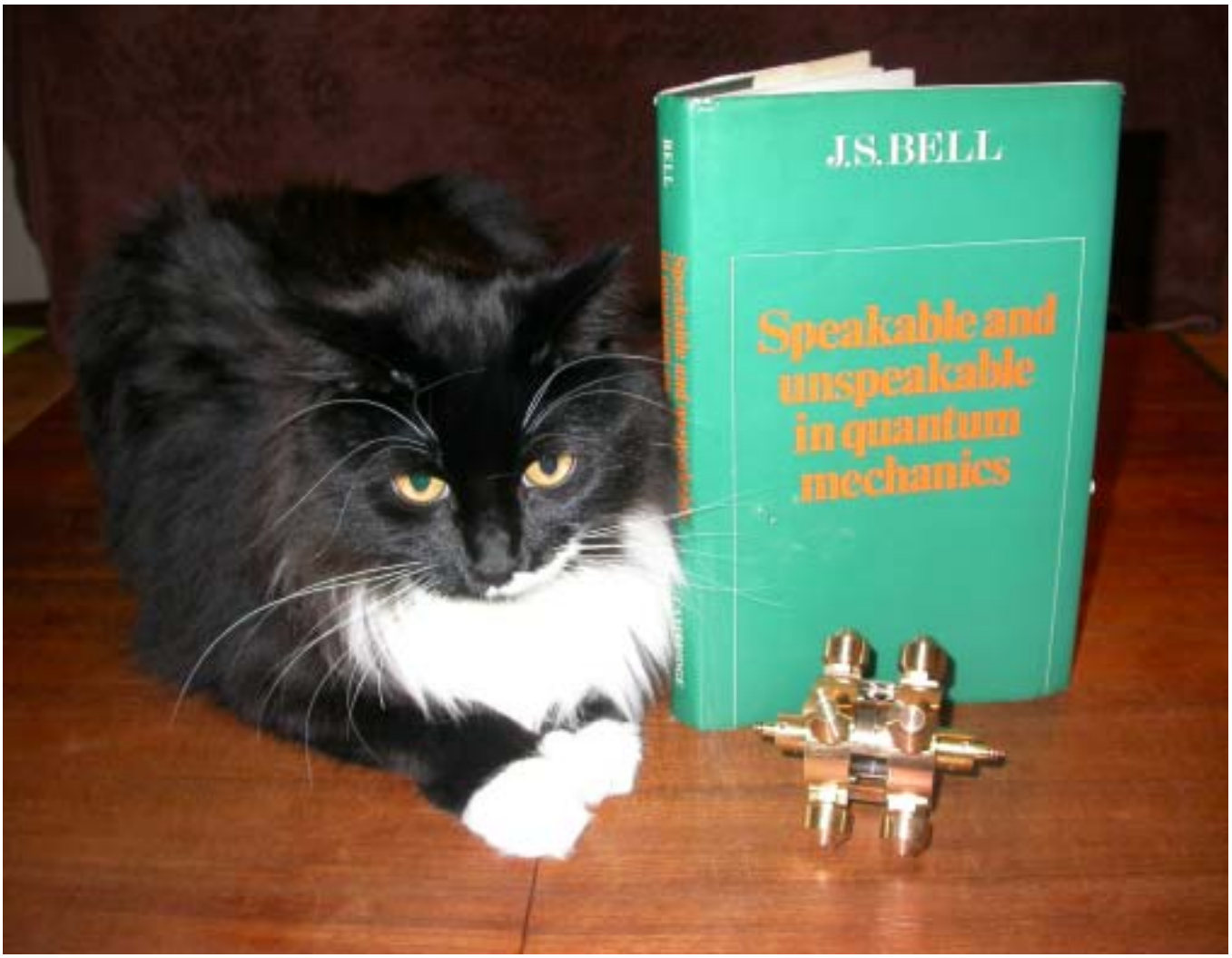
And as you would come to expect from a first-class Physics Department, fundamental questions are never far from what is being studied and taught. Space does not allow us to discuss all the experimental and theoretical effort bearing, often from quite unexpected directions, on the deepest levels of understanding of Nature. As just one example which was particularly amazing and amusing, we recall a colloquium by our Professor David E. Kaplan a few years back entitled *"Why is there Something rather than Nothing?"* After discussing this burning issue for an hour, with mathematical equations and physics arguments about the possibility that the total energy of the Universe may in fact be zero (negative contributions cancelling exactly the positive ones), he concluded that *"maybe there is in fact Nothing, cleverly disguised as Something"*.

To conclude this article we turn to John Archibald Wheeler (who contributed to many areas of Physics, but is perhaps best known for coining the term "black hole"), and his sweeping re-evaluation of our discipline:

Recent decades have taught us that physics is a magic window. It shows us the illusion that lies behind reality - and the reality that lies behind illusion. Its scope is immensely greater than we once realized. We are no longer satisfied with insights only into particles, or fields of force, or geometry, or even space and time. Today we demand of physics some understanding of existence itself.

Indeed, in a certain sense, the 20th century has transformed physics back to where and how it started: Natural Philosophy, contemplating, with a mixture of humility and exuberance, all the facets of Nature. For the 'real physicists' it is all too easy to be too absorbed in their professional, day-to-day, no-nonsense research to do much philosophizing (natural or not). For those who do find the time, it is not always easy to produce something publishable in the Physical Review. However, the rewards of even half-hearted attempts are very significant. It is an uplifting thought that the UW Physics Department effort is not half-hearted.

Vladi Chaloupka



At UW, Schrödinger's cat meets Baron von Eotvös.

In an attempt to illustrate the peculiarity of state superposition of states in Quantum mechanics, Erwin Schrödinger of the Schrödinger equation fame pointed to the absurdity of assuming that even a macroscopic object (such as a cat) could be in a superposition of different states (such as dead/alive - until you look ....). This is related to the notion of "decoherence" discussed in the article.

The shiny (in fact, gold-plated) object in front of the cat is a state-of-the-art torsional pendulum used by our Eot-Wash(ington) research group to address (among other things) the question: *Does Gravity Gravitate*? As this, and many other examples show, profundity of research at UW Physics is not limited to Quantum Mechanics!

M.S. Degrees Autumn 2002 – Summer 2003

Jason Bommer (Prof. Christopher Stubbs) *Infrared Camera Development*. As a first phase of development of an all-sky camera to be used as an aid during ground-based astronomical observations, an electrical interface has been developed for an infrared sensor. The project will enable to provide real-time information on the presence of clouds.

Tristan Hromnik (Prof. Craig Hogan) *Testing the Strong Equivalence Principle: the Binary Pulsar Experiment.* A pulsar is a highly magnetized neutron start that emits beams of electromagnetic radiation. When such a start has a companion, the resulting signals can be used to test detailed aspects of General Relativity. This work is a review and analysis of this field.

Anne Hurd (Prof. Kurt Snover) *An Estimate of the E0 Contribution to* $^{3}He + {}^{4}He \rightarrow {}^{7}Be$. This reaction is one of the nuclear processes in the Sun, and this work aimed at improving our understanding of the rate with which the reaction occurs. The motivating factor was the Solar Neutrino Problems (which has been solved by experiments at SuperK and SNO, with UW participation in both experiments.)

Robert Kyle (Prof. Blayne Heckel) Investigating Seismic Effect on Torsion Balance Experiments. As part of the Eot-Wash program (see the figure caption on p. 7), a system has been designed and implemented to monitor seismic activity, which interferes with the extremely precise measurements of the gravitational interaction. The predominant seismic problem seems to be traffic which causes the building to resonate (at 12.5 Hz).

Robert Lyman (Prof. Norval Fortson) *First Steps Toward a Measurement of the* ^{133}Cs *Anapole Moment.* An experimental arrangement is proposed and discussed to measure the nuclear-spin dependent parity violation (the anapole moment is the mechanism responsible for most of this effect.)

Mark Mendez (Prof. Oscar Vilches) *Analysis and Design of a Tunable Photonic Band Gap Optical Filter.* The goal of this project has been to analyze and design a filter, able to pick one out of the many different channels in a multiplexed optical fiber. This technology could increase the efficiency of fiber optic communications.

Jana Musgrove (Prof. Mark McDermott) *Computer Interfacing of Single-Crystal Adsorption Microcalorimeter Apparatus for Control and Data Acquisition.* A microcalorimeter is a device capable of measuring adsorption energies of gaseous reactants on single-crystal surfaces. This project developed a software systems controlling the data acquisition with this apparatus.

Christopher Rothfuss (Prof. Samuel Fain) *Investigating Charge Transfer Through Crystalline Ice in High Electric Fields.* Although seemingly a simple substance, water is rich with interesting behavior. This work is an experimental study of solid phase (crystalline ice) of water, using a field emitter tip.

Eric Peterson (Prof. Henry Lubatti) *The Absorption of Glycol Solution by Graphite Composites.* The goal of this project has been to test materials yo be used in the extreme requirement of the D0 experiment at Fermilab (specifically the support structure for the silicon detector.)

Congratulations to All!

PhD Degrees Autumn 2002 - Summer 2003

Luke Campbell (Prof. John Rehr) *Inelastic Losses in X-ray Absorption Theory*. The X-ray absorption spectroscopy is widely used to probe the atomic structures, and the chemistry of solids and liquids. This work improves the theoretical understanding of this technique.

Yejun Feng (Prof. Gerald Seidler) *Exciton Spectroscopy Using Non-resonant X-ray Raman Scattering.* In general, scattering has been a very powerful method used in many fields of Physics. This work studies how a special x-ray scattering can be used to probe condensed matter systems.

Meesoon Ha (Prof. Marcel Den Nijs) *Scaling and Phase Transitions in One-dimensional Nonequilibrium Driven Systems*. This theoretical work was triggered by a collaboration with an experimental groups studying slow combustion of paper induced by a columnar defect. This resulted into a thorough analysis in the very abstract and difficult field of physics far from equilibrium. Remarkably, the very last sentence of the thesis says: If the results prove universal, as we expect, they might apply even to highway traffic flow.

Marina Hruska (Prof. Boris Spivak) *Transport in low-dimensional conductors*. This work studies the onset of superconductivity (i.e. the transition from the normal conductivity). A model is developed that shows the existence of a specific transition in thin films. The study also applies to superconducting junctions, and to conductance of electron gas at low temperatures.

Thomas C. Luu (Prof. W. Haxton) *Effective Interactions within an Oscillator Basis*. In Nuclear Physics, the basic equations are known, but their solutions, at a many-body level, are extremely difficult to find. This work addresses issues related to the “effective interaction” to make the calculations tractable.

Reina Maruyama (Prof. Norval Fortson) *Optical Trapping of Ytterbium Atoms.* This is an experimental work exploiting unique properties of Ytterbium atoms for their trapping and study. A particular mode of Sisyphus cooling of the atomic beam has been demostrated for the first time.

Alexandre Morozov (Prof. David Baker) *Free Energy Functions in Protein Structural Stability and Folding Kinetics*. In the ongoing interdisciplinary effort involving the Physics Department, this is an investigation of the accuracy of the theoretical description of protein folding and protein interactions.

Jeffrey Reid (Prof. Thomas Trainor) *Event-by-Event Analysis Methods and Applications to Relativistic Heavy-ion Collision Data*. Collisions of heavy ions at high energies produce extremely complex events. This work presents novel methods of analyzing these events, providing insights into the physics of deconfined quark states.

Sung Wu Rhee (Prof. David Thouless) *Corrections to the Transverse Force for Superfluid Vortices*. Studies of motion of vortices date back to Helmholtz in 1858. The most interesting aspect of vortices in a superfluid is that the circulation is quantized. Results of this theoretical work are relevant to superfluid film flows and to superconductor systems.

Miles Smith (Prof. Steven Elliott) *An Investigation of Matter Enhanced Neutrino Oscillation with the Sudbury Neutrino Observatory*. Detailed experimental study of neutrino oscillation: a transformation of the electron-neutrino from the Sun into other “flavors” of neutrinos.

Congratulations to All!

News from the Department

Faculty Coming and Going

Our already strong string theory group was further strengthened by the arrival of Assistant professor **Mina Aganagic** from Harvard University. Her introductory Colloquium brought many Mathematics faculty and students to the audience (and made many physicists realize that there is more to mathematics than just calculus!). String theory addresses some of the most fundamental and profound issues (in fact - if space permitted, it would figure prominently in our cover story) and we are confidently expecting important contributions from Mina and her UW colleagues.

On the other hand, we were unable to prevent the resignation of Professor **Christopher Stubbs** -he left for a position at Harvard University. We wish him well, and we find some solace in the fact that he will continue to be associated with us as an Affiliate Professor.

Retirements

Professor **David Thouless** has retired - see our story on page 4.

Our marvellous glass blower **Bob Morley** has retired, after serving the Department since 1973. Fortunately for us, he has agreed to keep working on the part time basis, providing his expert services on which so much of our experimental program depends.

Since 1985, **Patricia Malavansos** has been assisting countless faculty, staff and visitors in the Main Office. Now she has retired, too, and we will miss her help and her good cheer.

Awards and Kudos

The American Physical Society Executive Board has voted to award Professor **George Bertsch** the 2004 Tom W. Bonner Prize in Nuclear Physics, for "*his many varied contributions to nuclear structure and reaction theory, which have guided and illuminated experiments for four decades.*" The purpose of this prize, which currently consists of $7,500 and a certificate citing the recipient's contributions, is: *"To recognize and encourage outstanding experimental research in nuclear physics, including the development of a method, technique, or device that significantly contributes in a general way to nuclear physics research."*

Professor **Wick Haxton** is the recipient of the 2004 Hans A. Bethe Prize for "*his noteworthy contributions and scientific leadership in the field of neutrino astrophysics, in particular for his success in merging nuclear theory with experiments and observations in nuclear physics and astrophysics.*" This prize is awarded *"to recognize outstanding work in theory, experiment, or observation in the areas of astrophysics, nuclear physics, nuclear astrophysics, or closely related fields"*, and it consists of $7,500 and a certificate citing the recipient's contributions.

Our graduate **Karsten Heeger** (2003 PhD under Prof. **Hamish Robertson**) received the 2003 Dissertation Award in Nuclear Physics, for "his role in the generation and analysis of the data from the Sudbury Neutrino Observatory, and the resulting resolution of the solar neutrino problem."

Congratulations to all!

Photos next page:
Top: On Networking Day 2003, lunch was served at the Faculty Club.
Bottom: The Career Development Organization Presidents (left to right): past (Hans Vija, Theresa Bullard and John Orrell) and present (Kareem Kazkaz).

Another successful Networking Day.

As we reported in the Winter 2003 Newsletter, the Career Development Organization (see http://students.washington.edu/~cdophys/CAREER/index.html) established an annual Networking Day, in which UW students of Physics and Astronomy meet with prospective employers, give talks, show posters about their research - in other words, students and employers network.

The 3rd Networking Day took place on Nov. 6, 2003, and it was a success, again.

Twenty employer representatives from large corporations, local companies and national laboratories heard 16 talks by the students, and saw and discussed 20 additional research posters. As on previous occasions, the talks and posters exhibited the broad range of research topics, from *The Rarest Events in the Universe* and *Dark Energy and Neutrino Mass* all the way to *Solid Foams: From Microstructure to Macromechanics* and *Survivability of Telemetry Under High-g Acceleration.*

Donors of $250 or more to the Department of Physics

from July 2002 to June 2003.

Prof. and Mrs. James M. Bardeen
Prof David Boulware & Ms. Susan Veltfort
Dr. and Mrs. John H. Connell
Dr. Alexander D. Cronin
Dr. Diana Dundore & Prof. Hans Dehmelt
Prof. Peter J. Doe and Ms. Younghee Lee
Dr. and Mrs. Lewis S. Edelheit
Dr. and Mrs. James L. Erskine
Dr. and Mrs. Eiichi Fukushima
Mr. and Mrs. Kelly C. Green
Dr. and Mrs. David M. Hadley
Prof. and Mrs. David Halliday
Prof. Blayne Heckel & Ms. Mary Hillyer
Drs. Ernest M. and Elaine D. Henley
Mr. and Mrs. Lee A. Licata
Mr. Alexander Lindsey & Ms. Lynn Manley
Profs. Mark N. and Lillian C. McDermott
Dr. and Mrs. Frederick C. Motteler
Prof. Ann E. Nelson
Dr. Donald J. Nelson
Ms. Linda R. Nelson
Dr. and Mrs. Shanti R. Rao
Prof. and Mrs. R. G. H. Robertson
Dr. and Mrs. Robert L. Rosenbladt
Dr. and Mrs. Wayne M. Sandstrom
Mr. Maurice B. Shurman
Profs. Margaret E. & David J. Thouless
Prof. and Mrs. John F. Wilkerson
Alfred P. Sloan Foundation
Applied Research Associates Inc
Battelle Pacific NW Div
The Boeing Company
Cadence Design System, Inc.
The Chisholm Foundation
ComEd
Compaq Computer Corporation
Exelon Corporation
Fidelity Investments
GE Foundation
Los Alamos National Laboratory
Mellam Family Foundation
Raytheon Company
Schwab Fund for Charitable Giving
Siemens Medical Solutions USA, Inc.

Physics Department Development Effort

As part of the University's coming development campaign, the Department of Physics is seeking endowed support to help us provide better education for our students and to enhance our research efforts. In particular, we are requesting assistance in obtaining funds for:

- Chairs and Professorships which provide support for faculty and their research
- Predoctoral Fellowships which support our graduate students,
- Undergraduate tuition scholarships to recognize our undergraduates
- a Teaching Prize
- Physics Endowment Fund to provide general support.

Your help in providing funding for these endowments will enable the Department to improve the quality of its teaching and research, and will be of great value in the recruiting of students and faculty.

To inquire about various options of supporting the Department and/or the University, please see http://www.supportuw.washington.edu or call the Department of Physics at 206-543-2770.

DEPARTMENT OF PHYSICS,
UNIVERSITY OF WASHINGTON
BOX 351560
SEATTLE, WA 98195-1560

NON-PROFIT
ORGANIZATION
P A I D
SEATTLE, WA
PERMIT 62