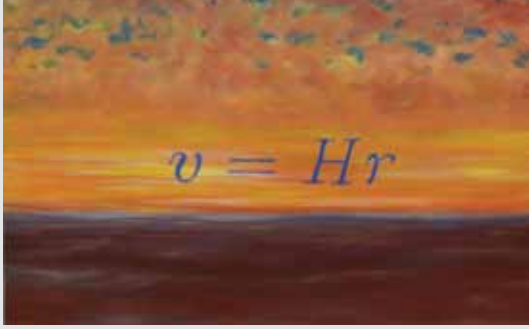
College of Arts and Sciences
University at Buffalo The State University of New York

# Interactions

## The Newsletter of the UB Department of Physics




Volume 2, Issue 1 Spring 2009

Dear alumni/ae and friends,

Well, it is over. We just finished a very hectic period in preparation of a self-study document, and a two-day visit by external visitors to evaluate the graduate and undergraduate programs. The team consisted of Allen Goldman from Minnesota, Susan Coppersmith from Wisconsin and William Trischuk from Toronto. The last evaluation of the Department took place in the spring of 2003. We have made significant progress since then with a 50 percent increase in faculty, a doubling of our undergraduate majors and a 30 percent increase in number of graduate students. So we have come a long way, but not without some significant growing pains. Most obvious is the lack of staff support in the Department which forces a substantial download of clerical responsibilities on the faculty. Our teaching, as measured by total credit hours, has also increased by over 40 percent over this period. Comparison with peer institutions shows that the physics faculty at UB shoulders a significantly larger teaching load. Other indicators also show the progress of the Department; these include papers published, number of students funded as Research Assistants, number of graduate students participating in publications and conferences and the number of Postdoctoral researchers. It will be interesting to see the written evaluators' assessment.

The young faculty that we have hired recently are progressing through the tenure process. This spring we have had four cases for promotion and tenure that have sailed unanimously through all of the University's committees. Congratulations to Jong Han (condensed matter theory), Will Kinney (cosmology), Hao Zeng (condensed matter experiment) and Igor Zutic (condensed matter theory). Congratulations also to Ulrich Baur and Surajit Sen who have been made Fellows of the American Physical Society. One negative on the faculty side, we have failed in a search for the addition of a senior condensed matter theorist. Hopefully, we will be able to search again next year.

The economy is also front-and-center at UB. We will have additional cuts to the state's contribution to the University's budget this year on top of the already substantial cut we received last year. There was a tuition increase this spring. However, 90 percent of the increase is being taken back by the State to cover looming operating deficits. This amounts to a direct tax on students. On top of this the University's endowments have also decreased significantly in value due to the economic downturn. As I said before, we are in for some challenging times.

Best regards,

Francis M. Gasparini, Chair
UB Distinguished Professor of Physics

## Reaching Out for the Stars

*By Dr. Bernard A. Weinstein*

On April 3rd over 150 public school students from Western New York came to the UB Physics Department to join in the world-wide 100 Hours of Astronomy celebration. This highly successful outreach event was part of our department's participation in the International Year of Astronomy (IYA) – a global initiative by the International Astronomical Union and UNESCO commemorating the 400th anniversary of Galileo's first telescope observations. One of the stated purposes of the year-long IYA events is, "to help the citizens of the world rediscover their place in the Universe through the day- and night-time sky, and thereby engage a personal sense of wonder and discovery".

continued next page

Banner: This painting by Williamsville artist Patty Wallace is one of eight paintings located in Fronczak Hall as part of a new Art & Physics installation funded by the 2008 Morris Fellowship for Artistic expression. Read more on page 7 of this newsletter. PHOTO: Patty Wallace

## Reaching Out for the Stars continued

The students who came to UB on April 3rd ranged in age from 3 – 18. Schools from Buffalo to Lockport sent large groups, and students from the Jewish Heritage School (Amherst), the BEAM program, as well as the UB day care program also participated. These young people were treated to live webcasts from 80 major observatories around the world, including from the renowned Keck (Hawaii), Arecibo (Puerto Rico), Herschel (Spain), and Atacama (Chile) observatories, as well as from the Hubble space telescope. Two large screen color monitors were set up in the lobby and a classroom of the physics building for the students to view the day-long webcasts. Faculty and graduate students served as docents, answering student questions, providing supplementary explanations, and guiding laboratory tours around the physics department. In addition, hall-way demonstrations of the "hair-raising" power of a Van de Graaff generator, and liquid nitrogen, thrilled the young students.

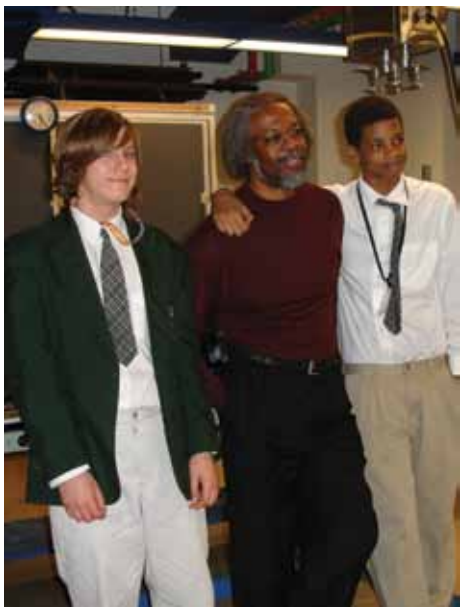
Demonstrations with liquid nitrogen by Dr. Andrea Markelz (right picture) and Justin Perron, a graduate student in Dr. Gasparini's laboratory (left picture), amazed visitors of the public IYA event at all ages.

Dr. John Cerne and Dr. Andrea Markelz, both Associate Professors of Physics, conducted demonstrations of the "hair-raising" power of a Van de Graaff generator at the public IYA event in the Physics Department.

As a bonus, the April 3rd outreach activities also coincided with the day of the Rustgi Lecture, this year given by Professor S. James Gates, Jr., the John S. Toll Professor and Director of the Center for String Theory at the University of Maryland. Professor Gates, a world leader in his discipline, is well known to many for his appearances on Public Television's Nova programs. He spoke at length to both our young visitors and UB's physics majors, sharing his outlook and passion for science.

Much thanks to all the committed faculty, staff, and students who worked on this project. Everyone felt that the day was extremely fruitful, and we hope that similar events can be held as part of regular Physics Department outreach activities. Looking outward, the telescopes reveal astounding science, but looking inward, it is the young minds that we can help to motivate who are the real stars.

Please see www.physics.buffalo.edu/iya/ for more information about IYA events.



High-school students enjoyed the opportunity to meet Professor Gates at the 100 Hours of Astronomy event in the Physics Department.

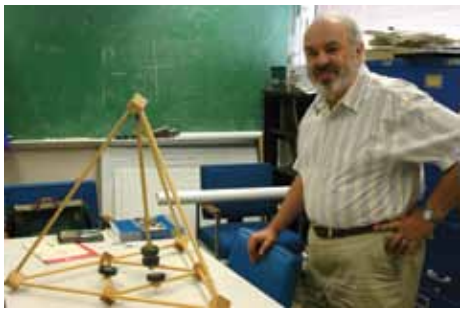
# Faculty in Focus

## Few Body Systems and Undergraduate Physics

*By Dr. Michael Fuda*

In the early 1960's a somewhat surprising breakthrough took place in understanding the quantum mechanics of few-particle systems. It was found that it is possible to construct models of three-particle systems that lead to equations that can easily be solved on modest size computers. In fact, for a particular type of interaction, called a separable interaction, it is possible to reduce solving a quantum mechanical three-body problem to solving rather simple coupled equations in one continuous variable, thereby reducing the three-body problem to a one-body problem!

One of the first systems that was treated using the new understanding of three-particle systems was the three-nucleon system. People calculated the binding energy of $H^3$ and $He^3$, as well as cross sections for elastic neutron-deuteron and proton-deuteron scattering, and for the breakup reaction in which the deuteron breaks up into a proton and a neutron. The earliest calculations assumed rather simple separable interactions that were fit to low energy nucleon-nucleon scattering data. My earliest research in this area entailed developing methods for calculating the properties of the three-nucleon system using "realistic" nucleon-nucleon interactions. Here "realistic" means interactions that account for the nucleon-nucleon scattering data up to energies of a few hundred MeV. My approach involved expanding the realistic interactions as a sum of separable interactions, thereby reducing the three-body problem to an effective one-body problem.



Dr. Michael Fuda, Professor of Physics, joined the Physics Department in 1967 and served as Undergraduate Director since. Dr. Fuda is the recipient of the State University of New York Chancellor's Award for Outstanding Teaching and is a Fellow of the American Physical Society. For more information please visit www.physics.buffalo.edu/professors/fuda.html. PHOTO: Patty Wallace

Calculating the properties of the three-nucleon system with realistic nucleon-nucleon interactions is important since there are alternative models for the two-nucleon system that do equally well in describing the two-nucleon elastic scattering data. In elastic nucleon-nucleon scattering the total energy and momentum of the nucleons is conserved, while in the three-nucleon system the energy and momentum of a two-nucleon subsystem is not conserved. The three-nucleon calculations test aspects of the nucleon-nucleon interaction that are not tested in the two-nucleon system.

The earliest work on exactly solvable three-particle models assumed non-relativistic quantum mechanics. It did not take long, however, for people to explore the possibility of constructing relativistic models of few-particle systems that are exactly solvable. One of the earliest systems for which this was done is the pion-nucleon system. At a certain point the energy of a pion ($\pi$) incident on a nucleon (N) is large enough to produce another pion. Once this threshold is reached it becomes essential to include $\pi\pi$N states in developing the quantum mechanics of the pion-nucleon system. The quantum mechanics of such a system involves the coupling between the $\pi$N system and the $\pi\pi$N system. For a number of years now my research has focused on developing a realistic relativistic model for this system. Such modeling is important because pion-nucleon scattering produces a spectrum of baryons whose properties can thereby be determined. In principle it should be possible to calculate these properties using quantum chromodynamics (QCD), the fundamental theory of strong interactions. It is my hope that in the near future I will be able to incorporate aspects of QCD into my model of the pion-nucleon system. Being retired will make it possible to devote a large amount of time to this interesting and important problem.

Before retirement I devoted quite a bit of time to the undergraduate physics program of the Department of Physics through my role as Undergraduate Director for Physics. I found it very rewarding to help the undergraduate physics majors succeed in completing a BA or BS degree in physics. For many years now we have produced a number of outstanding graduates who have gone on to do graduate work at the best universities in the country, as well as pursuing careers as high school physics teachers, and as researchers in government labs and industry. It has been very gratifying to watch the number of undergraduate physics majors double in the last five or six years. The future of physics in general, and at UB in particular, looks very bright.

Family, friends, colleagues and former students attended a dinner in honor of Professor Fuda. Among them Mrs. Kamla Rustgi (shown here with Professor Fuda), wife of the late Moti Lal Rustgi, Professor of Physics at UB 1966-1992. Read more on page 11.

# Faculty in Focus

CONTINUED

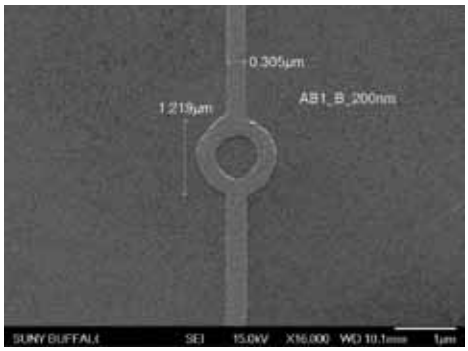
## Quantum transport in nanostructures

*by Dr. Sambandamurthy Ganapathy*

The word "nano" has recently become common knowledge and in our daily life we encounter electronic equipment such as music players, cell phones, computers etc. that utilize millions of nanodevices. There is no lack of understanding about the behavior of charges (electrons) in three-dimensional objects, such as the familiar copper wires, but we do not fully understand the behavior of charges when one or more dimensions of a material is reduced. The properties of the material change dramatically in reduced dimensions and interesting new scientific phenomena emerge. This forms the basis of the field of nanoscience and nanotechnology.

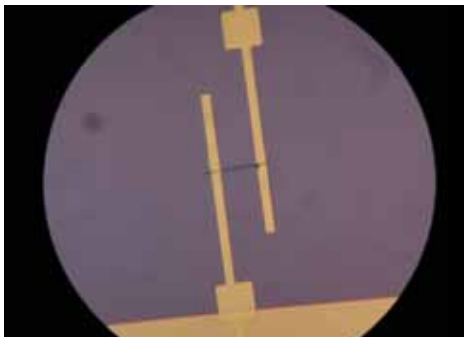
Dr. Sambandamurthy Ganapathy, Assistant Professor of Physics, joined the Physics Department in 2006. His experimental group studies electron transport in nanostructures at ultra low temperatures and high magnetic fields.

My research group focuses on how electrons (or holes) are transported in nanometer scale devices that are prepared in zero (quantum dots), one (nanowires) and two (thin films) dimensions. When electrons are confined in such small dimensions, quantum mechanical effects dominate their transport and new physical properties emerge. In my group, we study electron transport in nanostructures when they are subjected to ultra low temperatures (~ 10 mK) and very high magnetic fields (~ 16 T) where quantum transport is enhanced.




Dr. Ganapathy's group uses nanorings similar to the one shown above to study the quantum coherence nature of electrons in nanodevices when electrons go through the two arms of the ring and interfere with each other.

We use advanced nanofabrication techniques with controlled sample growth to design and develop nanometer scale devices of superconductors, carbon nanotubes, graphene layers etc. Our research interests are both fundamental and applied with specific interests in electron transport near a quantum phase transition, emergence of collective phenomena in low dimensions, conduction in nanowires and rods, microwave investigation of electron solids etc. The basic grasp of the unique properties of nanodevices is expected to herald an exciting future into the science and technology of consumer electronics.



Dr. Ganapathy's group studies transport properties of nanowires and nanorods of several strongly correlated materials such as superconductors and semiconductors.

**We congratulate the following faculty on their recent promotion to Associate Professor:**

**Dr. Jong Han**
Condensed Matter Theory

**Dr. William Kinney**
Cosmology

**Dr. Hao Zeng**
Condensed Matter Experiment

**Dr. Igor Zutic**
Condensed Matter Theory

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Dr. Doreen Wackeroth
Dr. John Cerne

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# Alumni in Focus

## Jason Ensher, B.S., 1993

*By Dr. Jason Ensher*

Dr. Jason Ensher graduated from SUNY at Buffalo with a BS in Physics in 1993. During his studies at UB, Dr. Ensher found his interests in optics, quantum and statistical mechanics and experimental work. Dr. Ensher pursued graduate work at the University of Colorado in Boulder where he joined the atomic physics group of Dr. Eric Cornell.

The timing was perfect, as Dr. Cornell was beginning his collaboration with Dr. Carl Wieman (also at CU) to produce the state of matter known as Bose-Einstein Condensation. Using techniques of laser cooling, magnetic trapping and evaporation, the group was the first to produce BEC in a dilute gas of ultracold alkali atoms in 1995. Dr. Ensher's thesis work included the first experiments to produce BEC and study its properties. Drs. Cornell and Wieman shared the 2001 Nobel Prize in Physics with Wolfgang Ketterle of MIT for the discovery of BEC.

Dr. Jason Ensher, who received a B.S. in Physics from the UB Physics Department, in his research laboratory at InPhase Technologies.

In 1998, Dr. Ensher continued his work with ultracold matter via a postdoctoral fellowship at the University of Connecticut, working with Dr. Edward Eyler. Dr. Ensher developed methods of creating ultracold diatomic molecules. Dr. Ensher also studied the properties of ultracold, highly-excited Rydberg atoms.

Dr. Ensher's interests turned to applied physics and he returned to Boulder, Colorado in 2000. A theme in his career is developing new optical devices in varied industries. Dr. Ensher has held positions at ILX Lightwave (fiber-coupled lasers and polarization devices); Precision Photonics Corp. (optical components and wavelength metrology) and Ball Aerospace (cameras and lasers for space).

Dr. Ensher joined InPhase Technologies in 2006 to work on a data storage system that writes data as holograms in a medium. Dr. Ensher is currently the lead of the Optics group at InPhase. He directs design, assembly and testing of optical systems and light sources for InPhase's holographic storage drive. In recognition of creating a tunable, blue external cavity diode laser for holographic data storage, Dr. Ensher was named a Finalist for the 2009 Industrial Applications of Physics Prize of the American Physical Society. Dr. Ensher expects that InPhase will ship drives to customers in the next year.

## Mark O. Kimball, Ph.D, 2005

*By Dr. Mark O. Kimball*

Dr. Mark Kimball has recently accepted a position as an Aerospace Engineer with NASA's Goddard Space Flight Center in Greenbelt Maryland. His new position is within the Cryogenics and Fluids Branch where he will design and build space-based cooling systems using the thermodynamics of electron spins. He obtained his Ph.D under the guidance of Professor Frank Gasparini while studying the behavior of liquid helium in restricted geometries. The knowledge and techniques learned during his years as a low-temperature physicist were instrumental in landing his new position.

Dr. Mark Kimball, shown here in Dr. Gasparini's research laboratory, recently joined NASA as an Aerospace Engineer.

During his tenure as a graduate student Mark assumed many roles within the department. These included a two-year term as the President of the Physics Graduate Student Association, co-leader of a small group of students who conceived and subsequently managed the graduate-student-run computing facility, and acting as the de facto Departmental IT consultant.

After graduation Mark offered to stay at UB as a postdoctoral researcher within the low-temperature physics lab. His original appointment of one year ultimately turned into a four year quest to understand the behavior of liquid helium confined to uniformly small boxes where coupling between neighboring boxes plays a substantial role in the system's thermodynamics. He also taught various undergraduate courses as well as a section of the graduate-level teaching laboratory over the years.

Banner: Dr. Brian Powell, Ph.D. 2008, took this picture of Mt. Fuji as seen from a bullet train heading towards Kyoto. After his graduation from UB, Dr. Powell joined the Institute for the Physics and Mathematics of the Universe (IPMU) at the University of Tokyo as a Postdoctoral Research Associate.

# Alumni in Focus
CONTINUED

## Michael Gerfin, B.S. , 2008
*By Dr. John Cerne*

Michael Gerfin received his BS in Physics from UB in 2008 and has become a member of one of the most elite crime-fighting organizations in the world, the Federal Bureau of Investigation. He began training at the FBI Academy in Quantico, Virginia, in fall 2008 and graduated in January of this year. He describes his five months of training at the Academy as very challenging, but also fun (sounds a bit like physics!). The photo shows Michael (on right) receiving his FBI badge from the FBI's Associate Deputy Director, Timothy P. Murphy. After a temporary assignment

Michael Gerfin (right) at his graduation from the FBI academy.

in Washington, D.C., Special Agent Gerfin began his first assignment in March 2008 at the FBI office in Akron, Ohio. While at UB, Michael developed exciting new educational simulations for our Conceptual Learning Approach to Waves web site (www.physics.buffalo.edu/claw) and given the creative abilities that he demonstrated on that project and his other work at UB, we consider the FBI very lucky to have recruited him!

## Ryan Heary, Ph.D., 2009
*By Dr. John Cerne*

Who ever thought that a physics PhD could lead to flying jet fighters for the US Air Force? That is in fact the highly unusual and exciting route that Ryan Heary is taking. Ryan is currently finishing his PhD in condensed matter theory in Prof. Jong Han's group. In order to make the transition from discontinuous quenching of quasi-particle states in nonequilibrium dynamical mean-field theory to high g aerobatics, Ryan will begin a 12 week program at the USAF Officer Training School in Montgomery, Alabama, this summer. This is followed by a 40-day Initial Flight Screening in Pueblo, Colorado. The "real excitement" begins in the year-long Undergraduate Pilot Training (UPT) program which will take place at either Laughlin, Vance, Columbus or Sheppard Air Force Base. The typical day in this grueling and intensive training program (www.baseops.net/militarypilot/) puts the students through formal academic and flight training that starts at 6am and ends at 6pm (this does not include time for homework and other extracurricular meetings). And you thought our physics program was demanding! During the UPT phase Ryan will be selected for more advanced training on a specific airframe (fighter, bomber, tanker, or multiengine turboprop). If all goes well, Ryan will be flying advanced trainers within a year, and front-line aircraft, perhaps even the new F-22 or F-35, within the next couple of years. We wish Ryan all the best on this exciting and demanding career!

Ryan Heary will be graduating soon to join the US Air Force.

### We congratulate our 2008/2009

**Physics Masters recipients:**
Daniel Bailey, Fatih Bulut, Peng-Jen Chen, Lili Chu, Pei-I Ku, Mark Laurri, Yichen Li, Chinmay Sikdar, Rohit Singh, Shou-Fang Tsao, Tianyi Yu

**Doctorate recipients:**
Gheorge Acbas (UB), Elena Brewer, Imran Khan (Temple University), Kwangwoo Park (Southern Methodist University), Brian Powell (Tokyo University), Konstantinos Tzirakis

### We thank our donors for their 2008/2009 contributions to the Physics Department funds:

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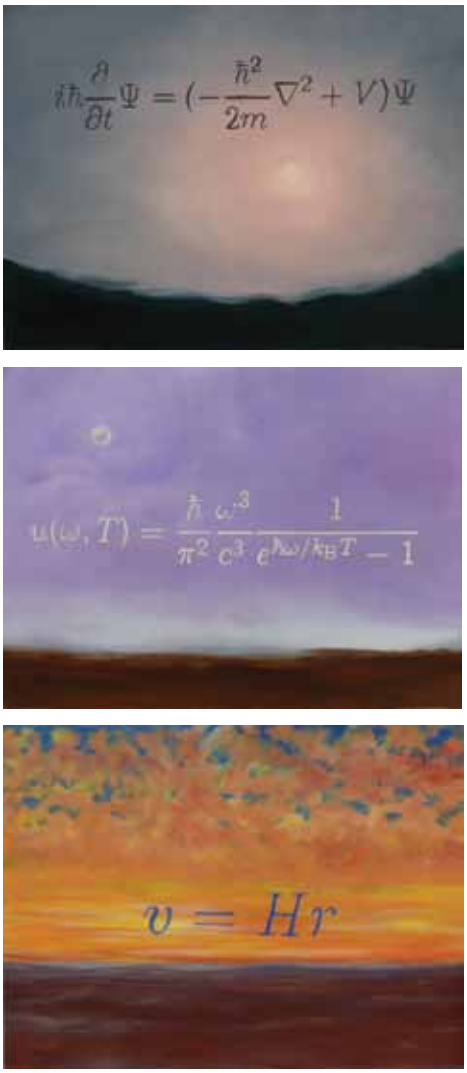
# Physics & Arts

## Impressions of Science in Nature

*By Patty Wallace*

In my paintings, an impression of the visible world is interpreted through art while I simultaneously present mathematical expressions of how physics charts its unseen workings. Both systems of representation strive to reveal theories for which there are no words, physicists using the language of mathematics and artists using visual images. Historically, we can track parallel breakthroughs that reveal correlations in vision. With this body of work, I am trying to investigate the romance of art and the drama of science by juxtaposing equations and formulae over various landscape backgrounds inspired by the works of master painters like Caspar David Friedrich (German, September 5, 1774 - May 7, 1840) and John Constable (British,11 June 1776 - 31 March 1837) whose Romantic investigations of skies and atmospheres were visual counterpoints to the idyllic pastoral valleys and the lugubrious Gothic ruins of the countryside at the height of the Industrial Revolution.




Three of the eight paintings created by Patty Wallace for the new Art & Physics installation funded by the 2008 Morris Fellowship for Artistic Expression. The paintings are part of the Physics & Arts exhibition in Fronczak Hall. The exhibition is open to the public and guided tours can be arranged by sending email to ubexpo@gmail.com. Shown are on the top: Schroedinger equation, middle: Planck's law of black body radiation, and bottom: Hubble's law). PHOTO: Patty Wallace

## The artistic beauty of fundamental physical law equations

*By Dr. Jorge Jose*

I still remember the deep feelings I felt the first time I went through the derivation of Einstein's General Relativity equations via the Bianchi equations or by using the Lagrangian variational principle when I was an undergraduate student. Years later in 2004 when preparations were being made to celebrate Einstein's 1905 Annus Mirabilis centennial, we wanted to do something special in the physics department at Northeastern University. In a conversation with a colleague from the philosophy department he said that often people are celebrated by engraving some of their landmark phrases like Roosevelt's "The only thing to fear is fear itself..". I mentioned that physics is characterized by the equations that describe basic physical laws. He then suggested to have those equations engraved permanently for artistic exhibition. He recommended stone engraving artist Mr. Houmann Oshidari, from New Hampshire. He could polish and carve black stone tablets with the basic laws of physics. I provided Mr. Oshidari with what we believed satisfied this criteria; In classical mechanics, Newton's second law; in Quantum Mechanics the Schrödinger Equation, Heisenberg's operator equations of motion as well as his Uncertainty principle; In electrodynamics Maxwell's four field equations in vector and tensor notations. The later one in dimensionless units; next we chose Einstein's Special Relativity mass energy equation as well as the kinematic geodesic and gravitational field equations, including the Cosmological constant; Then Boltzmann-Gibbs partition equation as well as Boltzmann's entropy equation and H-theorem approach to equilibrium. By a generous donation from the physics department at Northeastern University the tablet equations will now be exhibited as part of the Physics & Arts exhibition in the physics department at the University at Buffalo.

One of the four slate tablets created by Houmann Oshidari and donated by the Department of Physics of Northeastern University. They can be viewed in Fronczak Hall as part of the Physics & Arts Exhibition.

Banner: Prof. Reinhard Reitzenstein, UB Associate Professor of Visual Studies, is creating two bronze sculptures for the new Art & Physics installation funded by the 2008 Morris Fellowship for Artistic Expression. Shown here is the mold for the "Fermi Surface" sculpture. The unveiling of this new addition to the department's Physics & Arts Exhibition in Fronczak Hall will be celebrated during an opening reception in fall 2009. PHOTO: Reinhard Reitzenstein

# Outreach

## Physics and Outreach

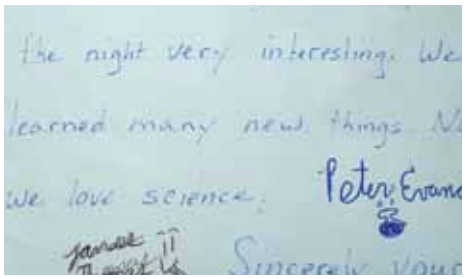
*By Dr. Doreen Wackeroth*

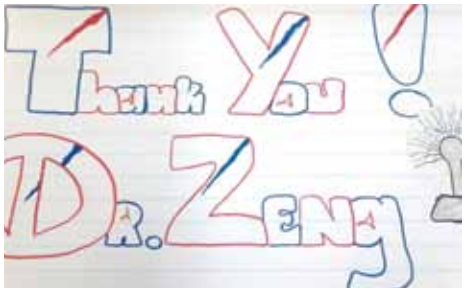
The Physics Department is involved in a wide variety of outreach activities such as the 100 Hours of Astronomy public event featured in this newsletter (see article on page 1). Physics faculty are committed to bringing the fascinating world of science to students of all age groups from day-care to high-school and to the public in all walks of life. Often with the enthusiastic support of our graduate and undergraduate students we engage and inspire through fun and awe physics demonstrations at public events and at school visits. Public lectures at UB and outside, for instance at the Sheridan Lions Club (by Dr. Will Kinney, Associate Professor of Physics) and the Buffalo Museum of Science (see below), inform and educate about state-of-the-art physics research. All our activities aim to create a non-intimidating environment for inquiring minds to explore physics in general and the research conducted at UB in particular. As also reported in this newsletter, a unique collaboration between physics faculty and artists resulted in a permanent, public Physics and Arts exhibition in Fronczak Hall. The visualization and illustration of often complex physics concepts through art allows the visitor a less inhibited access to physics and helps the physicist along in his/her explanations of concepts such as the non-deterministic nature of Quantum Mechanics or generation of mass in the Standard Model of particle physics via symmetry breaking.

Many of our outreach activities would not have been possible without the generous support of our alumni. The Physics & Arts exhibition and the Moti Lal Rustgi Memorial lecture series are only two examples of this support. The following partial list of recent outreach activities of the Physics Department illustrates the wide variety of activities:

- public events as part of the International Year of Astronomy (see coverage in this newsletter and www.physics.buffalo.edu/iya), spearheaded by Dr. Bernard Weinstein, Professor of Physics,
- two public talks as part of the Scientist in Residence Program of the Buffalo Museum of Science by Dr. Dejan Stojkovic, Assistant Professor of Physics,
- physics demonstrations involving liquid nitrogen and a van de Graaff generator at local schools by Dr. John Cerne, Dr. Andrea Markelz, Dr. Doreen Wackeroth and Dr. Hao Zeng, Associate Professors of Physics,
- a presentation by Dr. Michael Ram, Professor of Physics, at UB's Science Exploration Day targeting WNY high-school students,
- mentoring local high-school students in conducting research projects in soft condensed matter physics (Dr. Surajit Sen, Professor of Physics), theoretical particle physics (Dr. Doreen Wackeroth, Associate Professor of Physics) in cosmology (Dr. Dejan Stojkovic, Assistant Professor of Physics), and in solar energy research (Dr. Hao Zeng, Associate Professor of Physics),
- tours of the Physics & Arts Exhibition and the organization of the Physics & Arts Summer Institute for high-school students (Dr. Doreen Wackeroth), and
- QuarkNet activities involving high-school teachers and students, organized by Dr. Avto Kharchilava and Dr. Ia Iashvili, both Assistant Professors of Physics. One of the QuarkNet high-school teachers, Mr. David McClary, recently won the QuarkNet CERN fellowship, which enables him to spend some time at CERN in Geneva, Switzerland, to participate in LHC-related research. Most recent QuarkNet activities include the participation in the U.S. Masterclass 2009 of the Virtual QuarkNet Center and LHC Online (see http://cosm.hamptonu.edu/vlhc/doku.php for more information).

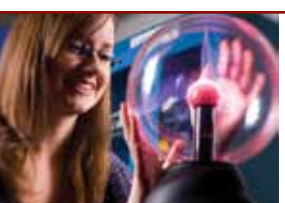
For inquiries about the Physics Department's outreach activities please contact Christine Gleason, cg57@buffalo.edu.





Students of St. Leo and Buffalo Native American Magnet 19 middle schools created beautiful 'cool physics' Thank you notes after a visit of UB physics faculty.



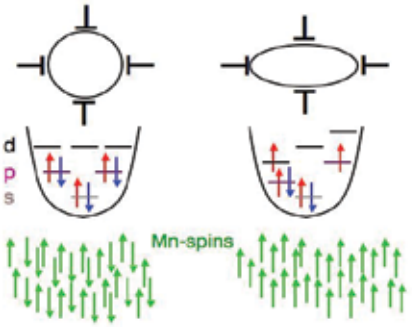
Banner: One of the participants of the Department's 2008 Physics & Arts Summer Institute (PASI) was featured in UB's Reaching Others initiative. At the three-week long summer institute eight high-school students created an artistic exhibit illustrating the concept of Symmetry in physics. PASI 2009 will take place from July 24 – August 17 and will explore Physics beyond the known, i.e. Supersymmetry and Extra Dimensions. For more information about UB's Reaching Others initiative and PASI please visit www.buffalo.edu/reachingothers and www.physics.buffalo.edu/pasi, respectively. PHOTO: Douglas Levere

# Research News & Awards

## Tailoring Magnetism in Quantum Dots

*By Dr. Igor Zutic*

Semiconductor quantum dots (QDs) can be viewed as artificial atoms allowing a versatile control of a number of carriers (by doping, applying gate voltage or illumination), the effects of quantum confinement and Coulomb interactions. This can lead to improved optical, transport, and magnetic properties. The motivation to magnetically dope (typically by adding Mn-impurities) QDs comes from the possibility for an enhanced control of magnetic ordering as compared to the their bulk-counterparts. Unlike in the bulk structures, adding a single carrier (electron or hole) in a magnetic QD can have important ramifications. Through carrier-mediated magnetism, an extra carrier can both strongly change the total carrier spin and the temperature of the onset of magnetization.




Gate electrodes can deform lateral confinement from circular to elliptical shape and change the ordering of the energy levels in a quantum dot. This in turn reversibly controls the zero and finite spin configuration of the valence electrons. Through carrier-mediated magnetism a finite total spin of electrons will align many Mn-spins.

In a recent work **[Physical Review Letters 101, 207202 (2008)]** we elucidate novel possibilities to tailor magnetism in QDs, even at a fixed number of carriers. Motivated by the experiments in nonmagnetic QDs which show that gate electrodes can be used to effectively change the symmetry of the quantum confinement, we predict an effect that can be viewed as a quantum analog of piezomagnetism. Magnetic order is obtained not by deforming the specimen, but the quantum confinement. The gate-controlled elliptical deformation of the confinement, depicted in the figure, removes the degeneracy of p-levels and induces the zero to finite spin transition of valence electrons. This change in turn provides an avalanche effect on hundreds or thousands of Mn-ions whose spins become aligned. While our initial studies of such mechanisms were limited to low temperatures (~20 K), new experiments in the groups of Professors Bruce McCombe and Athos Petrou at UB suggest that the magnetic ordering in Mn-doped QDs can persist even at 300 K.

## Who Is Influencing Who? The Physics Of The Interaction Between Biological Molecules And Water

*By Dr. Andrea Markelz*

Recently researchers in the Markelz group have demonstrated that the surface of proteins strongly affects the water dynamics immediately adjacent to the protein, and this change in the water dynamics subsequently changes the protein dynamics! A continuing discussion in the understanding of cellular dynamics is the actual physical properties of water inside the cell. The cell is a crowded environment with only 1-10 nanometers between the macromolecules! The diffusion and interaction between the different components within the cell is dependent on the physical properties of the water in this confined space. However, research on biomolecular interactions is often done by isolating constituents under study and perfoming measurements in dilute conditions. Computational studies use bulk water properties, that is properties of water like what you pour from the tap, which presumably has very few other components! These approaches may be seriously flawed if the nature of water in real biological systems is strongly influenced by the crowded environment, as the UB physics studies suggest.

Protein with adjacent surface water.

In a recent article in the prestigious Physical Review Letters **[PRL 101, 178103 (2008)]** the Markelz group explored the nature and origin of a phenomenon called the protein dynamical transition. They applied their technique of terahertz time domain spectroscopy to test assumptions of the origin of the effect. In exploring the nature and origin of the protein dynamical transition the group showed that this transition arises from the water layers immediately adjacent to the protein. The transition does not occur in bulk water, indicating that the nature of the water immediately adjacent to the protein is significantly changed by the protein surface. PhD student Yunfen He showed that this influence continued down to peptides only five amino acids in length, but ceased to occur for shorter peptides. This size dependence is startling and completely unexpected. The article has been featured in the Virtual Journal Of Biological Physics (an APS Division of Biological Physics online journal) and has been selected as an exceptional paper by the Faculty of 1000 in Biology and Medicine (an online service in which over 4,500 leading researchers evaluate the most important articles in biology and medicine).

Ms. He (now Dr. He) gave a keynote invited talk at the International Conference on Infrared and Millimeter Waves in Pasadena, CA last September and received a student travel award from the APS for this work. The group has

Banner: The Department's Linux cluster "Quantum" has been installed in 2005, initially consisting of 32 64-bit dual-core Opteron 270 processors networked with both Gigabit and Myrinet interconnects and a 2 TB file server. In February 2009 Quantum has been upgraded and has now 240 processors with a peak performance of about 1 TFlops. The cluster is maintained by UB's Center for Computational Research (CCR).

## Article continued from page 9: Who Is Influencing Who?...

*By Dr. Andrea Markelz*

been invited to give talks on these results at the Materials Research Society Spring Meeting 2009, the Protein and Water Interaction Workshop 2009, the 2009 Telluride Research Conference on Vibrational Dynamics, the 2009 Telluride Research Conference on Protein Dynamics, SPIE Optics & Photonics 2009, and the Shenzhen International Conference on Advanced Science and Technology 2009 (SICAST 2009, China).

The group is currently exploring the origin of the minimal surface interaction area requirement for the transition. Of immediate interest is how this interplay between the nature of the protein surface and the dynamics of the solvent influences protein folding and dynamics. This work was funded by a CAREER grant from the National Science Foundation.

## Congratulations to our recent award recipients:

Dr. Hao Zeng, Associate Professor of Physics, won the UB Exceptional Scholar-Young Investigator Award 2009.

Dr. Ulrich Baur, (pictured above) Professor of Physics, has been made Fellow of the American Physicsal Society for contributions to precision electroweak physics, especially the phenomenology of electroweak gauge bosons at hadron colliders. Nominated by: Particles and Fields (DPF)

Dr. Surajit Sen, (pictured above) Professor of Physics, has been made Fellow of the American Physical Society for the discovery of how solitary waves break and secondary solitary waves form in granular media, for his leadership in organizing forums to represent and recognize the physicists from India and for raising consciousness about the problems and the importance of rural science education in India and the developing world. Nominated by: International Physics (FIP)

Ian Swanson received an Om and Saraswati Bahethi Scholarship.

Seth Levy won the award for best undergraduate poster at the Spring meeting of the New York State Section of the American Physical Society.

## Support the Department of Physics Programs

*By Dr. Frank Gasparini*

The Department continues to rely on its alumni and friends to support a broad spectrum of activities. These range from targeted scholarships to lectureships, exhibits and a general endowment fund. These contributions truly make the difference in the quality of our academic endeavors both at the undergraduate and graduate level. Your contributions to any of these activities are much appreciated. To contribute your support electronically, visit www.physics.buffalo.edu and click the Support Physics button on the top right. Please contact Chris Gleason in the Physics Department at 716.645.2017 x112 or via e-mail cg57@buffalo.edu or you may contact Deborah McKinzie in the Development Office at (716) 645-6000, ext 1503, or via email at mckinzie@buffalo.edu with any questions.

### Physics Department Funds

**Physics Excellence Endowment:** Supports recruitment and recognition of outstanding students, outreach to the community, upper level experimental laboratories, undergraduate research projects, and activities of The Society of Physics Students.

**Frank B. Silvestro Endowment Fund:** Established in 2000 by Mr. Frank Silvestro, BA 1962, MA 1968, the fund supports outstanding students with financial need. Currently used for the support of graduate students.

**Dr. Stanley T. Sekula Memorial Scholarship Fund:** Established in 1990 by Mrs. Anne H. Sekula, honoring the memory of Dr. Stanley T. Sekula, BA 1951, and used to recognize outstanding undergraduates with financial need.

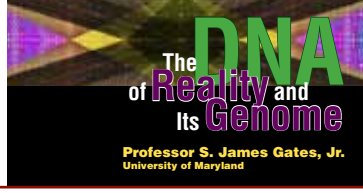
**Moti Lal Rustgi Professorship in Physics:** Endowed by the Rustgi family in 2006 to honor the late Professor Moti Lal Rustgi. Provides support for the Rustgi Professor, currently held by Professor Athos Petrou.

**Moti Lal Rustgi Memorial Lectureship Fund:** Established in 1993 by the Rustgi family, the fund supports an annual lecture by distinguished researchers.

**Ta-You Wu Lectureship Fund:** Established in 2008 by Professor Yung-Chang Lee in remembrance of the late Professor Ta-You Wu, who was a key member of the Department from 1966 to 1978.

**Physics & Arts Exhibition Fund**: This interactive permanent exhibition in Fronczak Hall opened in 2006, and was funded by alumni. It is one of the department's most effective outreach initiative. Support will allow continued evolution, development, and upgrade.

The Physics department sent a small delegation of undergraduate students to the Spring meeting of the New York State Section of the APS. Shown here are (from left) George Lindberg, Seth Levy, and Stephen Raiman at a visit to the University of Rochester's Laboratory for Laser Energetics.

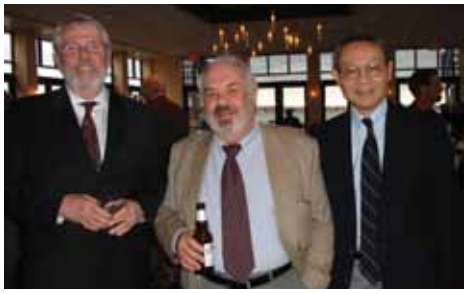



# Events

## Dinner party to honor Professor Fuda

*By Dr. John Ho*

Professor Michael Fuda retired from the department in the beginning of 2009 after 42 years of distinguished service at UB. A dinner party was held in his honor on April 4, 2009 at Harry's Harbor Grille by the shores of the Niagara River. It was well attended by Mike's family, his current and past colleagues, and his former students.



Professors McCombe, Fuda and Ho (from left) at the dinner party to honor Professor Fuda's distinguished service at UB.

Master of Ceremony Dean John Ho delivered special greetings from Provost Satish Tripathi. Dean Bruce McCombe gave a very entertaining multi-media presentation. Among others making remarks were alumni James Whiting (PhD 1977) and Britton Gerard (PhD 1978), as well as Mike's daughters Meredith Costello and Melanie Henderson, his sisters Joyce Crookes and Nancy Chervisky, and his wife Siri. The evening's highlight was the Guest of Honor sharing with his admirers warm reminiscences of his long career at UB. We wish Mike the best in his post-retirement ventures.

## Tera-rrific conference!!!

*By Dr. John Cerne*

UB physics professor Andrea Markelz recently organized the Optical Terahertz Science and Technology International Workshop 2009. The conference, co-organized by University of Alberta physicist Frank Hegmann, meets every two years to discuss the most recent developments in the rapidly developing field of terahertz physics. This year the technical co-sponsors included IEEE/LEOS, SPIE and OSA.

Poster session at the OTST 2009 conference co-organized by UB professor Andrea Markelz. The international conference had over 200 participants.

The conference received $17k in funds from the NSF to assist with student registration charges and travel. The conference, which is traditionally held in the second week of March, was held in sunny Santa Barbara, California. "With over 200 participants the conference was an incredible success, both organizationally and in terms of content. We were fortunate to attract two high profile plenary speakers, Prof. Alfred Leitenstorfer, winner of the Sommerfeld Prize and the Kaiser Prize and current director of the Modern Optics and Quantum Electronics Institute,University of Konstanz, Germany and Prof. Daniel Mittleman, Optics Letters editor, Optical Society of America Fellow, and director of the terahertz program at Rice University. In addition, our invited speakers included superb veterans in the field such as Antoinette Taylor from Los Alamos National Laboratory and Daniel Grischkowsky, father of terahertz time domain spectroscopy. Over 175 excellent abstracts were submitted and we were in the unfortunate position to reject some very good submissions because of space and time constraints. The previous OTST conference had only 120 attendees with ~ 100 submissions. We expanded our poster session and had it take on a much more central role, similar to that seen in the Material Research Society and Biophysical Society meetings," Markelz explained. Among the highlights of the conference were several sessions on the generation and use of high power terahertz light (1 terahertz = 300 μm = 4 meV) to examine nonlinear carrier and phonon dynamics. A special session on terahertz measurements of biological molecules and water established that indeed interfacial water behaves differently than bulk water and that changes in solvent dynamics very likely strongly effects solute dynamics, such as proteins. Metamaterials also played a central role in the conference, with dazzling examples of tunable negative refractive materials being produced in the terahertz range. This is certainly one of the hotbed applications of terahertz radiation. The wavelength range allows for the easy manufacture and testing of various negative refractive material designs. "I was delighted to see that the conference was so well received and am so happy that UB had such high visibility. We should be very proud of our UB students who were selected to give oral and poster presentations," Professor Markelz added. Several select presentations have been invited to publish manuscripts in a special issue of the Journal of Infrared, Millimeter, and Terahertz Waves with Markelz and Hegmann as editors.

## Events Calender

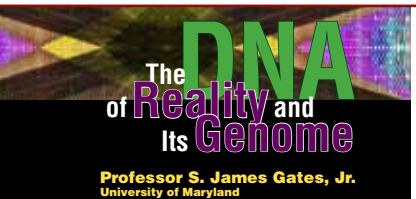
**June 27th, 2009:** Ride for Roswell, join the Physics Department team Ubphysics to raise money for the Roswell Park Cancer Institute. See www.physics.buffalo.edu for information about how to participate and donate.

**July 24 – August 17, 2009:** Physics and Arts Summer Institute (PASI) 2009 for high school students www.physics.buffalo.edu/pasi

**Fall 2009, Fronczak Hall:** Opening reception for the Robert and Carol Morris Physics & Arts installation

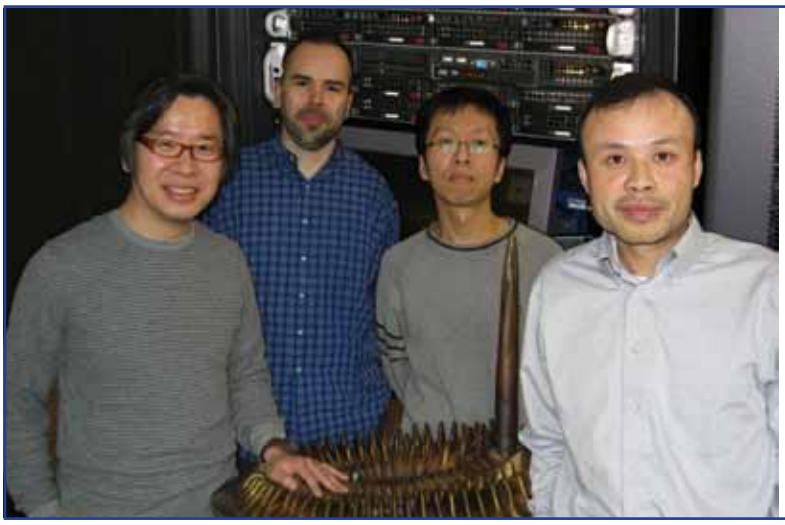
**Fall 2009:** Fall Open House, guided tours of the Physics and Arts Exhibition in Fronczak Hall are available by request (please send email to ubexpo@gmail.com)

**October 16, 2009:** Public lecture featuring Professor David Hogg, NYU Center for Cosmology and Particle Physics, www.physics.buffalo.edu/iya




The 2009 Moti Lal Rustgi Memorial Lecture entitled "The DNA of Realty and its Genome" was held on April 3, 2009, by Professor S. James Gates, Jr. from the University of Maryland. The public lecture was made possible by the generosity of the Rustgi family. For more information please visit www.physics.buffalo.edu. *POSTER: Renee Ruffino*

# The University at Buffalo Department of Physics Newsletter



## In this Issue:



Thanks to Physics faculty (shown from left) Dr. Jong Han, Dr. Igor Zutic, Dr. Wenjun Zheng and Dr. Peihong Zhang, the Department of Physics Linux cluster "Quantum" has been recently upgraded to 240 processors providing an invaluable resource for research conducted within the Department, especially in condensed matter and biophysics theory. Please see page 9 for more information. Also shown in the foreground: the bronze sculpture "Atom Corral" created by Prof. Reinhard Reitzenstein (UB Department of Visual Studies) which is part of the permanent Physics & Arts Exhibition in Fronczak Hall.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