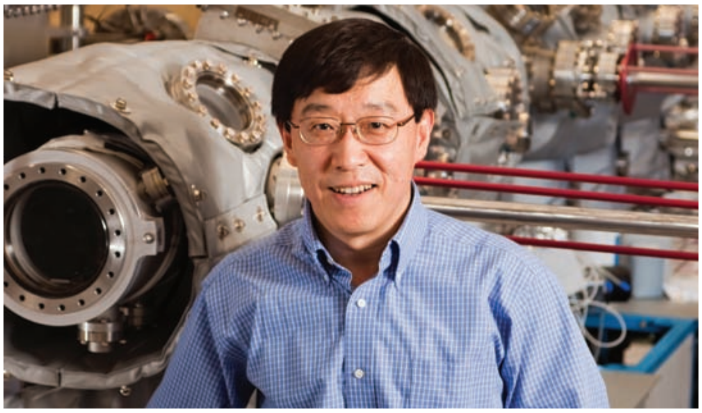
University at Buffalo *The State University of New York* | REACHING OTHERS

Interactions

The Newsletter of the UB Department of Physics

Volume 4, Issue 1 Spring 2011



Dear alumni and friends,

As you may have seen in the last issue of Interactions, we lost our dear friend and colleague, Professor Ulrich Baur on November 25, 2010, followed by the passing of a recent graduate and a friend of many of us, Dr. Christian Meining, one day later. It was a very difficult time for the Department, losing two of its own in such a short period of time.

Ulrich joined the Department in 1994, the same year as I did. He was primarily responsible for building up the group of high energy physics, and cosmology in the Department. The remarkable growth of this group is a great and lasting testament to his contributions to the Department. This loss was equally significant to his research community at large, as can be seen from an outpouring of sentiments from his friends and colleagues from all over the world, at the website that his wife Yvonne set up (http://www.forevermissed.com/ulrich-baur). The famous stack of papers on his desk, which grew to several feet tall over the years, will be made into a permanent display in Fronczak Hall. For me, this was also a loss at a personal level. He and I did many things together, including introducing team teaching to the Introductory College Physics course, and making use of in-class students' responses before the currently used "clickers" (an electronic student response system) existed.

Chris was a graduate student of Prof. Bruce McCombe and joined Intel after graduation. He was an excellent student and was active in all aspects of Departmental activities, including serving as the President of the Physics Graduate Student Association. I interacted with him extensively, especially during the few months when he was writing his thesis, and when we played soccer together, once making it to the championship game in the annual intramural soccer tournament on campus. Both Ulrich and Chris will be remembered, as colleagues and friends.

The University and the College of Arts and Sciences (CAS) both went through transitions of leadership. The former President, John Simpson, retired this semester. The previous Provost, Satish Tripathi, has become the 15th President of UB. McCombe will step down as the Dean of CAS in July this year. Replacing him is Prof. Bruce Pitman, who has been the Associate Dean.

The budget situation for the new fiscal year is uncertain, although some cuts are expected, as a result of the recently passed state budget. There is a positive sign, with UB2020 passing, which will give UB more autonomy in realizing its vision and dealing with challenges. A piece of good news is that we will likely graduate more than 20 majors again this year, after a record year last year. The days of single-digit-graduates are behind us.

There have been four promotion and tenure cases (not counting two senior hires) during this academic year. Congratulations to Prof. Andrea Markelz (biophysics experiment) for the promotion to full professor, and Profs. Ia Iashvili (high energy experiment), Avto Kharchilava (high energy experiment), and Peihong Zhang (condensed matter theory) to the rank of associate professor with tenure. Their accomplishments were well recognized and all of them sailed through the processes unanimously at all levels.

Keep in touch and let us know how things are going.

Best regards,

Hong Luo, Chair
Professor of Physics

Banner: Dr. McCombe presenting a "No, No, a Thousand Times No Award" to UB President Dr. Tripathi (right) while UB Interim Provost Dr. Stenger (left) looks on at a reception on June 20 honoring Dr. McCombe's outstanding service as CAS Dean for the past five years. Dr. McCombe is stepping down from administration this summer to allow more time for his active research program. Although the College and University greatly benefitted from Dr. McCombe's service, we are looking forward to having him back in the Department! Photo: A. Markelz

Photo: Yvonne Baur

Ulrich J Baur, 1957-2010

By Dr. Richard Gonsalves and
Dr. Doreen Wackeroth

Professor Ulrich J. Baur died in a tragic snorkeling accident on November 25th, 2010, while on vacation on the U.S. Virgin Islands with his wife Yvonne.

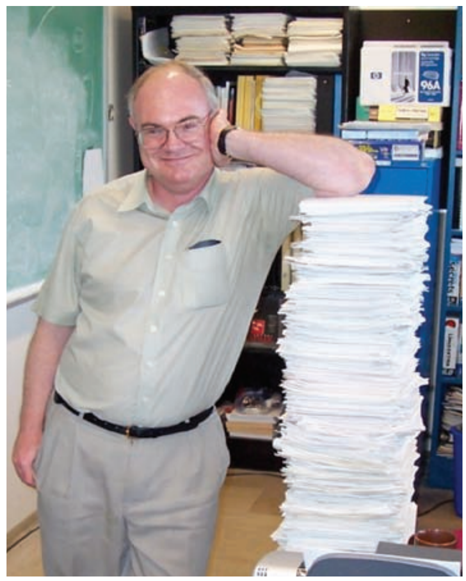
Uli served fifteen years as a professor in the Physics Department at UB. He moved to UB from a permanent research scientist position at Florida State University, Tallahassee, in January 1995, driving to Buffalo in mid winter. He had arranged for his new DEC Alpha workstation to be ready for his arrival in his new Fronczak office, and he hit the ground running, writing papers and an NSF proposal for research on "Electroweak Interactions at Very High Energies" that was funded right away, and preparing to teach Physics 101 in the Fall.

His research at UB divides naturally in two periods: from 1995 through 2002 he worked primarily on Electroweak phenomenology in collaboration with theorists and experimentalists outside UB. His best known work from this period was on electroweak radiative corrections to W and Z boson production, which led to several highly cited articles and to computer codes that are widely used in high energy physics research. He also published a landmark paper on including finite width effects in a gauge-invariant way in radiative W production and decay, and highly cited papers on QED radiative corrections to Z boson forward-backward asymmetries, QCD radiative corrections to anomalous triple-gauge-boson couplings, and on top-quark mass effects on the self-coupling of the Higgs boson.

For many years he traveled frequently to high energy physics laboratories and worked closely with numerous experimentalists, sharing with them his computer codes and insights. He held a Frontier Fellowship and was a frequent long-term visitor at Fermilab, where he worked with experimentalists on the CDF and D0 collaborations. He also collaborated with scientists at CERN, DESY, and several European universities, and maintained an active interest in experiments at underground neutrino laboratories. He played a leading role in planning efforts for future accelerators, in particular with the American Linear Collider WorkingGroup. He officially joined the CMS Collaboration in 2006.

Five students completed Ph.D. dissertations under his supervision: three of them Fizuli Mamedov (Khazar University, Azerbaijan), Elena Brewer (Erie Community College, Buffalo), and Philip Cheung (Ph.D. expected September 2011) in theory; and two Zarah Casilum (Financial Industry, New York City) with D0 at Fermilab and Mike Stamatikos (NASA/GSFC, Greenbelt Maryland) with Amanda/Ice Cube at the South Pole, in experimental high energy physics. He also mentored three Master's students and an undergraduate student, and served on the thesis committees of numerous other students at UB and other universities. As chair of the Computing Committee for many years he created the Departmental computer cluster and trained a generation of graduate students in managing it.

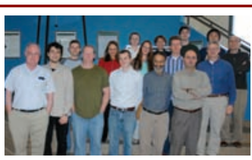
His office door was always open, and he was always willing to talk to students and colleagues who stopped by his office with questions about classes, physics, or life in general. He was an enthusiastic lecturer and taught a range of classes from freshman physics to advanced quantum field theory. His approach to teaching is perhaps best summarized in a sentence in his course syllabus for the sJunior-level course Intermediate Mechanics: "Required: PHY 301 or equivalent, an open mind for fun and physics, and a high level of tolerance for chalk dust".



Uli and his famous stack of scientific papers. Like tree rings , the different coloration of the papers from bottom to top indicate their age. Uli claimed that it serves as his earthquake detector.

Photo: Yvonne Baur

A second phase of his career at UB began at the turn of the century. He played a leading role in expanding the high energy and cosmology group by chairing four faculty search committees and serving on another, which resulted in the hires of three theorists and two experimentalists. He was pro-



Banner: Uli (left in front row) and the HEPCOS group at UB. The picture was taken in 2007 and shows faculty members, a Post-doc, PhD and Master's students. It was taken in front of the Foucault pendulum in the lobby of Fronczak Hall. The pendulum is part of a permanent Physics and Arts Exhibition, which was co-initiated by Uli. His famous "stack of papers" (see picture in the article) will become part of this exhibit.

moted to Full Professor in 2003 and appointed Associate Chair in 2004. In the years since, he spent increasing amounts of time building and nurturing the high energy and cosmology group at UB (see www.physics.buffalo.edu/hepcos), and working on LHC physics and the LHC Theory Initiative.

Uli's research achievements in Particle Physics were recognized by his peers when he was named a Fellow of the American Physical Society in 2008. He was unique in his efforts to bridge the gap between theorists and experimentalists. He especially enjoyed finding new ways to extract interesting physics information from data. For instance, he his well-known for his studies of the so-called radiation amplitude zero, an interesting interference effect in quantum field theoretical calculations of the production of a W boson in association with a photon, which was eventually observed at the Fermilab Tevatron.

His enthusiasm and passion for Particle Physics did not stop at his research but extended to ensuring the future and well-being of the field. He was one of the initiators of the LHC Theory Initiative, which is funded by the National Science Foundation and provides fellowships for graduate students and postdocs who work on LHC phenomenology. To strengthen the field of Particle Physics Phenomenology in the US in the LHC era was a goal close to Uli's heart, and he worked tirelessly to make sure that the US does not fall behind. He was a generous mentor to many young researchers in the community and to the young faculty in the Physics Department. We tremendously value our time with Uli as a colleague and friend and will especially remember his humor, generosity and cheerful outlook at life.

Uli's scientific achievements will be honored at the Uli Baur Memorial Symposium, which will take place at UB on September 24th, 2011. The Symposium will be preceded by a public lecture on September 23th, entitled Escape from Leipzig by Professor Harald Fritzsch, who was Uli's PhD advisor.

Colleagues Thoughts:

"For 25 years, Uli has been a source of joy and insight and inspiration, a fine physicist, an extraordinarily generous colleague. He has shown an exemplary community spirit, investing time and wisdom for the greater good. He drove the rise of the Particle Physics research group at Buffalo, and touched the lives and careers of many young scientists."

Dr. Chris Quigg, Fermilab

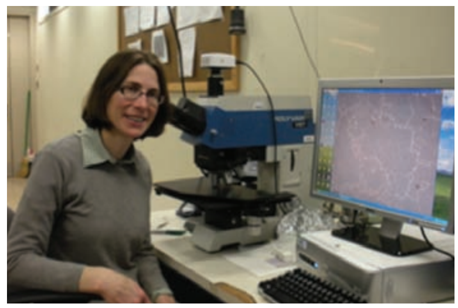
"Uli was a CMS collaborator from SUNY/Buffalo and a theorist actively working on the physics of the LHC. He was a leading expert on electroweak radiative corrections and triple gauge boson couplings and his contributions in these areas were of extraordinary benefit to CMS. Uli also had a major impact on the physics program at the Tevatron, and was one of the founders of the LHC Theory Initiative. Uli will always be remembered by his colleagues for his cheerful humor, his enthusiasm and dedication to physics, and for his encouragement of younger physicists. He will be sorely missed."

Dr. Guido Tonelli, CMS spokes person, CERN

Making detectors that make themselves!

by Dr. Adrea Markelz

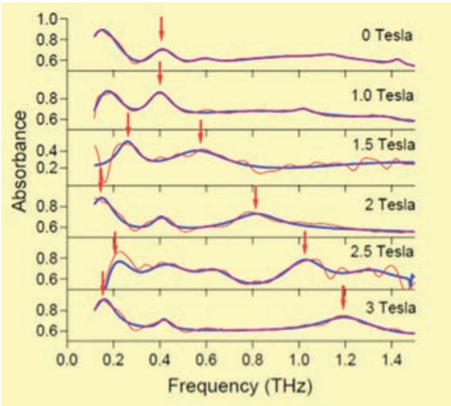
The Markelz lab studies materials with terahertz light. Terahertz light has shorter wavelengths than the cell phone range, but longer than the night vision mid infrared range. One of our major goals is the characterization of protein dynamics on the picoseconds time scale. To do this we are developing new techniques to address specific issues for biomolecular studies. We are also collaborating with the Cerne and McCombe groups for the study of strange materials, such as graphene and topological insulators. Our lab consists currently of 3 graduate students and one post doc, and we have benefited over the years from the contributions of many undergraduates.



Dr. Markelz imaging one of the plasmonic devices that her grad student Chejin Bae fabricated using self assembly techniques.

Several years ago the Markelz group began a collaborative effort for the realization of frequency tunable detectors in the terahertz range which was funded by the NSF Nanoscale Interdisciplinary Research Team (NIRT). The million dollar collaboration included funding for 5 investigators at 4 different institutions to address the need for detectors in this frequency range. The frequency range is important for product inspection and security screening, as most packaging materials are transparent thus one can nondestructively and noninvasively examine package contents.

Banner: Associate Professor Will Kinney was one of six recipients of the 2010-2011 Milton Plesur Excellence in Teaching Award given by the UB Student Association. The award, named in memory of Milton Plesur, a gifted and influential history teacher at UB from 1955 to 1987, is student-nominated and selected.
Photo: J. Cerne

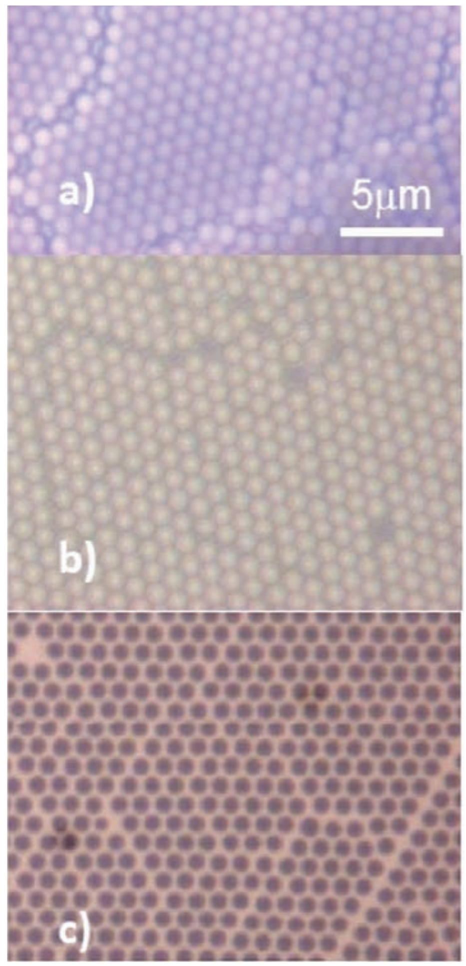


Terahertz spectroscopic data showing the resonant absorption at 0.4 THz can be tuned all the way to 1.2 THz using a magnetic field.

To identify substances, we need to know the precise frequencies that are absorbed, that is we need to perform spectroscopy. Unfortunately spectroscopy systems at terahertz frequencies take up a lot of space, have mechanical moving parts and often require liquid helium, a cryogen that is difficult to work with, is rare and expensive. One would prefer an all electronic spectrometer with no moving parts and at worst liquid nitrogen operation. With the advent of quantum cascade lasers compact sources for terahertz are now available, however all electronic frequency dependent detectors are not.

One method to achieve frequency dependent detection is to use electronic resonances. That is to make an electronic device that absorbs strongly at a single wavelength with this wavelength being dependent on for example an applied voltage. Then you can easily measure the spectrum by simply scanning the voltage.The two dimensional plasmon resonance that can occur in two dimension electron gases is such an electronic resonance. A plasmon is like a sound wave in an electron gas. In three dimensions one can excite these acoustic waves by shooting an electron through the gas. The momentum of the acoustic wave is supplied by the scattering electron. One cannot excite 3D plasmons with light. In two dimensions however, one can excite these waves with light, however one needs to have lateral confinement of the gas to overcome momentum conservation. The size of this confinement for the terahertz range is sub micron. Thus we could make a submicron device with a terahertz resonance. However one such device would not be very sensitive and the thermal background noise would be significant. To increase sensitivity and efficiency, one would like to have many of these devices closely packed together. The smallest one can focus terahertz light is approximate a 2 mm spot size. This means we would like to have many submicron devices over a 2 mm x 2 mm area. While a single device of this nature can be realized by using electron beam lithography, the cost to produce this array of approximately 2000 x 2000 devices is >$3000! In addition, the method cannot be scaled up. Enter lithography using self assembly! Inspired by the biomolecular systems we study, we decided we would try to let nature do our work for us! There are many systems in nature that produce periodic structures. Think about iridescent butterfly wings which arise from biologically occurring photonic crystals! We have realized these detectors by allowing 1 μm polystyrene spheres to self assemble on the surface of the two-dimensional electron gas material. By using this initial natural template, we can further process the system to get submicron features over 4 mm^2 areas, all without any specialized nanolithographic facilities.

Che Jin Bae, a graduate student in the Markelz group, has fabricated these devices and tested them with the help of graduate students Andreas Stier (McCombe group) and Deepu George (Markelz group). The students found that the devices have a very strong THz absorbance and have shown tunability with magnetic field. The figure shows a close up of the self assembled structure after metallization. The second figure shows the magneto-plasmon resonance that tunes with magnetic field. Che Jin has given oral presentations of his initial results both at the International Optical Terahertz Science and Technology 2011 conference held in Santa Barbara, California and at the 2011 APS March meeting. The group hopes to further refine the detectors so that they can be all electronically controlled, tuning the resonance without a magnetic field.



Terahertz plasmonic detector made at UB using self assembly techniques a) self assembled monolayer of polystyrene spheres b) reactive ion etch to reduce feature size and c) metal grid after metal evaporation and lift off.

Banner: The Department of Physics welcomed new office personnel in June. Our new Graduate Secretary, Kim Sargent, is from Undergraduate Academies on UB's north campus. Beth Wallace, our new Undergraduate Secretary is from the private sector. We are happy to have them both, and we look forward to a long rewarding association.
Photo: C. Gleason

Alumni in Focus

In Memoriam:
Dr. Christian J. Meining
By Drs. Bruce McCombe and Hong Luo

Dr. Christian J. Meining, a Senior Process Engineer in Intels Portland Technology Development VDF Group at the Ronier Acres Campus in Hillsboro, OR, and a former MS and PhD student and Postdoctoral Research Associate in the Department of Physics, died at the age of 37 on November 26, 2010 after a tragic accident while climbing Mt. Whitney in northern California. He is survived by his parents, Hilde and Helmut Meining, and a brother Klaus Meining, as well as several family members in northern California and Oregon.

Chris was born on July 27th 1973 in Werneck, Germany, and attended the University of Wuerzburg, obtaining a Vor Diplom in 1996 and a Diplom in 2000, both in Physics. He came to UB as part of the Wuerzburg/UB exchange program, and obtained an MS degree in 1999. After a brief time back in Wuerzburg, he returned to UB to work on his PhD dissertation research. At UB both his MS degree and his PhD in February of 2006 were results of his research as a student of Professor Bruce McCombe in the Department of Physics; his PhD dissertation is entitled "Infrared optical studies of spin-effects in semiconductor heterostructures." After receiving his PhD, Chris remained as a Postdoc in Professor McCombe‟s group for a little less than a year before joining Intel in Hillsboro, OR as a process engineer, where he spent the remainder of his all-too-brief career.

While at UB Chris became an expert in far IR and IR magneto spectroscopy, optical studies of spin injection in the near IR (in InAs-based materials), and optically detected resonance spectroscopy of quantum wells and interface fluctuation quantum dots in the GaAs/AlGaAs system. At the time he left UB, he had 13 publications, and was an author or co-author on more than 18 papers at national and international conferences, including an invited talk at the 17th International Conference on High Magnetic Fields in Semiconductor Physics in Wuerzburg in 2006. He was an excellent Ph.D. student and made many contributions to Professor McCombe's laboratory and research programs.

Chris in front of his poster at a workshop on spin effects in semi-conductors at Vanderbilt University in 2002. Photo: N. Kim

Music was an important part of Chris‟s life. He was a singer and a member of a rock group while in Germany, and was interested in all forms of music from rock to jazz.

After moving to Portland, he became an avid mountaineer, runner and kayaker, taking advantage of the beautiful and varied surroundings in the Portland area, as well as venturing far and wide to climb mountains (from Kilimanjaro to Machu Pichu). He was very proud of having climbed Kilimanjaro.

Chris was devoted to his family, and remained close to his childhood and University friends in Germany, as well as many graduate and undergraduate student colleagues at UB, and his wide array of friends at Intel and in the Portland Oregon area. He was outgoing with a ready smile, and was a caring person by nature who loved to cook for his friends and share his passions for music, science, books and the great outdoors. He enjoyed all aspects of life, and he will be remembered and missed by all who worked and played with him.

Dr. Robert Leighton Pfleegor
1942-2011

Dr. Robert Leighton Pfleegor died at his residence on February 10, 2011. He was 68 years old. Dr. Pfleegor graduated from West Seneca High School and went to receive his BA for the University at Buffalo in 1964 and his Ph.D. from the University of Rochester. Robert taught Physics at Carroll College. He later started a used machinery business in Waukesha, Wisconsin. He retired in 1999 and moved to Iola. He is survived by his wife Lynda and his son Brian. A memorial service was held at the Voie Funeral Home on Monday February 14, 2011.

Dr. James P. Nicklas
1922-2011

Dr. James Nicklas graduated from the Physics Department with a BS in 1950 and a PhD in 1956.

Banner: Chris and Dr. McCombe at a Department cookout in summer 2005.

Harold F. Webster, BA 1941, MA 1944

By Dr. Harold Webster

Dr. Webster, who received a BA and MA degree from the University at Buffalo and a PhD degree in 1953 from Cornell University, retired from the General Electric Research and Development Center where he worked for 34 years. While working for a masters degree he prepared radon seeds for SIMD (now Roswell Park Hospital).

A classmate of Dr. Webster, Robert V. Pound, BA 1941, who recently passed away (see the Fall 2010 issue of Interactions), graduated early and went to the MIT Radiation Lab, a secret war time lab, set up to develop microwave radar systems using the cavity magnetron from the British. Webster followed him and worked with Pound on the design of microwave mixers until the lab was dissolved in 1945 (see Vol. 16, MIT Lab Series). They worked together on the development of the matched waveguide “Magic Tee” for X band, 3 cm, and K band, 1.25 cm, radar systems. These systems were small enough that they could be placed in blimps and airplanes along the U.S. east coast. They were very effective in detecting German submarines that had been destroying shipping.

Webster then went to Cornell and had a teaching assistantship for three years. He took courses with Bethe, Feynman, Sproul and Morisson, Newhall and Booker. As an experimentalist Webster worked on thermionic emission. Feynman was the theory representative on his PhD committee. After receiving his PhD Webster went to work at the GE Research Lab. He married Helen Voorhis and they have three children, Sue, Kenneth and Jean. While working on some hollow electron beams Webster discovered an instability that causes the beam to develop vortices. This occurs in electric charge sheets moving in a magnetic field. It was later found that this occurs in the aurora and causes the rays to form. He and Robert Kyhl shared the WRGB prize of the IEEE for this discovery. Webster extended the work of Langmuir to find I-V characteristics of thermionic diodes. This led to the invention of the vacuum thermionic energy converter. While working on the cesium thermionic converter Webster investigated the relationship between crystal face, work function emission, and wetting of alkali metals on various refractory metals. Webster was one of the inventors of the GE Flip Flash for cameras. He served as U.S. Delegate to the London Meeting of URSI, the International Scientific Radio Union in 1960. In later years he was mostly involved with material problems in high power silicon devices. He has been granted 38 patents.

After retirement he and several others from the Lab started a program called “Fun with Physics” to interest children in science. It had demonstrations (many hands-on) dealing with Newton’s Laws, Bernoulli, Pascal, and some with electricity and light. The 45 minute long program was presented to more that 10,000 children, for instance at the Schenectady Museum and at various libraries in the 5 county area.

UB Physics reunion dinner 2011 APS March meeting in Dallas, TX

By Andreas Stier

The annual APS March meeting is a great venue to meet members of the UB Physics community. This year in Dallas, TX the UB Physics reunion dinner at the Sol Irlandes Mexican Grill attracted over 35 people. A side story with that event was that during the planning in February, we were not able to secure the restaurant at first as the person responsible for larger groups could not make it into work that day. The “Snowstorm of the Century” as titled by the Dallas News had hit the city earlier that week. Similar to the October storm in 2006 which hit Buffalo by surprise, a weather mix that even “the most aggressive computer model fell well short of predicting the bountiful snowfall” swept over Dallas. We investigated the situation and found that 12.5 inches of snow had fallen “smashing to bits” three snow falling records at once: the heaviest snowfall for that date, the heaviest single-day snowfall and the heaviest snowfall in a 24-hour period. The day we wanted to book the restaurant, the situation was still bad, the snow covered almost the entire ground which we Buffalonians can sympathize for not coming to work. Luckily we could finally make our reservations and were rewarded by a happy evening with much laughter and good times over great Mexican food and drinks. We are looking forward to next year’s meeting in Boston!

Banner: Co-inventor of the quantum cascade laser, Professor Federico Capasso from Harvard University, gave a talk to a general audience during this year’s Moti Lal Rustgi Memorial Lecture on April 11. Dr. Capasso is a distinguished leader in the fields of electronics, photonics, mesoscopic physics, nanotechnology and quantum electrodynamics, and his achievements include membership to the National Academy of Sciences as well as the National Academy of Engineering.
Photo: J. Cerne

Development

Thank you to our donors for their 2010 contribution to the Physics Department funds:
(includes faculty)

Elena Brewer
John Cerne
George Cernica
Jing-Yin Chen
Ji-Ping Cheng
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Igor Zutic

Support the Department of Physics Programs

The Physics Department is grateful to all our alumni and friends for their contributions. These contributions provide the margin which makes UB Physics an excellent Department. In today's environment of decreasing government support the contributions to any of these funds are instrumental in the quality of our academic endeavors every year. To contribute electronically, please visit www.physics.buffalo.edu and click the Support Physics button on the top right or contact Chris Gleason in the Physics Department at 716-645-3629 or via e-mail cg57@buffalo.edu. You may also contact Deborah McKinzie in the Development Office at 716-645-0839, 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 to support 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 initiatives. Support will allow continued evolution and development.

Physics International Graduate student Assistance Fund:

Established in January 2010 by Dean Bruce D. McCombe, College Arts and Sciences, to provide support for critical financial assistance to international graduate students in the Department of Physics, with a preference given to Asian students and 1st year Ph.D. candidates, at the University at Buffalo.

Banner: Rustgi Lecture speaker, Dr. Federico Capasso with UB Physics majors after an informal talk and an extended question/answer session. The students had the opportunity to not only ask about Dr. Capasso's research, but also found out more about his experiences and philosophy as a scientist.
Photo: J. Cerne

Seventh Annual Celebration of Academic Excellence

By Dr. John Cerne

There was a large physics presence at the Seventh Annual Celebration of Academic Excellence on April 6 2011. This event, held at the UB Center for the Arts, featured undergraduate and graduate research projects. Physics majors and faculty were involved in seven of the approximately fifty posters from the College of Arts and Sciences. Each student presented a poster describing his/her research. The students involved were (faculty mentor in parentheses): Richard Brosius (Kharchilava), Junhung Choi (Bianco), Kwan Chun Pui (Ganapathy), Michael Skvarch (Gonsalves), Grady Gambrel (McCombe), Matthew Westley (Sen), and Zelu Xu (Cerne).

Richard Brosius (top), Michael Skvarch (middle), and Zelu Xu (bottom) explaining their research.
Photo: J. Cerne.

Science & Art Cabaret: Illuminating Nano

By Dr. Arnd Pralle

Last November, in the Ninth Ward under Asbury Hall on Delaware Ave, a group of physics faculty, UB art faculty and artists 'illuminated' for the general public how light interacts with nano-scale materials causing beautiful, strange and very useful effects. This was the third Science & Art Cabaret which aims to entertain and educate by mixing cutting-edge science with art, music, poetry, and performance. About 70 people came to listen to and engage into the science and art while enjoying a drink at the bar.

Sambandamurthy Ganapathy and Arnd Pralle, both UB Physics faculty members, discussed together with Douglas Borzynski from the Buffalo Museum of Science, in short 15 minute presentations questions such as: How do nanostructures in butterfly wings create colors? What makes graphene so special that it deserved the Nobel prize? What is the potential of nano-science for biology and medicine? The talks were enlightened by the violin performance of Moshe Shulman, a UB graduate student in composition, who played his own composition coupling live play with delayed electronic feedback. Virocode, visual artists Peter D'Auria and Andre Mancuso, explained their installations using stroboscope lighting to freeze the bursting of water filled balloons into tiny droplets. The work was concurrently on exhibit in the gallery of Asbury Hall, so that after the presentations the group moved to the gallery to observe their work. Here, Douglas Borzynski and Arnd Pralle had set up an interactive display on using nanoparticles to created stained glass, a technique used since Roman times. So the evening ended in lively communication and interaction between scientists, artists and the general public. Overall, the evening was another very successful Buffalo Science & Art Cabaret ensuring this series which was originally initiated by our faculty member Will Kinney, will continue.

Dr. Pralle explaining novel biomedical applications of nanoparticles.
Photo: S. Parker

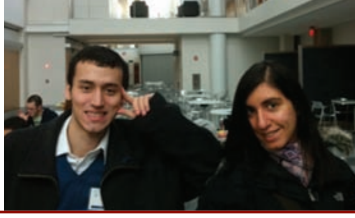
Engineering Week BattleBots Competition

by Grady Gambrel and Daniel Stoloff

Douglas Borzynski (Science Museum) talking to participants over the hands-on demostration on nanoparticle stained glass windows.
Photo: A. Pralle.

The SPS had an exceptional performance during the Engineering Week BattleBots Competition this year. We entered two Bots for the competition: a seriously designed Bot with a saw for a weapon and a radio-controlled car with a cake attached to the top. Ironically, the "cakebot," as it came to be called, managed to win its first round due its opponent's technical difficulties and the moral support of the crowd, while our main Bot did not fare as well, losing to one of the finalists in the first round.

Banner: Physics senior Grady Gambrel and his marvelous Cakebot, which used its high maneuverability to win the first round (an SPS first), but had a transformative loss in the second round at the UB Botwars.



Events CONTINUED

In the second round, which was the semifinal match on that side of the bracket, the "cakebot" was pitted against the same Bot which beat our main entry. The cakebot was swiftly destroyed after accidentally getting stuck to the side of the arena and becoming an easy target. However, because it was in the semifinal match, the cakebot was allowed to enter the consolation match for third place. The cakebot was unable to battle, so we were allowed to use our main Bot for the match. Unfortunately we lost that match because of motor problems. We are quite pleased with our performance this year and hope to do better next year by starting earlier and getting some new motors to avoid the problem we had with our main Bot this year.

Society of Physics Students (SPS)

By Grady Gambrel and Daniel Stoloff

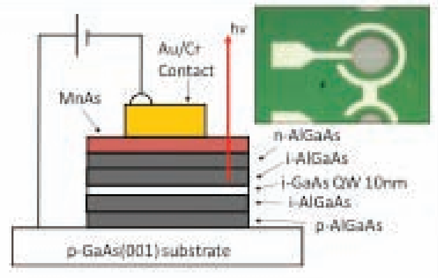
The undergraduate physics club, part of the National Society of Physics Students (SPS) has had an exciting year. We have seen the continued success of our professor talks, having members of the faculty talk to undergraduates in an informal setting, allowing for a great flow of advice from a knowledgeable source about the world of science.

Our entry in the Engineering Week BattleBot competition outperformed those of previous years. We entered two Bots into the competition, and the glorious cake Bot made it all the way to the semi-finals. Members also attended the Regional SPS Physics Conference at Cornell University where they were able to interact with students from various universities across the region and tour the facilities at Cornell. Activities also included the annual UB physics shirt (available to the whole department) and a talk with the Rustgi lecturer.

Research News

What makes MnAs a good spin injector?

By Drs. Hong Luo and Athos Petrou

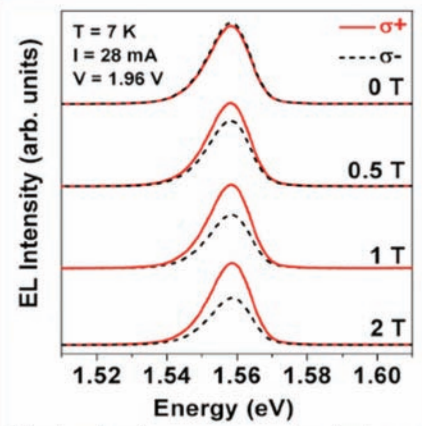


A schematic diagram of the LED structure with a 10 nm GaAs quantum well. The photograph is the top image of the LED fabricated with photolithography.

Spin injection into semiconductors is key to applications using the spin degree of freedom for logic devices. The most direct measurement of spin injection can be obtained with a spin LED shown in the figure above. A very limited number of materials have been shown to yield high efficiency for spin injection, among which Fe is the most studied. A problem related to spin injection is that most magnetic elements such as Fe and Mn, are known to diffuse strongly into semiconductors. In the diffused form, they are often in the paramagnetic phase and behave as spin scatterers, which complicate the interpretation of spin injection results, a fact which is often ignored. So far the effect of diffused magnetic elements is poorly understood.

Two related materials have been extensively studied, namely, GaMnAs and MnAs. The former is a ferromagnetic semiconductor, and the latter has the properties to be a good candidate for becoming an injector of spin-polarized electrons into semiconductors. The Curie temperature of MnAs is above room temperature, and it is structurally compatible with most commonly studied semiconductors, such as Si, GaAs and InAs, because it can accommodate a large range of lattice constants.

A systematic study of diffusion profiles of Mn from both GaMnAs and MnAs into GaAs (through a collaboration with Professor Gardella's group in Chemistry) revealed a very interesting effect. In the case of GaMnAs, a typical diffusion profile is observed, namely, a dependence on annealing temperature with higher diffusion constant at higher temperatures. Meanwhile, there is no observable change of diffusion at the interface between MnAs and GaAs as a function of annealing temperature. The contrast between the two cases can be easily understood in terms of thermodynamics. Two competing processes are in general present for Mn in GaAs, namely, diffusion and phase separation, both of which have been reported in the literature. Diffusion is observed in low temperature grown GaMnAs samples, low enough to inhibit the formation of phase separated MnAs precipitates. In this case, Mn is randomly distributed in GaAs. Studies have shown that diffusion of Mn in GaMnAs during low



Electro-luminescence spectra for two circular polarizations emitted from a GaAs-based LED with MnAs as the spin injector. The difference in their peak intensities is the result of spin polarization of the electrons injected into the LED.

Banner: Physics undergraduate students Richard Brosius and Nadine Ayoub at the SPS Physics Conference at Cornell University.

temperature annealing, typically below 250°C, can greatly raise the Curie temperature. When such samples are annealed at higher temperatures, i.e., above 300°C, phase separation takes place, with randomly distributed Mn merging into MnAs clusters, an opposite process of diffusion. In other words, MnAs is a more thermodynamically favorable state than randomly distributed Mn ions in GaAs. Thus when MnAs is used as a spin injecting contact, grown on top of GaAs, there will not be any significant diffusion.

This is reflected in our recent studies of GaAs-based spin LEDs with MnAs as the spin injector (E. Fraser et al., Appl. Phys. Lett. 97, 041103 (2010)), through a collaboration between research groups of H. Luo and A. Petrou. Spin injection rate is determined to be 52% at 7 K, and survives up to room temperature. These new results are a significant improvement over previously reported results with this material system.

Heisenberg spin chain as a quantum communication channel: The even-odd effects.

by Dr. Xuedong Hu

Parity is a fundamental property in physics. A simple demonstration in quantum mechanics can be found in the two lowest-energy states of a double well, where the ground state is

$$\psi_g(x) = [\psi_L(x) + \psi_R(x)]/\sqrt{2}$$

and the first excited state is

$$\psi_e(x) = [\psi_L(x) - \psi_R(x)]/\sqrt{2}$$

When we invert position, $x \to -x$ the ground state remains the same, while the excited state acquires a negative sign. Thus ψ_g has even parity while ψ_e has odd parity. Parity can determine, for example, whether a quantum state is accessible optically, or whether an atom can (^{47}Ag) or cannot (^{46}Pd) be detected by Stern-Gerlach experiment.

In a recent paper [Phys. Rev. B 82, 140403,Rapid Communications (2010)], we explored how the parity of a strongly coupled but finite Heisenberg spin chain, i.e. whether the number of nodes in the chain is even or odd, determines its behavior when its ground state is used to provide a quantum communication channel between two spin qubits (see Fig. 1 for a schematic). The spin chain here acts as a bus for qubit information exchange. We found that for chains of even or odd parity, the nature of the effective interactions and the ability to mediate long-range entanglement differs significantly. For example, when the spin chain is even in size, its ground state is nondegenerate, and the two weakly attached qubits (at the two ends, or an arbitrary pair of even and odd sites) would be maximally entangled in their ground state (and disentangled from the chain). The two attached qubits interact with each other via an effective interaction mediated by the chain. On the other hand, with an odd-size chain, whose ground state is a doublet, the attached qubits cannot get close to being maximally entangled in the ground state, because of an interesting phenomenon called "entanglement monogamy". In essence, if two quantum mechanical objects are highly entangled, neither of them can be highly entangled with a third quantum party. Here the odd-size chain acts like a spin-1/2, or a central spin. The central spin and the two external spins are coupled with each other, forming a three-body relationship that prevents the two attached qubits to become maximally entangled. In addition, the coupling between the central spin and an external spin qubit could be ferro- or antiferromagnetic depending on the attaching position, which opens up the possibility of building artificial spin lattices of arbitrary interactions solely out of antiferromagnetic couplings, as shown in the figure.

In short, for the finite-size spin chains we have considered, their parity determines how they act as a bus between the two attached qubits. Our results clarify the possibility of employing spin chains as efficient quantum communication channels.

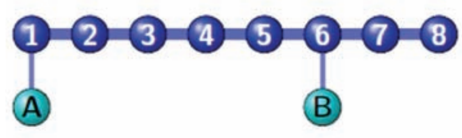


Figure 1: A schematic of a Heisenberg spin chain weakly coupled to two external qubits A and B. Here the spin chain is even in size.

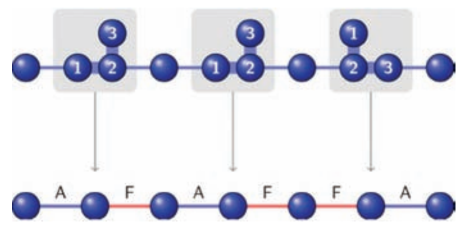


Figure 2: An engineered spin superlattice with ferromagnetic or antiferromagnetic couplings. Here three strongly-coupled (denoted by thick lines) spins in a shaded box act as a single effective spin. Coupling between this effective spin and an attached spin can be either ferromagnetic ("F", red line), when the attaching site in the effective spin is a middle node (2), or antiferromagnetic ("A", blue line), when the attaching site is an end node (1 or 3).

Banner: UB graduate student Chase Ellis and visitor Takahiro Morimoto enjoying a day away from the lab at Niagara Falls. Takahiro Morimoto, a graduate student at the University of Tokyo, spent a week at UB at the end of March and gave two seminars. During his stay he worked on a collaborative project with the McCombe and Cerne groups, and experienced a little bit of the Buffalo lifestyle... Niagara Falls, chicken wings, and Allentown.
Photo: C. Ellis

Research Awards
By Dr. Sambandamurthy Ganapathy

Dr. Igor Zutic received a $295,000 grant from the National Science Foundation to work on a project on Semiconductor Spin-Lasers during the period 9/2011-8/2014. The work aims to develop theoretical framework for lasers with operation that is directly modified and potentially improved by the presence of spin-polarized carriers.

Dr. Zutic, in collaboration with co-PI Prof. Andre Petukhov from South Dakota School of Mines and Technology, has received a $420,000 grant to work on a project, "Tailoring Magnetism and Spin in Quantum Dots", from the Department of Energy for the period 6/2010-5/2013.

These systems, also experimentally studied at the University at Buffalo in the groups of Drs. Athos Petrou, Bruce McCombe, and Hao Zeng, provide intriguing playgrounds to theoretically examine the influence of the quantum confinement and electron-electron interactions on the ordering of carriers spins and magnetic impurities.

Dr. Bruce McCombe received a $345,000 grant from the National Science Foundation – Materials World Network to study, "Spin Effects in quasi-1D systems of Narrow Gap Semiconductors" during the period of 07/2010-06/2013. This coordinated research program between the US PI (Dr. Bruce McCombe) at the University at Buffalo, and the German PI (Dr. Saskia Fischer) at the Humboldt Universaet zu Berlin involves materials growth, nanostructure fabrication, low-temperature magneto-transport measurements, THz photoresponse spectroscopy and collaborative theory to study spin and spin-orbit effects in quasi-one-dimensional InAs-based semiconductor structures. The information and detailed understanding derived from this coordinated effort should allow tailoring complex 1D-structures such as combining short quantum wires with quantum Hall edge channels in a Mach-Zehnder interferometer for spin-dependent coherence measurements.

We congratulate our graduates

BACHELORS:
Eric Daniel Treacy, February 2011

MASTERS:
Kamaljit Kaur Gill, February 2011

Ph.D. :
David Everett Fraser, Advisor, Professor Hong Luo, Thesis Title, "Studies on Ferromagnetic Metal/GaAs Heterostructures and Spin Electronic Devices"

Chae Hyun Kim, Advisor, Professor Hao Zeng, Thesis Title, "Dye-Sensitized Solar Cells Based on Free-Standing TiO2"

Linda Lee Shanahan, Advisor Surajit Sen, Thesis Title, "Time-Evolution of Strategic and Non-Strategic 2-Party Competitions"

Kenneth James Smith, Advisor Avto Kharchilava, Thesis Title, "Measurement of the Ratio of Inclusive Cross Sections Sigma (ppbar>Z+b)/sigma(ppbar->Z+jet) in Dilepton Final States"

Events Calendar

March 26th , 2011 - Physics Preview Day

April 11th -17th, 2011 - Annual Moti Lal Rustgi Memorial Lecture given by Dr. Frederico Capasso -Quantum Cas-cade Lasers: Widely Tailorable Light Sources from the Mid-infrared to the Far-infrared

May 15th, 2011 - Commencement

August 26th, 2011 - Welcome BBQ

September 23rd, 2011 - Public Lecture, Professor Harald Fritzsch "Escape from Leipzig"

September 24th, 2011 - Uli Baur Memorial Symposium (see www.physics.buffalo.edu/UliBaurSymposium)

October 2011 - Fall Open House

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Banner: Left to right: Kelly and Scott Whitmire, Andreas Stier, Laura Hovind, and Dr. S. Ganapathy at the reception honoring Dr. McCombe in June 2011.
Photo: A. Markelz

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The University at Buffalo Department of Physics Newsletter

Physics seniors preparing for the College of Arts and Sciences commencement on May 15, 2011. From left to right: David Elsaesser, Daniel Ferris, Dean Kirby, Janessa Pagliaccio, Jared Parks, Michelle Ratajczak, Steven Schott, Michael Skvarch, and Nicholas De Meglio. photo: J. Cerne