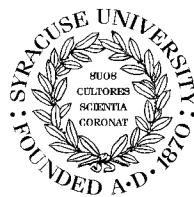


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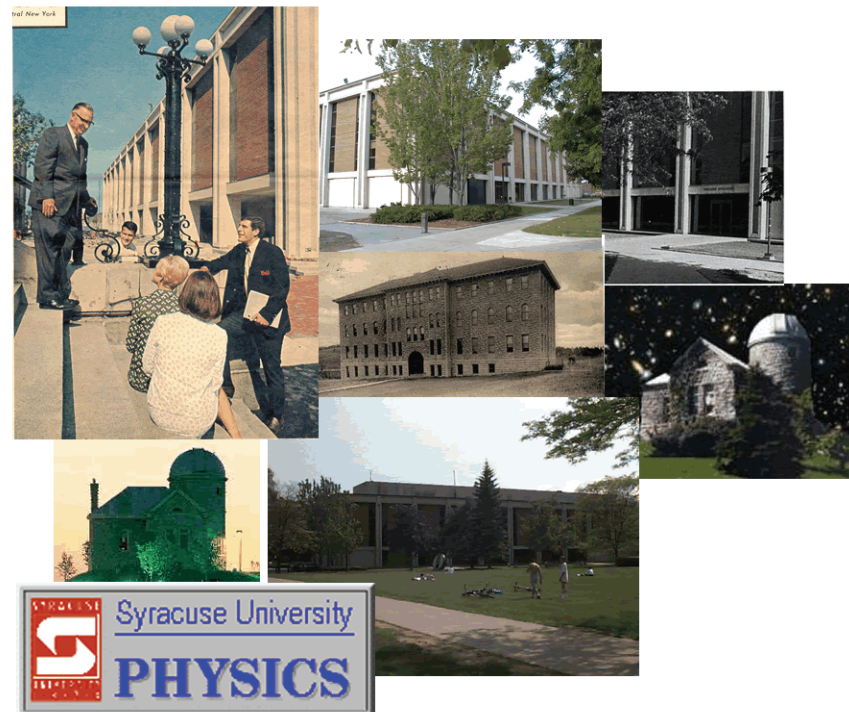
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### **Physics Matters**

Physics Matters is published by the Department of Physics of Syracuse University for its students, alumni and friends to inform them about the department and to serve as a channel of communication. Readers with comments or questions are urged to send them to Department of Physics, Syracuse University, 201 Physics Building, Syracuse, NY 13244-1130. Fax to 315-443-9103. Email to [phymatt@phy.syr.edu](mailto:phymatt@phy.syr.edu). The Web address is <http://www.phy.syr.edu/>.



# Physics Matters at Syracuse University

March 2007

Volume 1, Issue 1

### **From the Editor;**

This is the first issue of a newsletter about the Department of Physics at Syracuse University and about both undergraduates and graduate students. The idea is multiple. First of all, we would like all of you who are or were part of the Physics Department to be aware of activities and interests of faculty and students in the Department. But, more important, those of us who remain in the Department want to know what has become of those who have had at least part of their education here. We would like to have you tell us how your physics understanding has helped you in your life since leaving Syracuse. For some of you that will be a continuation of the life as a research physicist and teacher. But, for most of you, we suspect that has not been the case and that you have interesting stories to tell us which can help us in our teaching and advising of present students.



This first issue does not contain all of the above. It is devoted to introducing some new faculty and a description of some changes in the research in the Department. Condensed Matter Physics (CMP) group, where the main growth has been, is described by Mark Bowick. There are also articles describing new activities of the High Energy Experimental Physics (HEE) group and about possible use of polarized HD in the Tokamak for fusion energy. And you will find more inside.

Finally, if the newsletter is to grow into a relationship with the entire Syracuse Physics Family, we must hear from you in letters about where you are and what you are doing. But, we also want to hear from some of you with longer articles like those by Mark, Sheldon, and Army. That's true even if you are not involved with physics, but finance, law, medicine, or any other activity that you find interesting and perhaps exciting.

— Josh Goldberg, Emeritus Professor

### **From the Chair;**

It gives me great pleasure to reach out here to those of you who were members of the Physics Department in years past. During the 30-plus years I have been in the Department, I have had the opportunity to interact with many of you personally as teacher, research supervisor, adviser, or department chair. By the end of this academic year, I will have served 6 years as chair, distributed over two separate terms, and this has been a fulfilling and rewarding experience. Another faculty member (TBA) will take over as chair in summer 2007, and I will be able to increase my time for research and teaching. When I first came to Syracuse, my main research interest was in photosensory transduction in microorganisms, based on my postdoc work with Max Delbrück at Caltech. Beginning in the mid 1990s, I turned much of my attention to applied research areas including telemedicine and distributed medical intelligence, human-computer interfacing, and most recently medical imaging.



The department is healthy and growing, with six superb faculty hires since 2004, and with searches now in progress. As you will note in the following, much of that increase has been in the area of condensed matter. In addition to our other internationally recognized groups, condensed matter, particularly soft condensed matter, now has major recognition. The other groups have also been strengthened; see this and future newsletters, and the department website, for more details. We have benefited by strong support from Dean Cathryn Newton and from the SU central administration. Our teaching, outreach, and doctoral research activities are all strong, and enjoy ample support. Our majors program has grown to over 40 students, many of whom are active in research. Our emeritus faculty members remain active and come in regularly, often daily. The collegial and democratic traditions established by early leaders like

(continued on page 3)

## Prof. M. Cristina Marchetti Appointed Kenan Chair



The College of Arts and Sciences at Syracuse University has appointed M. Cristina Marchetti William R. Kenan Jr. Professor. Nationwide, only about 120 academics share this major honor. The Kenan Professorship of Science honors the commitment to the most exacting

standards for their own scientific work, along with great generosity of time and spirit in the mentoring of students and colleagues.

Marchetti, who has taught at SU for almost two decades, is known for her research in condensed matter theory and statistical mechanics. In 2000 she was elected Fellow of the American Physical Society. Recently, she was named a recipient of the 2005 Chancellor's Citation for Exceptional Academic Achievement at SU. She has served as chair of the scientific advisory board of the prestigious Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.

She received her *Laurea* in physics *cum laude* from the University of Pavia in Italy, and her doctorate in Physics from the University of Florida. She held postdoctoral positions at the University of Maryland, Rockefeller University and City College of CUNY, and then served for one year as assistant professor of physics at the University of Illinois.

Cristina Marchetti's research has spanned several areas within condensed matter physics. Cristina has proposed and developed theories that can be used to describe the flow of vortices, which have been tested by experiment. Recently she is applying her deep knowledge of hydrodynamics to problems in the interdisciplinary field of biophysics. The applications of non-equilibrium dynamics and statistical mechanics to problems from biology is one of the two hottest fields in physics at the current time. Again, research in this area is a very competitive enterprise. She is already making a strong mark on the field.

**"The Kenan Professorship of Science honors the commitment to the most exacting standards for their own scientific work, along with great generosity of time and spirit in the mentoring of students and colleagues."**

## Society of Physics Students — Prof. Steve Blusk, Advisor

The Society of Physics has been thriving with the influx of talented and enthusiastic physics majors at SU. Since 2002, Prof. Steven Blusk has served as the chapter's advisor. The chapter typically meets weekly or bi-weekly to enjoy pizza and refreshments while discussing various activities of the chapter. Over the last few years, the society has hosted several speakers including Dr. Al Bartlett on "Arithmetic, Population and Energy", Dr. Robert Godley from Nine Mile Point Nuclear Reactor on "Chernobyl: A Lesson in how NOT to Build a Nuclear Reactor", and Prof. Josh Goldberg gave a talk on Relativity. The society has also taken a number of educational trips, including visits to the Cornell Electron Synchrotron (CESR) and the associated detector (CLEO), NASA in Washington D.C., and the Laser Energetics Laboratory at the Univ. of Rochester. The society has also been active in outreach. For example, some members have helped put on physics demonstration shows for the public with our lab manager, Sam Sampere. We have also hosted star gazing nights from the SU Quad using portable telescopes and from the large telescope at the Holden Observatory.

Some members have visited local high schools with a few demonstrations to promote physics. The society also routinely hosts social events, including movie nights, ping-pong tournaments, field trips, ski trips, etc. We are always interested in helping with Educational Outreach, so helping with Educational Outreach, so if you have any ideas, please contact SPS President Jessica McIver at [jlmciver@syr.edu](mailto:jlmciver@syr.edu).

We're also very pleased to announce that on May 4, 2005, we re-inaugurated the physics honor society, Sigma Pi Sigma, at SU. Membership to the honor society is contingent on academic achievement (GPA of at least 3.6), participation in SPS, and educational outreach. In 2005 we inducted 8 members and in 2006, we inducted four new members: Jillian Dodge, Jeremy Chapman, George Mitchell and David Malling.



## Degrees Granted—2006 - 2007

### Doctor of Philosophy:

- Maqbool Ahmed, Faculty, National University of Sciences and Technology, Pawalpindi, Pakistan
- Durdana Balakishyeva, Gainesville, FL
- Jamila Butt, Post-doc, Quaid-i-Azam University, Pakistan
- Antonio DeFelice, Post-doc, University of Sussex, UK.
- Sofiane Ghadab, Software developer, Affiliated Computer Services, Lexington, KY
- Keith Joseph, Lockheed Martin, Liverpool, NY.
- JianJun Liang, Silicon Valley Solar, Inc., Santa Clara, CA
- Nabil Mena, Research scientist, industrial sector
- Radia Mena-Sia, Research scientist, industrial sector
- Radia Redjimi, .St. Genis Pouilly, France.
- Hongshan Zhang, Post-doc, Brookhaven National Lab

### Master of Science:

- Zafar Ahmed
- Alphonso Magri
- Abudureyim Rehemam
- Joseph Schneible
- Qian Wang

### Bachelor of Science:

- Thomas Bayuk
- Collin Capano
- Peter Clark
- Melissa Frei
- LaToya Crayton
- Jairo Velasco

### Bachelor of Arts:

- Angela Dawson
- Mark D'Aprile
- Joshua Gautreau
- Wesley Miles
- Orest Mykyta
- Kristin Pettit
- Levon Vogelsang
- Carl Wilk

## Tell us about yourself!

Mail us at the Department of Physics, Syracuse University, 201 Physics Building, Syracuse, NY 13244-1130 or email us at [physmatt@phy.syr.edu](mailto:physmatt@phy.syr.edu)

Here is my news: \_\_\_\_\_

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## Contributions can be made to the following:

\_\_\_\_\_ Henry Levinstein Fellowship Fund—this **graduate** fellowship is to foster graduate student research with members of the Physics faculty, based on academic excellence of the nominee and promise of excellence in research.

\_\_\_\_\_ William Fredrickson Fund— this **undergraduate** fund was established to provide a partial tuition scholarship for an incoming freshman who indicates an interest in physics.

\_\_\_\_\_ Neil F. Beardsley Prize—an award to an **undergraduate** physics major, based on outstanding academic achievement and contributions to the department.

\_\_\_\_\_ Paul M. Gelling Fellowship Fund—a memorial scholarship fund made to an outstanding **undergraduate** physics major based on outstanding achievement.

\_\_\_\_\_ General Department Gift Fund

Checks should be made out to *Syracuse University* with an indication of the selected fund, and sent to: Chair, Department of Physics, Syracuse University, 201 Physics Building, Syracuse, NY 13244-1130.

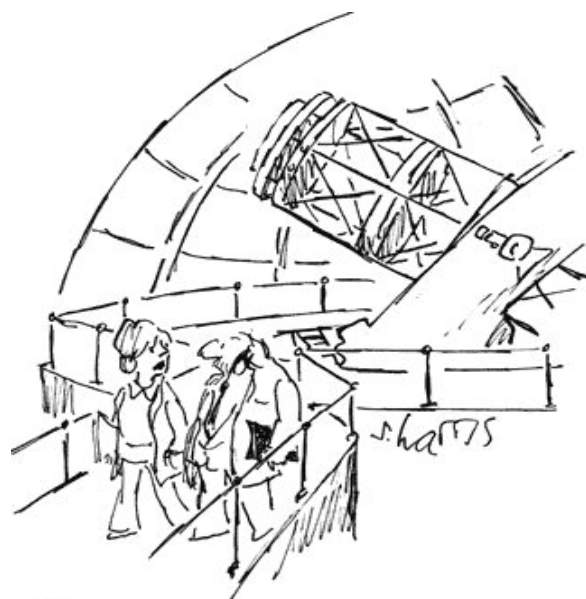
## AAPT – Teaching General Relativity to Undergraduates —by Rob Salgado, Lecturer

On July 20-21, 2006, Syracuse University hosted the AAPT Topical Workshop: Teaching General Relativity to Undergraduates. The meeting was held in the Heroy Geology Laboratory, where the main lobby was used as a site for lunch and for poster presentations. There were about 45 attendees from the United States and one each from Canada, Germany, and Slovakia.



The purpose of the conference was to share ideas for developing undergraduate courses in general relativity that are directed at different student audiences and that are teachable by faculty who are not necessarily experts in general relativity. The hope is that such courses can be incorporated into the undergraduate physics course offerings.

After Ed Lipson (Syracuse) and Charlie Holbrow (AAPT) delivered the opening remarks, Jorge Pullin (LSU) led off with a rapid review of general relativity. As an alternative to the traditional Math-first syllabus, Jim Hartle (UCSB) and Tom Moore (Pomona) presented their respective Physics-first and Physics-Math-interspersed approaches. Neil Ashby discussed the role of relativity in the Global Positioning System (GPS). Peter Saulson (Syracuse) discussed gravitational waves and their detection by interferometers like LIGO, with particular emphasis on the heuristics used to avoid misunderstandings on how this really works.



"I'VE SEEN OUT TO THE LIMIT OF THE OBSERVABLE UNIVERSE, AND BELIEVE ME, IT'S NO BETTER OUT THERE THAN IT IS HERE."

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Don Marolf (UCSB) introduced a new approach to visualize black holes using spacetime (rather than the commonly seen spatial) embedding diagrams. Rai Weiss (MIT/LIGO) gave a revealing presentation on the history of experimental results in general relativity. Stamatis Vokos (Seattle Pacific) concluded with studies exploring the student understanding of concepts important in general relativity. Each talk was followed by a lively discussion period.

Between the various sessions, the workshop participants were split up into three breakout groups, each focused on a particular audience that might be served by an undergraduate course in general relativity: General Interest, Physics Intensive, and Math Intensive. Among the participants were some relativity textbook authors (Jim Hartle, Bernard Schutz, Tom Moore, Edwin Taylor, and Richard Mould) who shared some valuable insights from their experience in teaching relativity.

A website <http://www.aapt-doorway.org/TGRU/> has been set up as an archive of the slides from the invited talks and the articles and posters submitted by some of the attendees. A more technical summary by Greg Comer (St. Louis U.) for the Matters of Gravity newsletter is available at <http://www.oakland.edu/physics/mog28/node12.html>.

The workshop was supported by the LIGO Project, the Center for Gravitational Wave Physics at Penn State, the American Association of Physics Teachers, and the Syracuse University Department of Physics. Thanks to Peter Saulson and the rest of the organizing committee for a thought-provoking workshop.

## Prof. Mark Bowick Receives Chancellor's Citation

The Chancellor's Citations is among SU's highest honors given each year to recognize the outstanding contributions made by faculty and staff. The 2006 honorees include Mark Bowick, professor of physics.

In the time it takes most professors to conduct groundbreaking research, garner the esteem of colleagues and make contributions to one field of study, Mark Bowick has succeeded in two. He is known throughout the University and in the international academic community as an expert in theoretical particle physics and condensed matter physics, having made award-winning discoveries in both areas while remaining dedicated to teaching and advising responsibilities. Born in Rotorua, New Zealand, Bowick received his bachelor's degree in 1977 from the University of Canterbury in Christchurch, New Zealand. He earned PhD in theoretical particle physics from the California Institute of Technology in 1983. Bowick came to SU in 1987 following post-doctoral research positions at Yale University and the Massachusetts Institute of Technology. He was promoted to associate professor in 1993 and to full professor in 1998. In the 10 years following his doctoral studies, Bowick made major advances in the fields of particle physics, string theory and quantum gravity, including experiments using liquid crystals to understand what may have happened in the moments following the Big Bang. Additionally, he wrote several award-winning papers on superstring thermodynamics and black hole

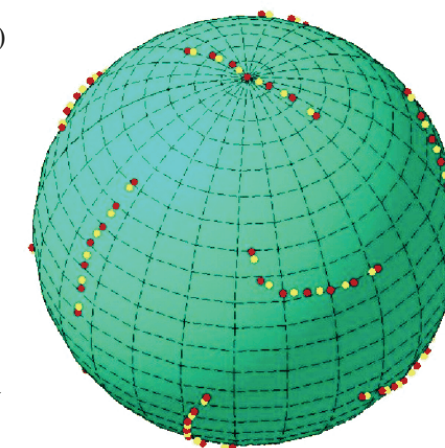
physics. He won first prize in the 1986 Gravity Research Foundation Essay Competition for his essay on the fate of black holes in the last stages of evaporation.

In the early 90s Bowick became interested in condensed matter physics, specifically the statistical mechanics of membranes and the physics of ordering on curved surfaces. Some of his most recent work centers on the century-old "Thomson problem," which deals with the minimum energy packing of particles on a spherical surface, posed in 1904 by Nobel Prize winner J.J. Thomson. Bowick, working with David Nelson (Harvard) and Alex Travesset (Ames Lab and Iowa State University), discovered irregularities in the structure of particles assembled on the surface of a sphere, which he called "scars." The discovery represents a major step in solving what is considered one of the top 10 mathematics problems of the 21st century.

Two graduate students, Luca Gioni and Homin Shin, are currently pursuing their PhDs under Bowick's supervision.



'The discovery [of "scars"] represents a major step in solving what is considered one of the top 10 mathematics problems of the 21st century



## From the Chair; continued

Bill Fredrickson and Peter Bergmann persist—a wonderful invariance principle.

When I approached Josh last Fall about editing this newsletter—knowing he was just the right one to do it—he immediately agreed. We can all be grateful for his excellent, dedicated work in producing this first issue of what we expect to become a continuing series. Indeed, I hope that this newsletter will promote interactions with you. You will hear from us

about the activities of the faculty and department. We want to hear from you about your life, your work, and how physics has been important to you. The latter is of particular importance to our students. So, please enjoy the newsletter, visit our website often, and stay in touch.

— Edward Lipson, Professor and Chair

## New Faculty 2006—2007—in their own words

**Kaustubh Agashe**—I joined the department of physics at Syracuse University as an assistant professor in August, 2005. I received my Bachelor of Technology degree in Electrical Engineering at the Indian Institute of Technology, Bombay in 1993. I then came to the United States to pursue graduate studies, obtaining my doctor of philosophy degree in physics from University of California, Berkeley in 1998. I also had post-doctoral research appointments at the University of Oregon, Johns Hopkins University and Institute for Advanced Study.



My research is in theoretical particle physics - on ideas going beyond the standard model (SM) of particle physics, a theory developed over the past couple of decades. Specifically, my work focuses on two extensions of the SM: supersymmetry (SUSY), which is a symmetry relating particles of different spin, and the existence of extra spacetime dimensions. My collaborators and I have shown that the idea of a "warped" extra dimension solves the puzzle of the enormous mass hierarchies, within the SM, offers a candidate for dark matter, and unifies the three forces of the SM. Hence, this framework is a worthy competitor to the more popular idea of SUSY which also enjoys some of the same successes. Currently, I am working on making predictions for the framework of a warped extra dimension. These predictions can be tested in ongoing and upcoming experiments, especially the large hadron collider (LHC) which will be operational at the CERN laboratory in Europe in a few years.

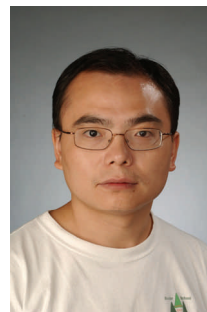
**Britton Plourde**—I joined the Physics Department in January 2005 and have been building a low-temperature research lab to study quantum coherence in superconducting devices. I did my undergraduate work at the University of Michigan where, in addition to a BS in physics, I received a Bachelor of Music degree in flute performance. While working on my dissertation in Physics at the University of Illinois at Urbana-Champaign, I also continued to study music. In 2000, I received my PhD for studying the dynamics of vortices in superconductors and a M. Music degree in flute performance. I met my wife Alina, a music graduate student, during this time. She had received her Bachelor degree from the Eastman School of Music and both her M. Music and DMA from Illinois. Before moving to Syracuse, I was a postdoctoral research associate at the UC, Berkeley. In 2006, I received a CAREER award from the NSF, providing funding for five years for my research program and education initiatives.



**Jennifer Schwarz**—Many of us have experienced the frustration of trying to get stuck coffee beans out of a dispenser, throwing out expensive paint that has dried out and hardened, or even being caught in a traffic jam. These phenomena, along with the better known glass transition, are all examples of jamming---the transition of a many-body system from a fluid-like state to a disordered solid-like state with an extremely long relaxation time. The nature of the jamming transition is one of the oldest unsolved problems in condensed matter physics. My research involves constructing and studying simple models of the jamming transition to provide a framework from which the more complicated problem can ultimately be understood. I also study more recent problems in condensed matter physics that involve biological systems, such as the cellular cytoskeleton and genetic regulatory networks. I received my BS/BA at the University of Maryland at College Park and went on to do PhD work at Harvard. After two post-docs, one at Syracuse and the second at the University of Pennsylvania, I am back at Syracuse as an assistant professor.



**Sean Xing**—After I received my BA degree in math from Nanjing University in 1993, I did graduate work there in mathematical physics. I did some research in group representation theory in the following few years. It did not take me much time to realize that the science I was doing was not what I looked for—not even close. After receiving my MA degree in Physics in 1996, I left Nanjing and found a job in the First Institute of Oceanography in Qingdao, a beautiful city in Northern China, famous for beer and mild weather, but no physics that truly interested me. Two years later, in 1998, I came to United States and became a physics graduate student (again) in University of Colorado at Boulder. Together with my advisor and other collaborators, I started my serious research in theoretical soft condensed matter physics. We analyzed the nonlinear elasticity of some novel material: nematic elastomer. I was awarded a graduate fellowship from KITP at UCSB and stayed in Santa Barbara for the year 2002 to 2003. In 2003, I became a postdoctoral research associate in University of Illinois at Urbana-Champaign. At UI, I mainly worked on the vulcanization theory of rubber/gel elasticity. In 2005, I became an assistant professor in SU.



## New Syracuse Postdoc Josh Smith—by Prof. Peter R. Saulson



The SU Physics Department is privileged to have many wonderfully talented postdoctoral fellows. But there is something extra special about a postdoc who will arrive in mid-March 2007.

Joshua Smith isn't exactly a newcomer to Syracuse University. I first met him as an undergraduate Physics major when he arrived in 1998. Josh was special even then. He came to us

from the tiny Adirondack hamlet of Indian Lake, NY (at the head of the beautiful lake of the same name.) Josh sought in the Physics Department the same sort of tight-knit supportive community that he so cherished from home. He began participating in research in my lab as a sophomore, and quickly became a key member of our group working on technology associated with the Laser Interferometer Gravitational Wave Observatory (LIGO). Helping to guide him were two post-docs, Steve Penn, now at Hobart and William Smith Colleges, and Gregg Harry, now on the research staff at MIT.

For all of 2000, I was on research leave in Louisiana, helping to install and commission one of the LIGO interferometers. That summer, Josh participated in the very competitive Caltech summer research fellowship program at LIGO Livingston Observatory. With an exciting big-science project taking shape around him and new friends from universities around the country, Josh returned to Syracuse in the fall of 2000 fully committed to a career in physics. His desire to

share his excitement about physics with his fellow students back in Syracuse led him to found a chapter of the Society of Physics Students at SU, which he also served as President - a lasting contribution to the life of our department.

Via contacts that he made through the SU research project, Josh learned of a summer research opportunity in Germany at the interferometer of the British-German gravitational wave detector project called GEO600. Only a year earlier, Josh had taken his first-ever commercial airline flight to go to Louisiana; in the summer of 2001 Josh flew confidently off to Hannover to deepen his knowledge of gravitational wave detection technology.

After writing a senior thesis that was published in the journal *Classical and Quantum Gravity*, Josh set off for the University of Hannover, so he could return to working on GEO600 for his PhD. By the time I was reading letters of recommendation in support of Josh's application to return to Syracuse as a postdoc, the leaders of LIGO's sister project were describing a mature physicist who had played a key role in developing one of the world's best gravitational wave detectors.

Josh is doing a brief postdoctoral stint at an all-European project on gravitational wave detector technology on the 3 km Virgo interferometer. LIGO will soon undergo a series of upgrades to guarantee that it will be able to find gravitational waves. Josh is arriving just in time to build a strong career as one of the young leaders of a dynamic and growing field of research. We in the SU Physics Department are delighted to be welcoming him home.

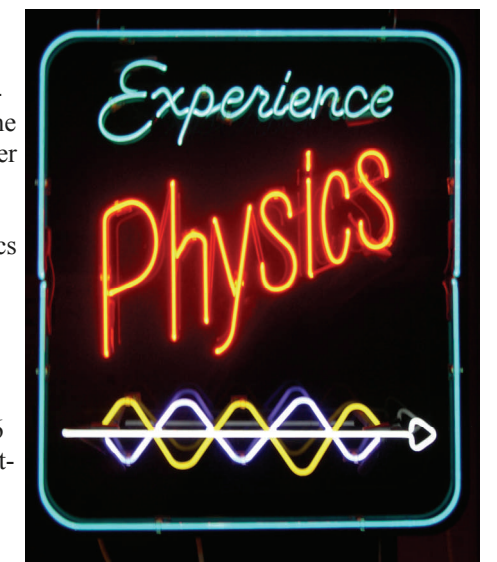
## The Neon Sign—Sam Sampere, Lab Manager

Sam Sampere (SU's "Demo-Guy") designed the neon sign that has hung in the lobby of the Physics Building since Fall 1999. The sign sends a message—physics is fun and all around us. "The message is that physics is something you can see, touch and hear," he says. "Students need to experience physics. They need to become part of the experiment. That's what makes physics fun."

Sam has been the lab manager in the department since 1994. It's Sam's job to figure out ways to make introductory physics courses fun, interesting and understandable for undergraduate students.



Besides revitalizing teaching labs, he has been the organizer of the department annual picnic, co-founder of the Physics Teacher Workshops (<http://www.phy.syr.edu/courses/K-12/K-12page.htm>) and co-ordinator of the 2006 AAPT Summer Meeting, hosted by SU, July 22 -26, 2006.



## Nuclear Fusion Fueled by Spin-Polarized $D+^3He$ – By Army Honig, Emeritus

Controlled nuclear fusion as a source of almost unlimited, safe, non-polluting and non-political energy is moving inexorably into the realm of realization. For both magnetic (MCF) and inertial (ICF) confinement fusion modes, ignition and net-energy production are expected from machines that are currently under construction and expected to operate before or by 2015. Our lab at Syracuse has been engaged in fusion-related efforts for the past 24 years through the seemingly improbable connection of 40 years of investigation of highly spin-polarized HD, whose special properties of simple isotopic composition, high polarization of the D, very long polarization retention (months) at convenient temperatures and fields of  $\sim 4K$  and  $\sim 10^{-2}$  Tesla, and transportability through cold-transfer operations which we invented and developed here, are well suited to injection into a fusion MCF tokamak machine or ICF polymer target capsules.

It has long been recognized that the fusion reaction  $D + T \rightarrow ^4He + n$  is spin dependent. It proceeds through a resonant spin  $3/2$  state of  $^5He$  of low enough energy so that no orbital angular momentum is involved and all angular momenta are from the spins. Since the spin of D is 1 and that of T is  $1/2$ , both  $3/2$  and  $1/2$  spin states occur for combined D T, with the statistical weight of the former equal to 4 and of the latter equal to 2. Since only the  $3/2$  combined state spin leads to fusion, the cross-section for unpolarized fusion fuels is  $(4/6)\sigma_0$ . With D and T fully polarized, *all* nuclei comprise the  $3/2$  state of the reactants and the cross section is 50% more than when unpolarized.  $^3He$  has the same nuclear spin of  $1/2$  as does T, and a parallel situation exists for  $D + ^3He$ . 50% reaction rate increase translates into billions of dollars lower costs from smaller allowable reactor size, or reduction in laser power. In addition, there are critical thresholds of reactor operation dependent on fusion reaction rate where polarization may take one “over the top”. Polarized fusion fuels have other potential advantages as well, among them the suppression at high plasma temperatures of the  $D + D$  reaction rate, one channel of which produces neutrons. Neutrons are very destructive of the first containment wall of a reactor, but they are unavoidable for the  $D + T$  reaction. However, the  $D + ^3He$  primary reaction produces no neutrons, and only the secondary  $D + D$  reactions result in neutrons. Thus, use of polarized D and  $^3He$  may suppress these, allowing a neutronless so-called 2<sup>nd</sup> generation reactor. In 1982, Kulsrud et al calculated the plausible relaxation mechanisms in the hot plasma of a MCF reactor



and concluded that the polarization should survive prior to the fusion reaction. This led to funding for our lab, both from DOE (US Department of Energy) and from Syracuse University, for a large top-loading mK temperature refrigerator with a high-field superconducting magnet. Its projected B/T of 1.5 Tesla/mK yields up to 90% H polarization, and through a radio-frequency dynamic spin transfer method up to about 75% D polarization.

A program to test the use of polymer shells with polarized D at the Laboratory of Laser Energetics (LLE) at Univ. of Rochester was interrupted because of a large scale upgrade of the ICF installation there, but resumption of a polarized fuel program is again being considered. In 1999, in collaboration with the Laser-Electron-Gamma Source (LEGS) project at Brookhaven National Laboratory and other groups at Orsay and Rome, we obtained high H and D polarizations in large (1.2 mole) HD targets. These were cold-transferred from the dilution refrigerator to a portable 4K storage cryostat which was trucked 300 miles to BNL. At BNL, the target was cold-transferred to an in-beam cryostat where it interacted with polarized gamma beams generated from laser light back-scattered by synchrotron electrons. After this demonstration of portability of the polarized targets, the entire system was moved to BNL, where it has been used in many exciting investigations of nuclear magnetism. The system is now highly reliable, with retention of the polarization for as long as 6 months.

Last year, we drafted a “white paper” that was sent to General Atomics in San Diego, which with DOE support runs the largest MCF tokamak in the US. It was pointed out that our accessible highly polarized D, together with available highly polarized  $^3He$ , also with long-duration polarization retention, can be loaded into ICF type polymer shells, transferred to the barrel of a cryogenic pellet gun and pneumatically fired into the tokamak plasma. The idea of testing enhanced fusion reaction rates with spin-polarized fuels was well received. A more detailed proposal followed, and a paper (viewable on www) was presented last October at the SPIN2006 Symposium held in Kyoto. We are now preparing such an experiment together with BNL. We have enlisted experts on cryogenic pellet injection at Oak Ridge National Laboratory, collaborators at General Atomics and at LLE who are expert on polymer ICF shells, and several of the operations people at the DIII-D. An experimentally established result of polarization retention and reaction enhancement will unleash vigorous efforts aimed at the more difficult T polarization problem, with utilization intended for ITER. There are many exciting spin physics problems in fusion, and the advantages of polarized fusion fuels may bring on an earlier inauguration of the fusion energy era.

## Condensed Matter Theory at SU

Over the last ten to fifteen years the Physics Department has built a strong research effort in the area of condensed matter theory. The Condensed Matter Theory (CMT) Group is now a very active group of 5 faculty members, 2 postdoctoral associates and 5 graduate students, with a specialization in Statistical Physics and Soft Matter. The faculty members are Mark Bowick, Cristina Marchetti, Alan Middleton, Jennifer Schwarz and Sean Xing. Both Jennifer and Sean arrived as new Assistant Professors in the Fall of 2005 (see New Faculty).

The group’s research focuses on two related topics: the physical properties of soft and living matter and the complex behavior of disordered systems. Soft Matter is the subfield of Condensed Matter Physics that deals with easily deformable (soft) substances such as fluids, polymers, membranes, colloids and granular media. A complete physical description of the properties of *soft matter* is a great theoretical and experimental challenge because such materials can easily adopt a myriad of complex shapes and typically exhibit different behavior on different length and time scales. This can lead to novel physical behavior such as contraction on heating (polymers) and lateral expansion on stretching (flexible membranes). Soft Matter materials also frequently defy the traditional classification of phases of matter. They may, for example, be solids on short time scales but liquids on long time scales (glass, silly putty and corn starch in water) – see <http://www.youtube.com/watch?v=f2XQ97XHjVw>. Some problems, such as the physics of granular materials, do not yet even have a proper physical formulation. Disorder and complex spatial and temporal variations are common ingredients as well in many soft matter systems and in disordered systems. The group’s activities in disordered materials



include memory, hysteresis and slow dynamics in random magnets and superconductors. In context, physicists have learned a great deal about “pure” (homogeneous) materials over the past 80 years, leading to developments in semiconductors, for example. Most natural materials and many lab materials are highly disordered: this leads to complex behavior over time and space. It also turns out that the numerical study of such materials is closely connected with problems in computer science, as computer scientists study large, complex, heterogeneous systems such as computer and transport networks. There is a commonality in tools and recent ideas in physics

have even led to new algorithms for problems in computer science. The group’s interests are closely tied to some of those of the CM experimentalists, especially with recently hired faculty Liviu Movileanu and Britton Plourde, given their research in biological systems and in the dynamics of superconducting vortices.

The CMT group is extremely active in the Department with a weekly Condensed Matter and Biological Physics Seminar, typically with an outside speaker, weekly group meetings and frequent research visitors and colloquium speakers. The group has initiated a semi-annual New York Complex Matter Workshop together with researchers at Cornell University and the Rochester Institute of Technology. The first meeting was held at Syracuse on Dec. 2, 2005, the second at Cornell on July 21, 2006 and the at Syracuse again on Dec. 14, 2006 – see <http://physics.syr.edu/condensedmatter/Workshop/>.

## Spotlight on—Alan Middleton, Associate Professor

Alan Middleton is a theorist who studies problems in condensed matter physics. His undergraduate degree is from Harvey Mudd College and he has graduate degrees from Cambridge University and Princeton University. Upon leaving the latter, he was a postdoctoral researcher at Syracuse University and then at the NEC Research Institute in Princeton, before bouncing back again to SU, where he has been a faculty member for 11 years.

Prof. Middleton is Director of Undergraduate Studies and supervises many undergraduate majors, with more majors each year. His most recent research studies deep relations between algorithms from computer science and disordered materials and surprising symmetries that exist in magnets with impurities.



## Mark Trodden Appointed Alumni Associate Professor

Dr. Mark Trodden was appointed Alumni Associate Professor on September 8, 2005. This named professorship is relatively new at SU. Only very few faculty, who, through their leadership have advanced the scholarly mission of SU have been given this particular honor.

Mark, a British citizen, earned an MA and a certificate of advanced study in mathematics from Cambridge University, and an MSc and PhD in physics from Brown University. He enjoyed research associateships at both MIT and Case Western Reserve University and became a Visiting Assistant Professor at Case Western in 1999. In 2000, Trodden joined the Department of Physics at Syracuse University. Trodden's research is in the area of *particle cosmology*, concerning the interplay between gravity and particle physics in understanding the universe. He is interested in the physics underlying the accelerating universe, the origin of the cosmic matter-antimatter asymmetry, cosmological inflation, the possible role of extra dimensions in physics, and the possibility that modifications to General Relativity might explain some of the most perplexing puzzles of cosmology. Mark regularly delivers invited plenary lectures at international conferences both in the U.S. and abroad. He has co-chaired the cosmology section of the American Linear Collider Physics Group,

and has served as a representative to the International Task Force on Linear Colliders and Cosmology. He currently sits on the editorial board of the *New Journal of Physics*. In 2003 he won a Cottrell Scholar Award and in 2005 he was awarded the Sir Thomas Lyle Fellowship from the University of Melbourne.

In addition, Trodden is involved in a wide range of outreach and public science education activities; e.g., the Saturday Morning Physics lecture series and Cafe Scientifique Syracuse. He was co-PI on a National Science Foundation grant, *Cosmic Connections*, through which a set of permanent cosmology exhibits were designed, created and installed in the Milton J. Rubenstein Museum of Science and Technology (MOST) in Syracuse. In 2006 Trodden and his Cafe Scientifique co-organizers received the Community Outreach Award from the Technology Associates of Central New York (TACNY) for their work.



**In 2003 Prof. Trodden won a Cottrell Scholar Award and in 2005 he was awarded the Sir Thomas Lyle Fellowship from the University of Melbourne**

## Buy an SU Physics T-Shirt!

**SU Physics T-Shirts:** T-2006 has “Don’t Drink and Derive” on back and a bunch of mangled physics equations and “SU Physics” on the front. The t-shirt design can be ordered (\$12 plus shipping) through the SPS web page at <http://phy.syr.edu/~sps/shirts.htm>. These t-shirts, can be ordered in both short and long sleeves. See the SPS webpage for pictures and prices of T-2007 (which can also be ordered in sweatshirt, with or without hood).



Shirt is based, with permission, on a design from AAPT (<http://www.aapt.org/Store>).

## Syracuse at LHCb - By Prof. Sheldon Stone

The Syracuse Experimental High Energy Physics group (Professors Artuso, Blusk, Skwarnicki and Stone, Research Professors Mountain and Wang, 3 postdoctoral fellows and 5 graduate students) has joined the LHCb experiment at CERN in Geneva, Switzerland. The new LHC machine will collide 7 Trillion Electron Volt protons head on with protons moving in the opposite direction so to obtain a total energy of 14 TeV. About 2% of these collisions produce a B meson, which contains a b quark; hence the name LHCb is suggestive of b quark decay studies at the LHC.

There are several important scientific reasons to investigate these decays. The Charge Conjugation operator  $C$  takes particle states to anti-particle states and the Parity operator transforms position  $\mathbf{r}$  to  $-\mathbf{r}$ . The combination is called CP. We know that CP is violated in the decays of B mesons, but we need to measure it precisely. CP violating decays of  $B_s$  mesons are particularly important and have yet to be found. (A  $B_s$  meson is a particle containing a b quark and an anti-strange quark.) CP violation is a necessary condition for a Universe that started as an equal mixture of matter and anti-matter to evolve to a matter dominated state, essential for life to exist.

Important as CP studies are, we also need to search for new particles that haven't yet been discovered. Many physicists expect that the LHC will discover such objects. These may explain the deviations of galactic motion from those expected due to the presence of ordinary matter, the so called “dark matter” problem. In any case, these objects should influence b decays. Even if the influences are very small, that will tell us a lot about the nature of these objects. Other scenarios are possible; for example, new physics at the LHC may be seen first in subtle deviations from expectations in b decay processes.

To accomplish these studies a highly technical and well functioning experimental apparatus is necessary. The LHCb detector is complex device with about 10 individual subsystems. (See <http://lhcb-geom.web.cern.ch/lhcb-geom/> for a detector picture, <http://en.wikipedia.org/wiki/LHCb> for a short description and <http://cern.ch/lhcb> for more information.) The Syracuse group has taken on several responsibilities toward implementing a successful program. One such part is testing the part at the heart of the experiment, the Vertex LOcator. This detector is built of silicon that is segmented electronically into very narrow (~50 mm) wide strips. The 21 VELO planes will allow us to measure the flight path of the B mesons before they decay and then see the particles that they decay into. Other activities include

responsibilities for the geometric alignment of all the individual detector elements, called “global alignment,” monitoring the way the detector is selecting the small component of B meson events that are interesting, called “trigger monitoring,” and some work on the particle identification device called “RICH.”

Low energy ~900 GeV collisions will start at the LHC in 2007. The full energy will be reached in 2008 when physics data taking will start. We are planning a full program of physics analysis where we will make good use of our local computing cluster and computing via the GRID at CERN.



3 bottom halves of VELO modules used in an external “test” particle beam at CERN (top halves are symmetrical)

