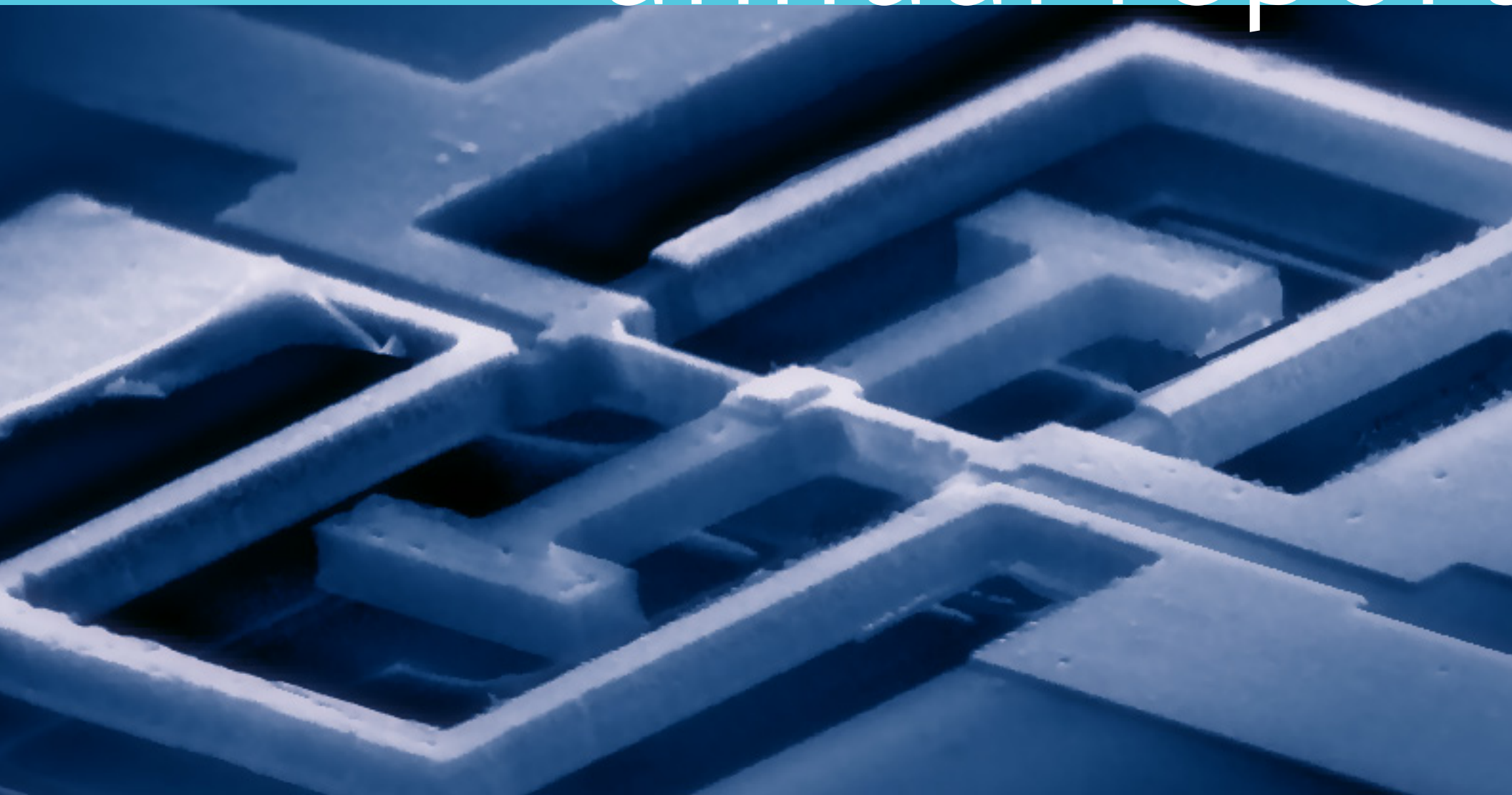
2008-2009

Physics annual report



MISSION

The mission of the Physics Department at Boston University is to provide excellence in teaching physics and advancement of knowledge through research and scholarship in service to the University and to society at large.

In teaching, we seek to attain a level and quality of physics course offerings at the undergraduate and graduate level that supports the breadth and depth of modern physics curricula and fosters growth in new interdisciplinary areas. The current educational mission is fulfilled through: (1) introductory courses for science and engineering majors; (2) upper-level undergraduate courses (and opportunities for undergraduate research participation) for majors in physics and related fields; (3) core and advanced-level courses as well as challenging research opportunities for physics graduate students; (4) distinctive courses for non-scientists both through the Core Curriculum and several departmental and interdepartmental offerings; and (5) K-12 outreach programs such as the pairing of physics graduate students with high school physics teachers in local schools, and teaching MET and SED courses that enable area high school teachers to qualify to teach physics at the challenging, 9th grade conceptual physics first level.

In research, our mission is to advance fundamental scientific explorations as well as applications of the related technologies. We seek both external prominence and internal cohesiveness of departmental research clusters in key areas of physics that have been identified as important and challenging, while gaining the flexibility to exploit unforeseen breakthroughs that will open new fields.

Our program has been steadily growing over the past 15 years and we now have a faculty of 39 within the department, 18 faculty from affiliated departments with joint appointments in Physics, plus about 30 visiting researchers and postdoctoral fellows in residence. Physics at Boston University provides a stimulating environment for our approximately 100 undergraduate and 110 graduate students. Our research productivity is high, as we rank in the top 10 in private universities in statistical measures of the number of refereed papers, the number of citations per year, and critically, impact, the number of citations per paper. External research funding totaled $15.5M ($396K per FTE) in the 2009 fiscal year.

Our program has strengths in condensed matter physics, elementary particle physics and biological physics. We are also heavily involved in interdisciplinary programs of research with many joint projects within the Electrical and Computer Engineering and Biomedical Engineering Departments, as well as the Photonics Center in quantum optics and hard and soft materials research. In elementary particle experiment, we host major experimental efforts at Fermilab and the Oak Ridge National Laboratory, at the LHC at CERN, with the Super-K neutrino experiment in Kamioka, Japan, and the MuLan experiment at the Paul Scherrer Institute in Switzerland. In elementary particle theory, our students are engaged in understanding the origin of the masses of the elementary particles and the signatures of physics beyond the Standard Model.

The department also hosts state-of-the-art infrastructure for the University, including a variety of supercomputers in the Center for Computational Science, the Electronics Design Facility, and the very well-equipped Scientific Instrument Facility.

CONTENTS

Major Accomplishments

The Physics Department has continued to grow its educational mission, expanding offerings with a new Freshman Seminar in Physics, with the introduction, jointly with the Computer Science Department, of a new course in Quantum Computing, and the development of a second semester of Modern Physics. The department saw significant growth in our main service courses as well as in the non-science majors' Cinema Physica, and new summer immersion and evening classes for in-service teachers. In research, our faculty published 399 papers in 2008, with 357 articles in refereed journals and 5 books.

Faculty garnered many national and international awards and accolades, including Professor El-Batanouny being selected as a Jefferson Science Fellow, Professor Polkovnikov being selected as an Alfred P. Sloan Research Fellow, Professor Smith being appointed to a Panel of Experts advising the Irish Government on science policy, Professors Chamon and Goldberg being elected as Fellows of the American Physical Society, and Professor Skocpol being recognized as an Outstanding Referee by the American Physical Society.

We awarded 16 PhDs, 6 MAs, and 17 BAs. Five undergraduates were named to Phi Beta Kappa, Daniel Pilon won the Alumni Student Award, and Brian Henning won the College Prize for Excellence in Physics.

Our graduate recruitment season was extremely successful as we made fewer offers to fill our incoming class than in previous years. This continuing increase in our acceptance rate is a clear measure of success, reflecting our growing national and international stature.

Research highlights of the department were numerous, and include major reports on the first proton beam being circulated in September at the Large Hadron Collider, the discovery of a new production process for the top quark at Fermilab, advances in nanotechnology and metamaterial fabrication, a potentially new phase of matter known as superglass, and a new device able to separate and manipulate the pathway of a wide range of microscopic particles.

Our Scientific Instrument Facility and the Electronics Design Facility continued to be very productive, meeting the budget projections in both facilities. The SIF Student Training Center, that offers a 6 week curriculum, has continued to teach cohorts of graduate students in physics, astronomy and engineering.

The CAS-funded visitors programs in elementary particle theory and condensed matter theory continue to bring many leading researchers to our department, providing both valuable collaborative interactions and positive exposure for our department.

The Physics Department has been very active with outreach and educational activities in the local Boston community. Several graduate students helped to develop new curricula for local high school physics programs; Physics Day attracted 250 urban high school students for a morning of demonstrations and lectures by faculty and graduate students; for a second year, Photon taught a unit on sun spots to local middle schools; the Improving the Teaching of Physics program entered its 6th year, and we expanded on the recently developed Teacher Immersion in Science program with a new, two-week workshop on Global Energy Distribution.

In early May, the department held its second Graduate Alumni Reunion, which attracted 75 current and former graduate students and faculty, and combined research talks with career panels, a mock career interview session and social networking events.

Goals

The Department has very strong research programs in condensed matter physics, particle physics and biophysics. Yet, a focus limited to these areas of research, today, is too narrow to allow for continued excellence. Through our self-study, and following the indications of the external review held in 2006, the faculty has identified the area of biological physics as the target for the most immediate expansion. A research effort in biological physics, of which biophysics can be considered one component, would build on our strength in biophysics and contribute to the institutional priority on systems biology. The department has requested that it be authorized to search during FY10 for two faculty appointments in biological physics. We argue that such an expansion would accomplish two key strategic goals: (1) broadening the Physics

Department's research basis in a field which is currently recognized as one of the most rapidly rising subfields of physics; and (2) strengthening the Physics Department's interdisciplinary links with a variety of related programs and centers at the university. This includes, but is not limited to, the new university-wide initiative in quantitative/ systems biology, the Photonics Center (which has recently launched a 5-year growth plan in biophotonics), the training program in quantitative biology and physiology, the Bioinformatics Program, the Center for Adaptive Systems, the cross-campus Cellular Biophysics Training Program, and the Department of Physiology and Biophysics at the Medical School.

A somewhat larger faculty would also allow the Physics Department to broaden its outreach and impact in the area of undergraduate teaching. In addition to anticipating enrichment of the physics undergraduate electives in biological physics, we have begun planning for a new, one semester physics offering, specifically tailored to the new neural science major. There is also an opportunity for broader offerings by the Physics Department that serve both CAS and ENG. Our calculus-based introductory courses have been reinvigorated with more biologically relevant content for SMED students, particularly in light of the fact that many ENG students now go into biomedical engineering. We also teach a very successful writing seminar on cosmology, and a new freshman seminar experience course.

In previous reports, we identified needs within our majors program: to improve the sophomore year course, to infuse computing into the curriculum, to offer a new interdisciplinary course in biological physics, and continue the expansion of undergraduate research opportunities. We also planned to expand the connections between physics and departments in CAS and ENG. We have made substantial progress toward these goals, with the redesign of the undergraduate course in computational physics, the introduction of a second semester of modern physics, and the joint offering with the Computer Science Department of a new course in quantum computing. Our continued goals are: strong support for the Core program and for the New College, the development of interdisciplinary course offerings for non-science majors, the development of a second freshman writing course, to couple our service courses to subsequent classes in other majors, and to design a specialized physics class for the new neuroscience program. Finally, we will follow up our Undergraduate Alumni Reunion and two Graduate Alumni Reunions with a joint Alumni reunion, which we plan to hold in the fall of 2010.

In the graduate program, the department will give continued attention to curricular needs, examining the number of required courses, seeking to allow students greater flexibility to take classes outside of physics while maintaining core educational breadth and depth, and developing and implementing a long-term teaching plan for the frequency of 500-, 600-, and 700-level course offerings. We will expand our connection to materials science, quantitative/systems biology, and interdisciplinary centers and programs in CAS and ENG. We will continue to help the graduate student organizations, specifically, the community and the teaching methods groups, and plan and run events with speakers, faculty and the broader community. We will also design and implement a new approach to training our teaching fellows, with a new integrated 699 curriculum that includes coupling to the ERC STEM efforts and focusing on science pedagogy within a workshop model.

To extend our already strong relationships across the university, we will make an effort to strengthen the Physics Department's role within the new Materials Science and Engineering Program, and consider whether a new effort in Materials Physics and Materials Chemistry would make sense for CAS and the university. We will also expand our existing efforts to help develop new educational and research initiatives with the Photonics, Nanoscience and Computational Science Centers, where a large number of physics graduate students already receive support.

Organization

The Physics Department houses 39 faculty members. Two hold full-time, administrative posts: Andrei Ruckenstein is the Associate Provost and Vice President for Research, and Scott Whitaker is the Associate Dean of the Graduate School in the College of Arts and Sciences. Of these faculty 35 are active in funded research programs. The department has strong research programs in high energy theory and experiment, condensed matter theory and experiment, and biological and polymer physics. The faculty teach graduate and undergraduate courses in the major, service courses for CAS, ENG, SAR and SMED students, interdisciplinary courses for non-majors, and courses for K-12 teachers. In fall 2008, two faculty were active in the Core Curriculum.

We have 11 emeriti faculty, 5 of whom are still very active in research and continue to contribute to the department. Eighteen faculty hold joint appointments in the Physics Department, with contributors and collaborators from 8 different departments and 4 colleges. In particular, joint faculty from ECE and BME are very active in supporting our graduate students through to PhDs, as well as serving on admissions committees and faculty search committees. The Physics Department supports 9 research faculty and 27 research associates (post doctoral fellows) in our funded research programs, as well as 5 lecturers in the teaching program. The Physics Department has two permanent visitor programs in high energy and condensed matter theory, currently hosting 5 visiting scholars.

The department supported 111 graduate students this past year, with 78 on external research grants and external research or teaching fellowships, 2 on Dean's fellowships and 31 on teaching fellow support. We typically have an incoming class of 17-20 students and graduate about 16 PhDs per year. The graduate students have several internal organizations, including a physics graduate student committee that meets regularly with the Chair and organizes events, an ad hoc graduate student teaching group that meets to discuss physics teaching, pedagogy and novel active learning, and a women in physics graduate student group that organizes and hosts events for female physicists.

The Physics Department had 94 declared, undergraduate majors this past year. We typically graduate about 20 students per year, ranking us as one of the top 25 departments in the nation in terms of physics baccalaureates. We support an undergraduate student organization, Photon, that meets weekly and plans and holds a variety of educational, outreach and social activities.

Chairmanship is currently held by Claudio Rebbi, who started serving as Chair in September 2008. A Faculty Director (William Skocpol) supports a wide range of administrative and teaching tasks. Two faculty are appointed to lead the teaching program, the Director of Graduate Studies (James Stone) and the Director of Undergraduate Studies (Ulrich Heintz). Next year Shyam Erramilli and Martin Schmaltz will serve as DGS and DUS, respectively. Supporting staff include 9 in the front office: a business manager (Rachel Meisel), a financial accounts administrator (Anita Gupta), a facilities and purchasing administrator (Lawrence Cicatelli), a program coordinator (Solomon Posner), a graduate administrator (Mirtha Cabello), an undergraduate administrator (Courtney Clark), an executive administrative assistant (Kelly Lyons), a senior administrative secretary (Winna Somers) and a senior accounts technician (Nancy Kostowski).

In support of the laboratory and lecture teaching mission, we have 3 staff: a laboratory manager (Erich Burton), a laboratory technical coordinator (Mark Badway) and a lecture demonstration coordinator (Valentin Vorosholov). In support of computing we have 2 staff, a computer resource manager (Guoan Hu) and a systems analyst (Richard Laskey). Several additional administrators support the Polymer Center, the Center for Computational Science and the Learning Resource Network.

The Physics Department operates two major cost units for the University. The Scientific Instrument Facility, which serves 30 BU departments, is run by a manager/machinist (Heitor Mourato) and a coordinator/welder/machinist (Robert Kingsland), with support from 4 experimental machinists (Sam Ma, Umberto Fazio, Robert Snee and Jose Velho). The Electronics Design Facility serves several departments, and is run by a director (Eric Hazen), with support from 2 senior electronics engineers (Shouxiang Wu and William Earle), a production engineer (Paul Bohn) and an administrative coordinator (Chris Lawlor).

Leadership

A few years ago, the department transitioned to a rotating Chair model. Professor Bennett Goldberg served as the first rotating Chair from 2005 to 2008, after serving as acting Chair in 2004/05. In the spring of 2007, two faculty members were appointed to engage in both private and open discussions about the succession of the chairmanship, and report back to the Dean. The process ultimately led to the appointment by the Dean of Claudio Rebbi as Chair to succeed Goldberg in 2008. The department plans to initiate the same procedure in the spring of 2010, making recommendations to the Dean for the succession of Rebbi.

In addition, one faculty member, Bill Skocpol, is appointed as Faculty Director, to support a wide range of administrative and teaching activities. Two faculty members are appointed to lead the teaching program; Jim Stone and Ulrich Heintz have served during the past academic year as Director of Graduate Studies and Director of Undergraduate Studies, respectively. Next year, Stone will be on leave as a Jefferson Fellow at the State Department and will be replaced by Shyam Erramilli. Heintz will move to Brown University, and will be succeeded by Martin Schmaltz. These three faculty frequently advise the Chair on a range of issues.

The department organizes two committees to overview the undergraduate and graduate teaching and research programs. Additional committees are in charge of graduate admissions and conversion, comprehensive exams, merit review and facilities (SIF, EDF and computing), mentoring for junior faculty, faculty searches, and tenure and promotion review.

Committees report to both the Chair and the faculty at faculty meetings, which are held monthly, with additional meetings scheduled as needed. Nearly all decisions are made at faculty meetings.

Professional Development

Faculty mentoring

The Physics Department actively mentors new faculty to support and develop their full career in research, teaching and leadership. We assign mentors who have demonstrated excellence in both teaching and research, who have successfully mentored junior faculty in the past, and who are familiar with the new faculty's research area. We facilitate frequent meetings of the committee and the junior faculty member, with the Chair acting ex officio.

These committee members visit lectures, and share their evaluations with both the new faculty member and the Chair. The mentoring committees meet with the faculty they mentor for discussions of current research, planning for future directions, and in particular, help with prioritization; a notoriously difficult task for young faculty. The mentoring committees also assist the Chair in the preparation of the mid-tenure review, and, if appropriate, in making the departmental case for tenure.

Faculty teaching development

The department supports activities that train young faculty in teaching and science pedagogy in general. In particular, the department encourages attendance of the American Institute of Physics/ American Association of Physics Teachers; a two day workshop on the teaching of physics.

Staff professional development

The department also instituted a new approach to staff professional development three years ago. At the end of each academic year, each member of staff is asked to self-reflect and assess their job in three distinct ways, and to provide specific personal goals. These are then reviewed together with the business manager and Chair. The three areas are:

(1) Improving the staff member's job: This occurs through definition of the job, identification of key elements, methods they could use to measure their own performance, and how they go about setting goals for themselves. They are asked to identify barriers to improvement, and come up with short-term and long-term job-related goals. They are then asked how they see their job interacting with others.

(2) Improving the operations of the department: Staff are asked to take a look beyond their specific jobs, and to examine the broader interaction and work flow of the department, whether in academic programs, finances, or research operations. They are asked to address organizational issues that include: improving the flow of information, whether they have clear paths for answering questions and getting assistance, whether staff meetings or structural procedures would improve collective efforts, how to best utilize human and

other resources, and how the physical layout could be used to improve the efficiency of the work environment.

(3) Finally, the staff is asked to examine and suggest improvements for the behavior of their constituents. Certain staff supports certain constituents – students, faculty, researchers, etc. They are asked how they would modify their constituents' behavior to best improve the job, and how they would alter student or faculty interactions to best deliver services. These responses and the meetings that follow provide many opportunities for staff development.

Faculty and Staff at the Annual Department Barbeque in front of Metcalf Science Center.

Faculty

NAME	TITLE	EDUCATION
Steve Ahlen	Professor	University of California, Berkeley; 1976
Richard Averitt	Assistant Professor	Rice University; 1998
Rama Bansil	Professor	University of Rochester; 1975
Tulika Bose	Assistant Professor	Columbia University; 2006
John Butler	Professor	Stanford University; 1986
Rob Carey	Associate Professor	Harvard University; 1989
Antonio Castro Neto	Professor	University of Illinois, Urbana-Champaign; 1994
Claudio Chamon	Professor	Massachusetts Institute of Technology; 1996
Andrew Cohen	Professor	Harvard University; 1986
Andrew Duffy	Assistant Professor	Queen's University, Canada; 1995
Michael El-Batanouny	Professor	University of California, Davis; 1978
Shyam Erramilli	Professor	University of Illinois, Urbana-Champaign; 1986
Sheldon Glashow	Professor	Harvard University; 1959
Bennett Goldberg	Professor	Brown University; 1987
Ulrich Heintz	Associate Professor	State University of New York, Stony Brook; 1991
Emanuel Katz	Assistant Professor	Massachusetts Institute of Technology; 2001
Ed Kearns	Professor	Harvard University; 1990
Bill Klein	Professor	Temple University; 1972
Ken Lane	Professor	Johns Hopkins University; 1970
Karl Ludwig	Professor	Stanford University; 1986
Jim Miller	Professor	Carnegie-Mellon University; 1975
Raj Mohanty	Associate Professor	University of Maryland; 1998
So-Young Pi	Professor	State University of New York, Stony Brook; 1974
Anatoli Polkovnikov	Assistant Professor	Yale University; 2003
Claudio Rebbi	Professor, Chair	University of Turin; 1967
Sid Redner	Professor	Massachusetts Institute of Technology; 1977
Lee Roberts	Professor	College of William and Mary; 1974
Jim Rohlf	Professor	California Institute of Technology; 1980
Ken Rothschild	Professor	Massachusetts Institute of Technology; 1974

Faculty

continued

NAME	TITLE	EDUCATION
Andrei Ruckenstein	Professor, Associate Provost and Vice President for Research	Cornell University; 1984
Anders Sandvik	Professor	University of California, Santa Barbara; 1993
Martin Schmaltz	Associate Professor	University of California, San Diego; 1995
Bill Skocpol	Professor	Harvard University; 1974
Kevin Smith	Professor	Yale University; 1988
Gene Stanley	Professor	Harvard University; 1967
Jim Stone	Professor	University of Michigan; 1977
Larry Sulak	Professor	Princeton University; 1970
Ophelia Tsui	Associate Professor	Princeton University; 1996
Scott Whitaker	Professor, Associate Dean of the Graduate School of the College of Arts and Sciences	University of California, Berkeley; 1976

New Hires

Tulika Bose
PhD in Experimental Particle Physics,
Columbia University, 2006

Dr. Bose was hired as an Assistant Professor of Physics in May 2008, and began employment at BU in September 2008. Her hire was the result of a faculty search in experimental particle physics that saw about 60 applications and 8 interviews.

Promotions and Tenuring

Professor Anders Sandvik was promoted to full professor during the 2008-2009 academic year.

Assistant Professor Andrew Duffy was promoted to Master Lecturer in June 2009.

Leaves and Sabbaticals

Professor Rama Bansil has spent the last two years at the NSF under an Intergovernmental Personnel Act assignment. She continues to work as a Program Director in the Division of Materials Research (DMR) of the Mathematical and Physical Sciences (MPS) Directorate. Her primary responsibility was to manage the Materials Research Science and Engineering Centers (MRSEC) program. That involved running the 2008/2009 MRSEC competition, managing existing MRSECs and Nano Science and Education Centers (NSEC), and participating in activities related to funding decisions and future directions of research in DMR and MPS.

Professor John Butler spent 2008 on sabbatical at CERN, where the Large Hadron Collider (LHC) is currently under construction. He spent much of his time working intensively on ATLAS, one of the two major experiments at the LHC. The sabbatical allowed him to play a significant role in commissioning the detector, analyzing the early LHC data, and potentially uncovering new physics.

Professor Michael El-Batanouny spent the academic year as a Jefferson Fellow at the Office of Science and Technology at the State Department. The program centers on the notion that "science and technology make fundamental contributions to the security, economic, health, and cultural foundations of modern societies, and are integral to the development and implementation of foreign policy."

Professor Kenneth Rothschild took a 2008 leave of absence to work closely with AmberGen, Inc. to develop a prognostic "signature" assay to predict the course of colorectal cancer (CRC), the second leading cause of cancer deaths in the U.S. The assay, based in part on spin-off technology from his research at BU, has the potential to save thousands of lives by predicting which of the 150,000 CRC patients each year in the U.S. should be treated to prevent metastasis relapse.

Associate Professor Martin Schmaltz spent the academic year on sabbatical at UC Berkeley and Lawrence Berkeley National Laboratory. These institutions are home to important Large Hadron Collider (LHC) groups which currently lead the global efforts in new physics analysis for the ATLAS experiment. Schmaltz collaborated with Berkeley physicists to construct models of particle physics which will be tested at the LHC. In addition, he

studied the new physics reach of the first run of the LHC. The resulting paper is intended as a guide to experimental groups wishing to discover new physics at the LHC with a limited data set.

Awards and Honors

Professor Michael El-Batanouny, was selected as a Jefferson Science Fellow, which was "established to create opportunities for substantial engagement of tenured scientists and engineers from U.S. academic institutions in the work of the [State] Department."

Assistant Professor Anatoli Polkovnikov was selected as an Alfred P. Sloan Research Fellow. The Alfred P. Sloan Foundation awarded the prestigious fellowship to 118 outstanding early career scientists, mathematicians and economists.

Professor Kevin Smith has been appointed as one of eight members of a Panel of Experts advising the Irish Government on science policy. The Panel will assist the Chief Science Advisor to that Government in the formulation of science related policies and directives.

Professors Claudio Chamon and Bennett Goldberg have been elected as Fellows of the American Physical Society. Chamon was chosen for his important theoretical work on the probing of fractional charge and statistics in strongly correlated systems, and Goldberg, for the development and application of nanoscale optical spectroscopy to semiconductors and biological systems and for the commitment to improving urban education.

Professor Bill Skocpol has been recognized by the American Physical Society as one among 360 Outstanding Referees of Physical Review and Physical Review Letters. Initiated in 2008, the Outstanding Referee program expresses appreciation for the essential work that anonymous peer reviewers do for their journals. Each year a small percentage of their 42,000 referees are selected and honored with the Outstanding Referee designation. Selections are made based on the number, quality and timeliness of referee reports as collected in a database over the last 20 years.

Promotions

Arno Heister was promoted in June from Research Associate to Research Associate Professor in the Physics Department, with his main focus on CMS at CERN.

Research Faculty

NAME	POSITION	EDUCATION
Arno Heister	Research Associate Professor	PhD, Physikalisches Institut (Switzerland); 2005
Raquell Holmes	Research Assistant Professor	PhD, Tufts University; 1997
Mi Kyung Hong	Research Professor	PhD, University of Illinois, Urbana-Champaign; 1988
Plamen Ivanov	Research Associate Professor	PhD, Boston University; 1998
Paul Krapivsky	Research Associate Professor	PhD, Moscow Institute of Physics and Technology (Russia); 1991
Valeri Kotov	Research Assistant Professor	PhD, Clarkson University; 1996
Kevin Lynch	Research Assistant Professor	PhD, Boston University; 2002
James Shank	Research Professor	PhD, University of California, Berkeley; 1988
Saul Youssef	Research Associate Professor	PhD, Carnegie-Mellon University; 1982

Research Associates

NAME	FIELD	EDUCATION
Roman Barankov	Condensed Matter Theory	PhD, Massachusetts Institute of Technology; 2005
Vladislav Bergo	Biological Physics	PhD, Boston University; 2003
Nathalie Bouet	Condensed Matter Experiment	PhD, University of Orleans (France); 2006
Edgar Carrera	Particle Experiment	PhD, Florida State University; 2008
Yu Chen	Condensed Matter Experiment	PhD, Boston University; 2008
Dookee Cho	Particle Experiment	PhD, University of Rochester; 2004
Sang Wan Cho	Condensed Matter Experiment	PhD, Yonsei University (Korea); 2008
Leyla Colakerol	Condensed Matter Experiment	PhD, Boston University; 2008
Ippei Danshita	Condensed Matter Theory	PhD, Waseda University; 2007
Brian Feldstein	Particle Theory	PhD, University of California, Berkeley; 2007
Andrew Fitzpatrick	Particle Theory	PhD, Harvard University; 2008
Yoshihisa Fujii	Condensed Matter Experiment	PhD, Kyushu University (Japan); 2008
Rob Harrington	Particle Experiment	PhD, Northeastern University; 2006
Shabnam Jabeen	Particle Experiment	PhD, Kansas University; 2005
Ameya Kolarkar	Particle Experiment	PhD, University of Kentucky; 2008
Yongsheng Liu	Condensed Matter	PhD, Boston University; 2008
Ivan Logashenko	Particle Experiment	PhD, Budker Institute of Nuclear Physics (Russia); 1999
Sergey Mamaev	Biological Physics	PhD, Novosibirsk Institute of Bioorganic Chemistry (Russia); 1987
Constanze Metzger	Condensed Matter Experiment	PhD, Ludwig-Maximilian-Universität Munich (Germany); 2007
Vitor Pereira	Condensed Matter Theory	PhD, University of Porto (Portugal); 1996
Louis Piper	Condensed Matter Experiment	PhD, University of Warwick (UK); 2006
Andrew Preston	Condensed Matter Experiment	PhD, Victoria University of Wellington (New Zealand); 2009
Jennifer Raaf	Particle Experiment	PhD, University of Cincinnati; 2005
Veronica Sanz	Particle Theory	PhD, Universitat de Valencia (Spain); 2002
Vasisht Tadigotla	Condensed Matter Experiment	PhD, Rutgers University; 2006

New Hires

Edgar Carrera began work with Professor Tulika Bose in April, and has been working at Fermilab on the D0 experiment.

Yu Chen joined the department as a Research Associate (previously Research Assistant) in September. He has been working with Professor Pritiraj Mohanty in the field of nanoscale electronics for biomedical applications.

Leyla Colakerol started work with Professor Karl Ludwig in January. Leyla is stationed at Brookhaven National Laboratory, where she performs real time x-ray studies of surface and thin film processes.

Ippei Danshita began working with Professor Anatoli Polkovnikov in November. He has been focusing his research in the areas of quantum dynamics and non-equilibrium thermodynamics.

Andrew Fitzpatrick joined the department's particle theory group in August working with Professor Emmanuel Katz.

Yongsheng Liu began working with Rama Bansil in September. He has been researching protein phase separation, and has been handling numerous administrative tasks for that lab while Professor Bansil has been at the NSF.

Vitor Pereira joined the department as a Research Associate (previously Visiting Scholar) in February. He works with Professor Antonio Castro Neto on graphene.

Andrew Preston began work with Professor Kevin Smith in March 2009 at Brookhaven National Laboratory. His duties involve running experiments on new electronic materials and developing new spectroscopic methods for their study.

Professor Claudio Rebbi mingles with graduate students at the Department Picnic.

Research Associates

continued

NAME	FIELD	EDUCATION
Zhaohui Yang	Condensed Matter Experiment	PhD, Peking University (China); 2005
Yan Zhen	Particle Experiment	PhD, Shandong University (China); 2006

Associated Faculty

NAME	POSITION	FIELD
Irving Bigio	Joint Professor	Biomedical Engineering
Kenneth Brecher	Joint Professor	Astronomy
David Campbell	Joint Professor and Provost	Condensed Matter Theory
Charles DeLisi	Joint Professor	Biomedical Engineering
Alvaro Derujula	Joint Professor	Particle Theory
Evan Evans	Joint Professor	Biomedical Engineering
Roscoe Giles	Joint Professor	Electrical and Computer Engineering
Dirk Kreimer	Joint Professor	Mathematics
Anne Matsuura	Adjunct Assistant Professor	Condensed Matter Experiment
Amit Meller	Joint Associate Professor	Biomedical Engineering
Jerome Mertz	Joint Associate Professor	Biomedical Engineering
Theodore Moustakas	Joint Professor	Electrical and Computer Engineering
Meenakshi Narain	Adjunct Associate Professor	Particle Experiment
Alexander Sergienko	Joint Professor	Electrical and Computer Engineering
Anna Swan	Joint Associate Professor	Electrical and Computer Engineering
Malvin Teich	Joint Professor	Electrical and Computer Engineering
Selim Unlu	Joint Professor	Electrical and Computer Engineering

Emeriti

NAME	NAME, continued
Ed Booth	Bill Hellman
Bernard Chasan	Abner Shimony
Robert Cohen	John Stachel
Ernesto Corinaldesi	Chuck Willis
Dean Edmonds	George Zimmerman
Wolfgang Franzen	

Lecturers

NAME	COURSE	SEMESTER
Ahlam Al-Rawi	General Physics I and II	Summer 2008 and 2009
Manher Jariwala	General Physics I and II; Immersion in Green Energy	Fall 2008, Spring 2009; Summer 2009
Anca Mocofanescu	Elementary Physics I	Fall 2008
Val Voroshilov	Elementary Physics I and II	Fall 2008, Spring 2009 and Summer 2009
Joel Weinstein	Electronics for Scientists	Spring 2009

New Hires

Our teaching faculty was joined by five excellent lecturers this year:

Ahlam Al-Rawi taught General Physics for both the 2008 and 2009 summer sessions.

Manher Jariwala taught General Physics in the fall and spring. He also taught the course Immersion in Green Energy through the School of Education in summer 2009.

Anca Mocofanescu taught Elementary Physics in the fall.

Valentin Voroshilov, our Teaching Demonstrations Coordinator, taught Elementary Physics in the fall and spring, as well as in summer 2009.

Joel Weinstein, who has taught Electronics for Scientists at BU since 2003, once again lectured for us in the spring.

Visiting Scholars

New Hires

Ranjit Chacko joined the department in December working with Professor Bill Klein in computational physics.

NAME	EDUCATION
Bruno Barboza	PhD, State University of Campinas (Brazil); 2004
Vladislav Bergo	PhD, Boston University; 2003
Ranjit Chacko	MA, Boston University; 1999
Harvey Gould (left in June)	PhD, University of California, Berkeley; 1966
Brigita Urbanc	PhD, University of Ljubljana (Slovenia); 2004

Administrative Staff

New Hires

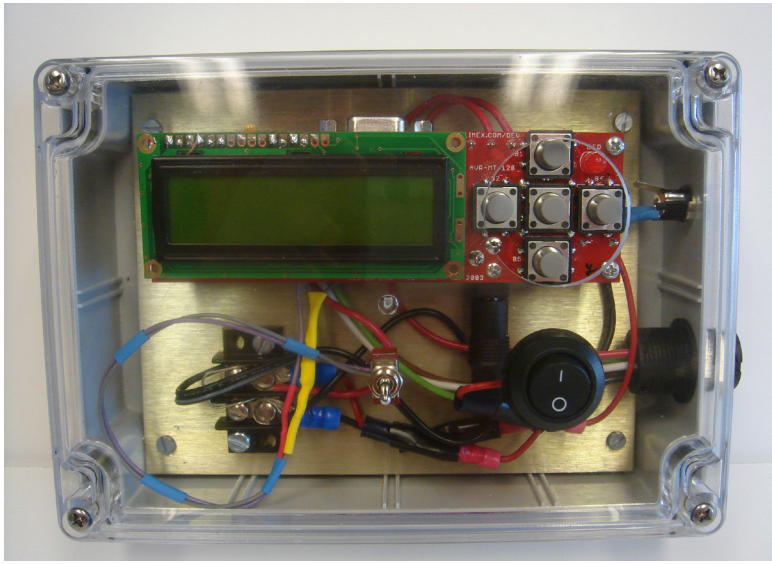
In September 2008, Kelly Lyons began work as Administrative Assistant to the Chair. Also in September, Kristen Woods began working as the Prostars/STEM Administrator.

In March 2009, Courtney Clark began work as the Undergraduate Coordinator for the department.

NAME	POSITION
Cynthia Brossman	Administrative Director, LERNet
Cora Carey (left in January)	Educational Outreach Coordinator, LERNet
Larry Cicatelli	Facilities and Purchasing Specialist
Courtney Clark	Undergraduate Coordinator
Anita Gupta	Grants Administrator
Nancy Kostowski	Accounts Technician
Kelly Lyons	Administrative Assistant
Rachel Meisel	Business Manager
Solomon Posner	Program Coordinator
Mirtha Salcedo-Cabello	Graduate Coordinator
Winna Somers	Senior Administrative Secretary
Kristen Woods	Prostars/STEM Administrator

Technical Staff

NAME	POSITION
Mark Badway	Teaching Laboratories Technical Coordinator
Paul Bohn	Production Engineer, Electronics Design Facility
Erich Burton	Undergraduate Teaching Laboratories Manager
William Earle	Electronics Engineer, Electronics Design Facility
Umberto Fazio	Senior Experimental Machinist, Scientific Instrument Facility
Eric Hazen	Director, Electronics Design Facility
Guoan Hu	Computer Resource Manager
Robert Kingsland	Coordinator/Welder, Scientific Instrument Facility
Richard Laskey III	Systems Analyst
Chris Lawlor	Administrative Coordinator, Electronics Design Facility
Sai-Ho Ma	Senior Experimental Machinist, Scientific Instrument Facility
Heitor Mourato	Manager/Machinist, Scientific Instrument Facility
Robert Snee	Senior Experimental Machinist, Scientific Instrument Facility
Jose Velho	Senior Experimental Machinist, Scientific Instrument Facility
Val Voroshilov	Teaching Demonstrations Coordinator
Shouxiang Wu	Electronics Engineer, Electronics Design Facility



The Cell Stretcher Controller, built by the Electronics Design Facility, is a device used to control stretching of heart tissue on a custom-made apparatus.

UNDERGRADUATE PROGRAM

Our undergraduate physics program gives students a foundation of knowledge and problem-solving ability on which to build a variety of careers. Reflecting the diversity of careers available to our students, the department offers two options for the BA with concentration in physics, as well as joint concentrations with astronomy and philosophy. Students take introductory physics courses in mechanics, electromagnetism, and modern physics, as well as basic math courses during their first two years. In the junior and senior years, they take advanced courses in math, physics, and in the joint concentrations. Option II of the physics concentration rigorously prepares students for graduate school in physics, with advanced courses in electromagnetism, quantum mechanics, and statistical thermodynamics. Option I is intended for students interested in related science fields, and allows up to three courses from other science departments. In addition, the department offers two BA/MA programs: one in physics and one in astrophysics and space physics. Finally, we offer a minor concentration in physics, which is an excellent complement to degrees in engineering, mathematics or other sciences.

Although many of our graduates continue their careers in physics or astronomy, a BA in physics also offers preparation for careers in such areas as: industrial research and development, engineering, environmental sciences, medical physics, geophysics, oceanography, computer science and energy-resource management. It is also ideal preparation for professional schools such as medicine, law, teaching, engineering, or business management.

The department prides itself on the quality of its teaching, while also maintaining a vigorous research program. The diverse faculty assures an opportunity for close interaction with teachers and mentors. Students are encouraged to participate in ongoing research projects, and many get involved as early as their sophomore year. Qualified students enroll as seniors in independent work projects, leading to a degree with distinction.

Teaching Highlights

Cooperative Curricular Efforts

Professors Scott Whitaker and Karl Ludwig were two of eight faculty who taught Core Curriculum Natural Science I: Evolution of the Physical Universe and the Earth (CC105) in the fall.

Professor Sheldon Glashow taught Physics of the 20th Century and Beyond (PY100/UNI NS100) in the fall. He was also selected to offer one of the New College Freshman Seminars on a pilot basis next spring.

Professor Andrew Duffy taught the honors sections of Elementary Physics I and II (PY105 and 106) for the Honors Program in the fall and spring.

Professor Larry Sulak taught a Writing and Research Seminar (WR150 LA) for the College of Arts and Sciences in the spring, organized around the broad topic of Cosmology.

Professor Andrew Cohen was deeply involved in the deliberations regarding New College, and will be an Associate Director for the program next year. He also taught Cinema Physica (PY103) to 56 general education students this spring.

Curricular Changes

The Physics Department did not propose any new degrees or change any degree programs this year. However, two new courses were instituted, while two were modified. All these proposals have received academic approval from the University. Budgetary and degree requirement issues are still under review.

For several years, we have considered broadening our one-semester Modern Physics course (PY354) into a two-semester sequence PY351/352 which will allow more coverage of current applications. This year the course content was worked out and academic approval from the department, the Natural Sciences Curriculum Committee, and the CAS Faculty was obtained. Certain changes to the syllabus of PY354 were made, in directions approved by cognate disciplines that may only require PY351. Once budgetary consequences of the new labs are decided, PY352 will be instituted in Spring 2010. Whether PY352 will be a required course or an elective for Physics majors, while determining if PY313 will continue

to be an acceptable alternative to PY351, as it has reluctantly been for PY354, are policy matters that will be discussed next year.

A new course, PY555 Quantum Computing, was approved after successful offerings as PY897, with an associated PY492 reading course. This course, created by Professor Claudio Chamon, explores the computation possibilities of entangled quantum systems, as well as concrete physical realizations that are currently being evaluated. This course would not be offered every year, but rather on a two or three year cycle alternating with other courses.

Finally, the evolution of PY421 was recognized by a change of title to "Introduction to Computational Physics" and a significantly altered syllabus was approved, differing from the parallel-computing environment in which it was originally created.

New Developments in Pedagogy

As usual, teaching laboratories in the courses for Physics and physics-related majors have been a key focus of our efforts. The Physics Department has completely revamped its first-year teaching laboratories over the years, with much more reliance on computer-based instrumentation and analysis. The PY351/352 course proposal will create a wider variety of lab experiences for our sophomore majors, including work with vacuum systems, instrumentation interfacing and other useful subjects.

Professor Bill Skocpol has continued to make modest improvements to experiments in the junior lab associated with PY408. In addition, our Advanced Lab for seniors has several new experiments under development. Mark Badway, an experienced physics teacher hired into our upgraded Lab Tech Coordinator position, continues to have a major role in working with Professor Larry Sulak to improve the Advanced Lab experience for undergraduates.

Professor Andrew Duffy consulted with faculty in the Chemistry Department regarding whether a consensus could be reached on the type of personal response system students are required to purchase. Manher Jariwal, who received our departmental prize for outstanding part-time lecturer, experimented with one of the possible compromise systems. This issue should continue to be addressed at the interdepartmental and perhaps College or University level.

Advising and Mentoring

Physics majors and minors meet with the Director of Undergraduate Studies and are assigned a faculty advisor as soon as they express the intent to study in the department. Almost all faculty members participate in advising the students. Typically a faculty member is an advisor to 3-4 undergraduate students. Students are strongly encouraged to join one of our research groups during the school term or the summer, as a junior or senior thesis student, or for independent study. Before they complete their apprenticeship with the department, most undergraduates have had hands-on training with a research group and many have co-authored a research paper.

Educational research has shown that students who work in research laboratories as undergraduates are more likely to succeed in graduate school. Considerable care is paid in advising students on post-graduate training and obtaining jobs. We continued our training seminars for the GRE exam and will be hosting career seminars this coming year.

Since students majoring in Astronomy and Physics and in Philosophy and Physics take the majority of their courses in Physics, those students are assigned an advisor in our department in addition to one in their home department.

Co-Curricular Programs

Photon

Photon is the Boston University chapter of the Society of Physics Students (SPS). Photon serves as a social organization for undergraduates involved in physics at BU. Every semester, Photon organizes social events for physics majors, sets up lectures by faculty on subjects of current interest, and offers attendance at professional meetings.

For the past two years, Photon's president Claire Thomas, and vice president Brian Henning, have worked towards making Photon a more active SPS chapter. For its work last year, Photon received the Outstanding Chapter Award from the SPS.

Photon's primary effort this year was organizing and hosting the SPS Zone 1 Meeting in March. Sixty-four students, as well as three faculty members from our Zone, attended the meeting

PHOTON members prepare to make liquid nitrogen ice cream.

and it was a great success. Of these sixty-four attendees, five students gave 10 minute talks on their undergraduate research, and eight presented posters. In addition to student talks, Photon organized a career panel, a graduate student panel, and two hour-long talks given by professors at BU. Photon members worked hard to put on the conference, and many were also able to participate by giving talks and poster presentations about their research.

Photon also attended the Sigma Pi Sigma Quadrennial Congress at Fermi National Accelerator Lab in Batavia, Illinois in early November 2008. Four Photon members traveled from Boston to Chicago for the weekend, and three presented posters on their undergraduate research at the event.

Fourteen Photon members attended the Undergraduate Women in Physics Conference at Yale University on the weekend of January 16, 2009. This large group of students made BU the most broadly represented school at the conference.

During weekly meetings this year, Photon often did physics demonstrations. This past year during meetings, they demonstrated eddy currents and played with magnets. They used a microwave oven to measure the wavelength of microwaves in chocolate, and played with light polarizers and a Van de Graaff generator.

Also, many of the students gave presentations at the regular Friday meetings. Talks delivered at the Friday meetings served as practice for more formal presentations given at conferences, and also provided a learning experience for other Photon members, who were unable to attend conferences.

Photon also spent a few meetings constructing radios, which gave members the chance to learn about soldering and circuit fabrication. Both are essential to experimental physics and can be something that is missing from formal coursework. And finally, they made awesome physics club t-shirts!

Photon also helped organize The Annual Pumpkin Drop at Boston University. Members emptied pumpkins of their natural stuffing, and filled them with paint, jello, and other interesting items, and had physics professors drop them off of the roof of our Science Building. This took place on Halloween, and, as in the past, attracted a large crowd.

This year, Photon also continued the Outreach Program, which was started the previous year. Members created a presentation about the sun and its energy, and then presented it to the entire 8th grade class at the Andrew Peabody School in Cambridge. Photon also created a worksheet teaching the children how to simply calculate power, as well as get quantitative ideas about different power sources, helping the children develop qualitative ideas about energy. As a part of the outreach program, the students also worked on a lab, using solar panels to measure the power produced from the sun, from indirect sunlight, and various light sources like flashlights and lamps. The children were excited to use the solar panels and asked some fun and inquisitive questions. Like last year, the presentation was successful in getting the children thinking about physics and applying it to their lives.

Finally, Photon also took a tour of the fusion lab at MIT. Photon members contacted BU Alum Zach Hartwig to organize the event; Zach is a graduate student working in fusion, and gave Photon a tour of the facility. The tour included an introduction into the basics of fusion and fusion power. He then showed the group around the control room for the reactor. The machine was undergoing maintenance, so the visit was especially exciting as Photon got a chance to see the reactor disassembled.

Pumpkin Drop

On October 31, the department hosted its fourth annual Pumpkin Drop at the Metcalf Science Center. The tradition, which involves dropping pumpkins filled with substances from powder to paint onto Metcalf Plaza — 70 feet below — was continued as both a promotional and an educational tool. Photon, our undergraduate

Professor Bill Skocpol tests gravity at the fourth annual Pumpkin Drop.

student organization, was heavily involved this year, along with several graduate students and professors.

Research

The department continues to take pride in the large number of undergraduate majors who work in our research laboratories. This year, roughly half of our upperclassmen were involved in research projects. Upper-level students are strongly encouraged to become involved with a research group and gain exposure to experimental and theoretical research projects. This experience offers essential, practical training for students who wish to pursue technical careers after their undergraduate education, and broadens the background of those planning graduate study in physics.

Many of our undergraduate research assistants work under their advisors' research grants. Others are funded by NSF Research Experiences for Undergraduates grants, and several students join research groups through exchange programs or via UROP research awards.

The following paragraphs showcase most of the research being done by our undergraduates.

Deborah Avery (2010) is working with Professor Steve Ahlen on his dark matter project. She has helped with the construction of a dark matter detection chamber and with data analysis.

Chelsea Bartram (2011) will have been working with Professors Bennett Goldberg and Anna Swan in the Photonics Buliding for a year by the end of the summer. She is studying graphene, a single layer of carbon atoms, well known for its extraordinary strength and conductivity. In graphene, massless Dirac fermions travel near the speed of light, and it is thought that relativistic effects may be observed at room temperature. Her current project, however, is to demonstrate how the conductivity of graphene varies when suspended over a trench rather than attached directly to the surface of a silicon substrate. Additionally, she will test cleaning procedures to examine their effects on both suspended and non-suspended samples of graphene.

Ian Cohen (2010) is working with Astronomy Professor Harlan Spence to find spectral similarities between galactic cosmic ray fluxes, and properties of the solar wind. He also spent a summer at Rutgers University working under the direction of John Hughes. His task was to process and analyze Chandra x-ray observations of supernova remnants, to determine their expansion rates.

Jessica Donaldson (2009) searched for long-term temperature trends in the upper atmosphere with Engineering Professor William Oliver.

Hugh Enxing (2009) worked with Professor Rob Carey on the Muon Lifetime Analysis (MuLan) project at the Paul Scherrer Institute in Villigen, Switzerland. His work involved measuring the muon's lifetime by aiming a beam of muons at a target, and detecting the electron created during the muon's decay.

Ryan Eriksen (2010) is doing research in the Mechanical Engineering Department under Professor Gopalan and Professor Pal. He is testing the diffusivity of different layers of a hydrogen fuel cell. He is testing how fast oxygen and hydrogen can pass through the layers of a fuel cell. This can lead to better optimization and efficiently for hydrogen fuel cells.

Brian Henning (2009) completed his Work for Distinction under the supervision of Professor Ed Kearns and the BU Super-Kamiokande group. In his three years working with the group, Brian got a compressed experience similar to that of a graduate student. First, he helped with software algorithmic improvements to the data reduction stream for upward-going muons. Then, he helped

with the Super-K electronics upgrade, taking responsibility for details related to providing power to the electronics crates, and also helping to quality control test several hundred ethernet readout cards. Finally, he undertook a full analysis of Super-Kamiokande data that searched for the decay of two nucleons into two leptons. Unfortunately, he did not observe any of these exotic decays, but he set the world's best limit by more than an order of magnitude, and helped the Super-K team understand some important theoretical effects in the simulation of nucleon and dinucleon decay. This summer he is completing this work by preparing a paper for Physical Review.

Katie Jameson (2009) worked on the Galactic Plane Infrared Polarization Survey, headed by Professor Dan Clemens of BU's Institute for Astrophysical research. Katie did data reduction, writing, and modifying IDL code for data processing. She worked on side projects in spectroscopy, such as analyzing the optical and near infrared spectra of stars in a newly discovered cluster, Mercer 23.

Alexander Krause (2009) worked with Engineering Professor Anna Swan to build a microscope to test predictions for using fiber as a phase sensitive detector.

Jessica Leach (2010) is studying the dynamics of polymer films. The dynamics of polymer films have been found to be different from the material in bulk, especially when the film thickness is reduced below 10 nanometers. It is generally believed to be caused by the different properties the polymer may have at the film interfaces. Jessica is exploring the effect of polymer-substrate interfaces where the polymer slips when it is subject to flow. Previous studies have only looked at films that do not slip.

Chad Madsen (2009) spent a summer at the Paul Scherrer Institute in Villigen, Switzerland to join a collaboration of Boston University, University of Illinois and James Madison University researchers on the MuLAn experiment (Muon Lifetime Analysis), a 1 ppm measurement of the positive muon lifetime. His most important contribution has been his analysis of the muon beam profile, which uncovered the rate of "errant muons": the rate of muons that stop in the beam pipe but still send their decay positron into the detector. Chad worked with Professor Rob Carey.

Kristopher Maynard (2010) is working on the IBEX (Interstellar Boundary Explorer) project with the Center for Space Physics. IBEX is a satellite that will launch in June 2009 and will detect particles coming from the heliosphere. This will achieve one of the project's goals of generating a global map of the heliosphere. Under the guidance of Professor Nathan Schwadron, Maynard is working on visualization tools for the satellite's orbit and detected particles.

Julie Moreau (2011) also studies star clusters with the Galactic Plane Infrared Polarization Survey (GPIPS), which seeks to characterize the galactic magnetic field. Julie looks at the photometry (electromagnetic intensity) of stars in specific clusters, and tries to identify them. Once she can say with certainty that a particular star is part of a cluster, she measures the polarization of that star's light. Polarization of the interstellar medium is directly tied to magnetic fields.

Adam Patch (2009) has been working on superconducting nanomechanics for the past year under Professor Raj Mohanty. He fabricates nanomechanical structures from boron-doped diamond thin films to study interplay between superconductivity and strain. He is the recipient of UROP research grant.

Dan Pilon (2009) worked with Professor Richard Averitt investigating electromagnetic metamaterials that are resonant at terahertz, or far-infrared, wavelengths. Dan's work included electromagnetic design and simulation of various metamaterials coupled with characterization using terahertz time-domain spectroscopy. This includes, as examples, composites that function as resonant perfect absorbers and ultrathin quarter waveplates. The results of Dan's work were published in Physical Review B Rapids and Optics Express. He is the recipient of a UROP research grant.

Zach Raines (2011) is working with the Boston University Intermediate Energy Physics Group. The group is responsible for several components of a new experiment to search for a permanent electric dipole moment of the neutron, which is being mounted at the Oak Ridge National Laboratory. The experiment will improve on the present limits of the neutron electric dipole moment by a factor of 100, or perhaps observe it. One of the responsibilities is the development of a lightguide system that will provide the signal for the experiment. Because of the very low light levels produced in the experiment, high transmission lightguides need to be developed. Furthermore, these lightguides must be operational at temperatures as low as 0.3K. Zach is working on the testing of lightguide prototypes for their transmission properties.

Scott Stackley (2011) is helping to build and test equipment for a new dark matter experiment called Mini-CLEAN. Mini-CLEAN is comprised of 500 kg of liquid argon viewed by about 90 photomultiplier tubes. It will be installed a mile underground at SNOLab in Sudbury, Ontario sometime in 2010. Scott is working with Professor Ed Kearns and graduate student Dan Gastler.

Ted Stinson (2009) developed a near-field scanning optical microscope capable of high resolution imaging on the nanoscale with Professor Bennett Goldberg.

Claire Thomas (2010) is undertaking Work for Distinction on the Double Chooz reactor neutrino experiment, as a continuation of her previous summer REU with Janet Conrad, a professor now at MIT; Ed Kearns is her BU supervisor. Claire is studying long-lived radioactive spallation background from cosmic ray interactions in the detector, such as 8Li. These backgrounds are important to understand for the precise measurement of reactor neutrino disappearance, which is the goal of the Double Chooz experiment.

Andrea Welsh (2011) worked with Professor Bennett Goldberg on the fabrication and electronic properties of graphene project. Graphene, a single layer of graphite, is a substance that has unusual electric properties, and thus is very promising for nanotechnology and other applications. Currently, we are finding more efficient methods of depositing, characterizing, and locating graphene so that we can eventually measure the Quantum Hall Effect in graphene sheets. This process requires multiple steps using optical lithography to prepare the samples for measurements. The fabrication technique of micromechanical cleavage uses tape on graphite flakes repeatedly to create thin layers of grapheme, which is then deposited on silicon wafers. However, this leaves tape residue that affects the sample. The two-dimensional graphene surface created is extremely sensitive to contamination. Annealing, the process of heating a graphene wafer by sending a current though, gets rid of excess contaminants on the wafer. With less dirt, the graphene wafer decreases in resistance, increasing the mobility of electrons across the graphene. Also, Raman spectroscopy measurements are able to give us more details about the effects that annealing has on the graphene samples by observing shifts in the 2D band, as well as confirming the number of layers of our graphene sample.

Program Completion

The Physics Department had 94 majors this academic year, with 63 concentrating in Physics, 30 in Astronomy and Physics, and 1 in Philosophy and Physics. There were 9 students minoring in Physics. We graduated 17 majors; 11 earned degrees in Physics and 6 in Astronomy and Physics.

Bachelor's recipients from the Physics Department have been successful in being accepted to the most prestigious graduate programs in the United States. They have also been successful in entering into a diverse range of disciplines, reflecting the broad value of an undergraduate degree in Physics.

Physics Professor and Nobel Laureate Sheldon Glashow addresses the Class of 2009.

Below are some of the plans of this year's graduating students:

Joshua Beldner will be attending Northeastern University School of Law to pursue a future career in Intellectual Property, Corporate, Technology, or another field of law in which he will remain involved with facilitating scientific research.

Jessica Donaldson will attend graduate school for Astronomy at the University of Maryland.

Brian Henning will be attending graduate school

at the University of California Berkeley to study Particle Theory.

Michael Jacobs will be pursuing a Master's degree in Performance at the Royal College of Music in London.

Katherine Jameson will be pursuing a PhD in Astronomy at the University of Maryland.

Alexander Krause will pursue graduate studies in the Cal Tech Applied Physics Department.

Kathleen Lee will attend UC Davis, to pursue a Chemical Physics PhD. She is also a Borge Fellowship recipient.

Chad Madsen will be attending graduate school at Boston University for Astronomy.

Alice Olmstead has been deferred from the graduate Astronomy program at the University of Maryland College Park. She will be taking a year off to live in Santa Barbara, California.

Adam Patch will continue to work at Boston University until September 2009.

Daniel Pilon will be entering MIT's PhD program in Experimental Condensed Matter Physics.

Harry Stinson III is deferring admission from UC San Diego for a year to teach English in Taiwan.

Daniel Walkup will be attending graduate school at Boston College for a PhD in Physics.

Awards and Honors

Phi Beta Kappa
Jessica Donaldson, Brian Henning, Michael Jacobs, Alice Olmstead, Daniel Pilon

Alumni Student Award
Daniel Pilon

College Prize for Excellence in Physics
Brian Henning

Photon Leadership Prize
Claire Thomas

Looking Forward

In the coming year, we will focus on several interrelated areas of our undergraduate program. We will work with our majors' program to improve the sophomore year course and infuse computing into the sophomore curriculum, offer a new interdisciplinary course in biological physics and continue the expansion of undergraduate research opportunities. We will also focus effort to expand the connections between physics and departments in CAS and ENG. Our intent is to continue our strong support for the Core program, increase our new, interdisciplinary course offerings for non-science majors, develop a second freshman writing course, couple our service courses to subsequent classes in other majors, and design a specialized physics class for the new neuroscience program. Finally, we will follow up the first ever Undergraduate Alumni Reunion with related events and development activities. Here are the details:

(1) We have completed the redesign of our curriculum for undergraduate physics majors. We have modified the sophomore sequence of courses such that it provides an up to date introduction to modern physics topics with the required mathematical sophistication. Our plan turns Modern Physics (PY354) into a two semester class (PY351/352) with greatly expanded modern topics, and better coupling to Methods of Theoretical Physics (PY355). Pending approval by the College, we intend to teach the two semester sequence for the first time in AY 2009/10. This new expanded modern physics course will blend well with the new freshman seminar experience course, which

introduced first year students to the top ten unanswered questions in physics.

(2) This fall we will begin a new, multi-year effort to infuse computing and computational approaches into the majors curriculum. Computing is a critical component to solving modern physics problems, and has been effectively used as a tool for visualization and teaching of physics concepts. Professor Anders Sandvik will be spearheading a program to develop new laboratories for the new sequence PY351/352 over the next several years. The goal is to train all majors in sufficient depth that computing becomes a ready tool, part of the lexicon of every student, to be used in situations from coursework to laboratory research. Two laboratories will initially be developed to introduce students to computational concepts as well as techniques. In later laboratories, visualization and computational problem solving will be developed.

(3) We plan to complete the design of a new undergraduate course in biological physics to be accessible to juniors in physics and other departments. As we build up in biological physics, and work with the University's program in Integrated/Quantitative/Systems Biology, as well as the Biology Department's new Quantitative Biology program, it is important to offer a solid introduction to biological physics at the junior level.

(4) We are also concerned about the large number of students who apply for transfer credits for introductory physics courses taken at other institutions and whether those courses really give students a basic foundation in physics that corresponds in quality to the courses that we teach. We will evaluate how we can more efficiently ensure they are receiving an equivalent education. We met with Associate Deans Jackson and Snyder to discuss this last year, and received a promise to alter the forms, which has not yet occurred. We will investigate the possibility of an on-line post-transfer credit exam, as well as work to inform advisors, especially those in Biology and Sargent College.

(5) Undergraduate research is a cornerstone of our program. Data demonstrate that students that have a year of intensive research are far more likely to get into top graduate schools and have an accelerated career path than those who don't. Currently, more than half of all physics majors have at least one year of undergraduate research experience. We hope to increase this number to two-thirds of all majors. We are aggressively pursuing REU programs, and are funding eight additional women and underrepresented minorities in summer research from an NSF STEP grant. We are also planning to help support UROP applications that receive only partial funding.

(6) On the infrastructure side, we intend to normalize the delivery and support of our large service courses. We have a server and database system dedicated to storing and making available all past syllabi, class notes, homeworks, exams and conceptual exercises. We are developing more active learning techniques in the classroom, and supporting the demonstrations and radio controlled response systems from the educational staff. Physics will work closely with CAS and minor construction on the renovation of the SCI lecture space. We are also enhancing the training of teaching fellows, adding pedagogical workshops, and encouraging our graduate student informal teaching seminar series - all to be better focused on support of students.

(7) We are redeveloping our relationship with the ERC, with the help of their director. This coming year we will institute a new ERC tutoring fellow, who will be the liaison between the ERC and the department. Further, we will likely utilize ERC training for our teaching fellows.

(8) We intend to plan several follow-up elements to our very successful Undergraduate Alumni Reunion, which was held for the first time this past spring. These include a career panel, since the junior and senior undergraduates found that session in the Alumni Reunion extremely valuable, as well as follow-up events to further develop our relationship with alumni interested in supporting departmental activities.

GRADUATE PROGRAM

Our department offers multiple programs leading to degrees of Master of Arts and Doctor of Philosophy in Physics. In addition to our primary program in physics, a PhD in Cellular Biophysics is offered in conjunction with the Department of Physiology and the Biophysics Institute of the Medical School. Many of our students opt to conduct their thesis research with faculty holding joint appointments with the Photonics Center or with the Departments of Biomedical Engineering and Materials Science Engineering. Our graduate students are admitted exclusively for the PhD program, however, many students choose to also obtain the Master of Arts degree following the successful completion of the comprehensive qualifying exam. In a few cases, students with performance on the written comprehensive examination below the high pass level may exit our program with a terminal Master's degree.

Research opportunities are offered in experimental high energy particle physics and intermediate energy physics, particle astrophysics, theoretical particle physics and cosmology, molecular biophysics, experimental biophysics, biological physics, experimental and theoretical condensed matter physics, polymer physics, econo-physics and statistical physics. During their first year, graduate students are encouraged to explore the various research areas and facilities available in the department.

Curricular Changes

Several meetings of the full Physics faculty were conducted in order to discuss the physics component of the Materials Science and Engineering Initiative at Boston University. The faculty endorsed the recommendations of the graduate committee to allow physics students to take selected Materials Science and related Engineering and Chemistry courses to partially fulfill the distribution requirements of the Physics PhD degree.

Advising and Mentoring

Members of the Graduate Curriculum Committee advise incoming graduate students and graduate students who have not committed to a research field. The advisors meet both before and after initial discussions with students to develop standard guidelines and to resolve open issues. An academic review of entering students occurs at the end of the each semester to identify potential problems as early as possible and to offer guidance in preparation for the written comprehensive examination. The first year students (both post master's and post bachelors) are also required take a seminar course on ethics and scholarly methods in physics, taught by the Director of Graduate Studies. This course gives the DGS weekly contact with the new students, which aids in spotting potential problems and offers informal opportunities for counseling and advising.

The Chair also hosts two informal lunches with graduate students every year to discuss student concerns. This year, students discussed the proposed changes to comprehensive exams and course requirements, how to enhance alumni events, and how to improve the graduate community. Students were especially interested in reviving the graduate-student physics organization, which was resurrected shortly after the lunches.

Student Recruitment

The Graduate Admissions and Recruiting Committee aggressively recruited the best graduate applicants this year. Each admittee was contacted several times by email and invited to visit the department. We held an open house at the Boston University Castle, with 20 prospective students attending. We also offered sessions for academic presentations, meetings with faculty, and lunch with current graduate students. Of the 27 total students who visited our department in the spring, 11 eventually chose to enroll in our graduate program, including some recruits with the best undergraduate records. These results demonstrate the importance of campus visits in the recruitment process.

The Dean's Fellowship continues to be an important recruiting tool. This year, we awarded

Applicants and Admissions	2007	2008	2009
TOTAL APPLICANTS	372	328	319
Domestic	156	148	153
Foreign	216	180	166
Male	295	264	253
Female	77	64	66
TOTAL ADMITTED	65	67	68
Domestic	32	32	45
Foreign	33	35	23
Male	49	60	57
Female	16	7	11
Prospective Visits	24	17	26
Conversions	8	10	11
TOTAL ENROLLED	21	16	17
Domestic	7	9	8
Foreign	14	7	9
Male	19	14	12
Female	2	2	5
Yield (admitted/enrolled)	3.10	4.19	4.00

FIELDS FOR 2009 ENTERING STUDENTS	#
Biological physics	2
Condensed matter experiment	8
Condensed matter theory	2
Particle experiment	1
Condensed matter experiment/Condensed matter theory	2
Condensed matter theory/Particle theory	1

two fellowships to outstanding applicants who accepted our admission offer and the fellowship. In addition, the possibility of offering an apartment to these fellowship recipients in the graduate student residences at 580 Commonwealth Avenue also appears to be helpful in our recruiting efforts.

In February, the Physics Department also sent a graduate student to the Joint Annual Conference of the National Society of Black Physicists and National Society of Hispanic Physicists in Washington, D.C., to represent the science departments at BU. We set up a recruitment booth, where we promoted our graduate program and our research. Several students expressed interest in attending BU and were interested in the physics PhD program, while many other students picked up our materials.

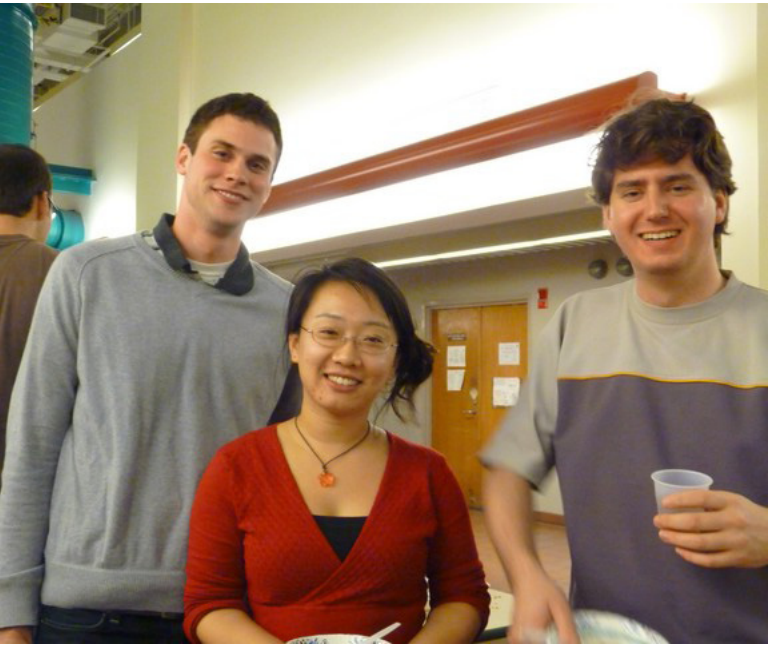
Of the 319 applications submitted, 68 admission letters were sent out. Seventeen students accepted our offer.

2009 Admissions Statistics

319 applicants: 24 countries.
66 women, 253 men
Average Physics GRE: 762 (64%)

68 admits: 11 countries.
11 women, 57 men
Avergage Physics GRE: 827 (76%)

17 accepts: 6 countries.
5 women, 12 men
Average Physics GRE: 807 (73%)



Graduate students take a break from studying and research at their monthly Ice Cream Social.

Fellowships and Aid

Photonics Fellowships for AY 2008-09
Utku Kemiktarak, David Newby, Alexander Kitt

GK12 Fellowships for AY 2008-09
Mikkel Jensen, Kaca Bradonjic

CAS Writing Fellowship
Marc Betnel

Awards and Honors

The Gertrude and Maurice Goldhaber Award in Physics
Adam Avakian

Teaching Fellow of the Year in Physics
Alan Gabel

Chair's Book Award
Chang-Yu Hou, Kipton Barros, Daniel Volovik, Philip Lawson

Alvaro Roccaro Memorial Award
Hidefumi Tomita

Dean's Fellowship
Elsa Abreu, Eva Cornell

Photonics Travel Matching Grant
Sebastian Remi

2009 GSNP (American Physical Society topical Group of Statistical and Nonlinear Physics) Student Speaker Award
Kipton Barros

I2CAM Fellowship Award (to spend the summer in Trieste, Italy)
Claudia De Grandi

NSF Award to attend the Boulder School for Condensed Matter and Materials Physics Summer 2009 Program on Nonequilibrium Statistical Mechanics: Fundamental Problems and Applications
Daniel Volovik

Photonics Center Berman Future of Light Award at the Boston University Science & Engineering Day
Andrew Strikwerda

Office of Technology Development Award at the Boston University Science and Engineering Day
Hidefumi Tomita, Andrew Inglis

Fundação para a Ciência e a Tecnologia PhD in Physics Fellowship
Joao Ricardo Lemos Rodrigues dos Santos, Elsa Caroline Souto Gonçalves de Abreu

CNN Summer Fellowship Award
Dongdong Peng

Ican International travel Award
Armin Rahmanisisan

Program Completion

The Physics Department Graduate Program served 111 students this academic year. We awarded 6 MAs and 16 PhDs.

Master of Arts in Physics

Chen Liu, Mikkel Jensen, Keith Otis, Christopher Serino, Ying Tang, Jingdi Zhang

Doctor of Philosophy in Physics

Ronald Babich, Leyla Colakerol, Yiping Chen, Yu Chen, Mehmet Dogan, Fanny Dufour, Chang-Yu Hou, Maksim Kitsak, Joel Kralj, Marco Mazza, Le Qiu, Fengzhong Wang, Xihua Wang, Andrew Walsh, Zhenyu Yan, Jun Zhou

The following table provides initial career paths for our recent PhD recipients. For a list of dissertation titles and thesis committees for this year's graduates, please refer to the appendix.

Career Paths of 2009 PhD Recipients

NAME	POSITION	INSTITUTION
Ronald Babich	Postdoctoral Fellow	Boston University, Computational Science
Leyla Colakerol	Postdoctoral Fellow	Boston University, Physics Department
Yiping Chen	Scientist	Mariner Investment Group
Yu Chen	Postdoctoral Fellow	Boston University, Physics Department
Mehmet Dogan	Senior Research Scientist	Science Research Lab, Somerville, MA
Fanny Dufour	Postdoctoral Fellow	University of Geneva, Switzerland
Chang-Yu Hou	Postdoctoral Fellow	Leiden University, Netherlands
Maksim Kitsak	Postdoctoral Fellow	University of California, San Diego
Joel Kralj	Postdoctoral Fellow	Harvard University
Marco Mazza	Postdoctoral Fellow	TUB Technical University of Berlin
Le Qiu	Postdoctoral Fellow	Beth Israel Deacones Hospital
Fengzhong Wang	Postdoctoral Fellow	Boston University, Polymer Center
Xihua Wang	Postdoctoral Fellow	University of Toronto, Canada
Andrew Walsh	Senior Engineer	MTPV Coorporation, Boston University Photonics Center
Zhenyu Yan	Postdoctoral Fellow	Harvard University, School of Public Health
Jun Zhou	n/a	n/a

PhD recipients Leyla Colakerol, Marco Mazza and Fanny Dufour relax at the Physics Commencement reception.

Looking Forward

In the upcoming academic year, we will focus on several areas of development in our graduate program. These include: (1) an examination of the number of required courses, with the aim of allowing students greater flexibility to take classes outside of physics, while maintaining core educational breadth and depth; (2) organizing a long-term teaching plan for the frequency of offering 500-, 600-, and 700-level courses that provides both graduate students and faculty greater ability to plan, and a more predictable program of advanced study; (3) helping the graduate student organizations, specifically, the community and the teaching methods groups, to plan and run events with speakers, faculty, and the broader community; (4) examining the Physics Department's role in the new Materials Science and Engineering program, and considering whether a new effort in Materials Physics and Materials Chemistry would make sense for CAS and the university.

We will re-examine the graduate curriculum, specifically, the number of required core courses. In the context of other graduate school programs in physics that are considered competitive with ours, the BU program is somewhat anomalous in requiring 10 lecture courses that are basically predetermined. There is some sentiment among the full faculty that fewer core requirements would allow students to take additional elective courses more closely related to the area of their PhD research. In some cases, these courses may be outside of the Physics Department. The graduate committee will assemble a list of acceptable non-physics courses, and generally evaluate the core requirements. A recommendation to the faculty for their full consideration will take place before any change in the formal requirements is enacted.

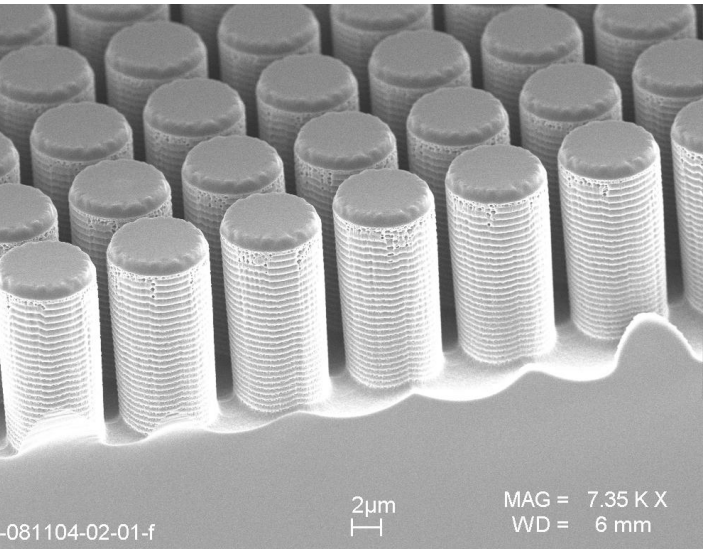
The graduate students organize three effective groups. The general physics graduate student organization oversees community interactions and addresses graduate student concerns, like health care, common space, and educational issues. Women in Physics is a group of female graduate students who work to arrange talks, go to conferences, and create awareness and develop supportive ties with similar organizations in Biology and Chemistry, as well as in neighboring institutions. A group devoted to the teaching of physics meets periodically as a discussion group and journal club, examining current pedagogy, articles of interest, and new techniques to improve the teaching of physics. The initiative for the activities of these groups often comes, commendably, from the students themselves, and the faculty serves as mentors. Our goal in the upcoming year is to help these organizations in their endeavors, supply funding for activities, and encourage them to meet regularly and expand and strengthen the physics graduate student community.

Highlights

Our teaching faculty and research faculty have been exceptionally productive in terms of research this year, producing dozens of publications and making headlines in the larger physics community. Below are highlights of the year.

Research in the News

> Research done by Professor Raj Mohanty, former graduate students Guiti Zolfagharkhani and Alexei Gaidarzhy, and collaborators, was featured on the cover of the December 2008 issue of Nature Nanotechnology. Their work utilizes a nanoscale torsion oscillator to measure the torque in a metal nanowire with unprecedented sensitivity, and could have applications in spintronics and fundamental physics, chemistry and biology.



Studded with rows of tiny pillars, this silicon wafer is used to separate and manipulate the pathway of a wide range of particles, including red and white blood cells. Photo courtesy of Ophelia Tsui.

> Glasses do not flow, while superfluids flow without resistance. A phase of matter that is both glassy and superfluid sounds like an oxymoron. In a recent paper, Professor Claudio Chamon and his collaborators have shown that interacting bosons can form a superglass at a very low temperature and high density. This phase of matter is the amorphous counterpart to supersolids, which may have been observed in He4 experiments. Superglassy phases may also appear in mixtures of cold atoms trapped by lasers in frustrated lattices.

< A new device developed by Professor Ophelia Tsui and collaborators at Princeton University was highlighted by New Scientist and Engadget.com in the summer of 2008. The device is a silicon wafer studded with rows of tiny pillars through which a liquid containing particles of various sizes is made to flow. Due to friction, the liquid flows more slowly close to the pillars than midway between them. Small particles are unaffected by this, but those above a critical size tend to pass close to the pillars and are deflected. By tailoring the arrangement and size of the pillars, different sizes of particle can be collected into streams following diverging paths, an effect akin to a prism separating a beam of white light into its constituent colors. With the device, the team was able to separate and manipulate the pathway of a wide range of particles, including red and white blood cells and platelets.

> The D0 Collaboration at Fermilab has submitted a paper announcing the discovery of a new production process for the top quark. BU Associate Professor Ulrich Heintz, who co-led the top quark physics analysis group of the D0 Collaboration between 2006 and 2008 and postdoc Shabnam Jabeen have contributed directly to the work that resulted in this discovery.

The top quark was discovered at Fermilab in 1995 by the D0 and CDF experiments is the most massive elementary particle known. The Tevatron collides protons and antiprotons at an energy of 2 TeV, the highest energy particle collisions ever produced in the laboratory. In some of those collisions top quarks are created, most of the time together with their antiparticle, the anti-top quark, through the strong force, the force that holds together the atomic nucleus. Theorists have predicted that sometimes only a top quark or only an antitop quark is created through the weak force, which is responsible for nuclear decay. Scientists at Fermilab have been searching for this so-called single top production mechanism for many years. The D0 Collaboration reached a major milestone in December 2006, when it announced that it had observed evidence for this process, indicating that it had observed some collisions in which top quarks seemed to be produced singly but not quite enough to be certain. In the meantime the D0 Experiment has collected more than twice as much data and many more such collisions were found confirming the 2006 result and establishing single production of top quarks beyond any reasonable doubt.

This discovery is significant because the interaction of the top quark through the weak interaction can only be measured in this process and its measurement may be sensitive to possible new fundamental interactions or elementary particles

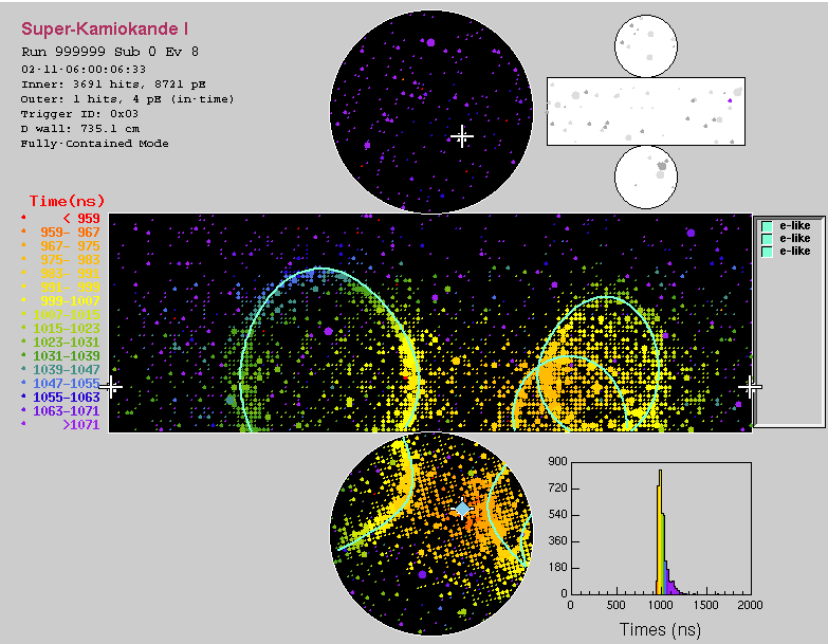
that have not yet been directly observed. The observation of this process thus creates a whole new laboratory in which the standard model can be tested. The measurement by the D0 Experiment shows that single top quark production occurs at a rate consistent with the prediction of the standard model of particle physics, the theoretical framework that summarizes our understanding of the fundamental particles and their interactions.

> The D0 Collaboration also recently published a paper announcing results from a novel search for an exotic charged massive stable particle that could shed light on the future of particle physics. Such a particle is predicted by many exotic theories, including supersymmetry, and its discovery could potentially explain many of the mysteries of the universe, from dark matter to the Higgs boson. A team of D0 physicists conducted this search, with Assistant Professor Tulika Bose being one of the primary contributors to the analysis. The search involved looking for a particle with a striking detector signature. Such a particle is expected to be long-lived such that it traverses the entire detector before decaying. Additionally, owing to its large mass, this exotic particle travels substantially slower than other known particles that travel near the speed of light. No evidence for such a particle was found in the data analyzed by the D0 researchers; however, the search results allowed Professor Bose's team to set upper limits on the production rate and possible masses of such particles. This result greatly improves on results from previous searches at the LEP and Fermilab colliders.

> The Super-Kamiokande experiment published the world's best limit on the important proton decay mode to a positron and neutral pion. This decay is highly anticipated by a wide range of Grand Unified Theories; observation of such a decay would demonstrate the existence of new force carrying particles with masses exceeding 10^{16} GeV. Unfortunately, the experiment saw no candidate events after more than six years of detector exposure. This allowed the experimental group to make a statistical statement that the lifetime of the proton into this decay mode must be greater than 8×10^{33} years. Boston University researchers involved in Super-Kamiokande currently include Professors Ed Kearns, Jim Stone and Larry Sulak, research associate Jen Raff, and graduate students Fanny Dufour and Mike Litos.

> After over 15 years of planning and construction, the first proton beam circulated on September 10 in the Large Hadron Collider at the CERN laboratory in Geneva, Switzerland. The LHC is the highest-energy particle collider in the world with a beam energy of up to 7 TeV and will allow physicists to study the fundamental particles and forces that make up our universe at energy scales that have never before been accessible. Professors Steve Ahlen, Tulika Bose, John Butler, Ulrich Heintz, Jim Rohlf and Larry Sulak are involved with the ATLAS and CMS experiments at the LHC.

The Compact Muon Solenoid (CMS) at the LHC is a 15 thousand ton detector and the world's largest superconducting magnet. At the center is the 1000 ton hadron calorimeter whose 10,000 channels of electronics was in large part designed and built at Boston University. The calorimeter will measure the energies of scattered quarks revealing for the first time the secrets of nature at distance scales of 10^{-19} meters. The LHC marks an unprecedented time in particle physics and promises to reveal the mechanism for electroweak symmetry breaking, or why the electomagnetic interaction is mediated by a massless photon and has infinite range, while



Monte Carlo simulation for the decay of a proton into a positron and neutral pion. Photo courtesy of Ed Kearns.

the weak interaction (responsible for fusion in the sun and other natural phenomena) is mediated by massive W and Z particles, also discovered at CERN.

The detection of the first LHC beam induced events has been very useful for the commissioning of the experiments. In particular, it allowed a CMS team led by Assistant Professor Tulika Bose to study the timing and performance of the CMS High Level Trigger (HLT). The HLT forms the second tier of the two-tier CMS trigger system that must reduce an input data rate from the LHC bunch-crossing frequency of 40 MHz to a rate that can be sustained for writing to permanent storage. Since this archival storage capability is only O(100) Hz at the LHC (as determined by real world cost and network limitations), an efficient trigger system is a critical component of the experiment for capturing interesting physics events while ensuring at the same time a large reduction from un-wanted high rate background processes. During operations with the first LHC beams and commissioning with cosmics, the HLT system was configured to apply no rejection, but simply "tag-and-pass" the events. These events were then monitored using various online data quality monitoring displays. These events are currently being used by Professor Bose's team (including post-doc Edgar Carrera and graduate student Cory Fantasia) to improve and optimize various HLT algorithms in preparation for the first collisions expected in Fall 2009.

> Professor Richard Averitt's group and collaborators have been active in creating flexible multilayer metamaterials that are resonant at far-infrared wavelengths. Specific electromagnetic functionality has been obtained through judicious design and fabrication unique subwavelength composites. This includes ultrathin quarter waveplates and "perfect" absorbers. Graduate students Andrew Strikwerda, Tiger Tao and Kebin Fan, and recent undergraduate Dan Pilon have contributed to this effort. The results have been published in Physical Review B Rapids and Optics Express and have been highlighted by Science and Nature.

Nanomechanical SQUID (Superconducting Quantum Interference Device) fabricated by graduate student Matthias Imboden out of superconducting boron-doped diamond. Photo courtesy of the Mohanty Group.

> Professor Robert Carey and colleagues have completed installation of the MuSun detector at the Paul Scherrer Institute in Switzerland, and hope to collect their first data in the spring of 2010. MuSun is a precision measurement of muon capture on deuterium, which should provide the best ever experimental constraint on a key process in the Standard Solar model.

Featured Publications

Our faculty put forth 399 publications this year, with 357 articles in refereed journals and 5 books. Here are a few samples:

D. Dujmic et al. Observation of the "head-tail" effect in nuclear recoils of low-energy neutrons. Nucl. Instr. Meth. In Physics Research A584, 327, (2008). - Ahlen

A.C. Strikwerda, K. Fan, H. Tao, D.V. Pilon, X. Zhang, R. Averitt. Comparison of birefringent electric split-ring resonator and meanderline structures as quarter-wave plates at terahertz frequencies. Optics Express, Volume 17, Number 1, Page 136 (2008).

M. Li, Y. Liu, R. Bansil. Brownian dynamics simulation of phase transitions in triblock copolymer in selective solvent: kinetics of hexagonal cylinders to face-centered cubic spheres transition. Submitted to Macromolecules.

CMS HCAL Collaborations. Design, performance, and calibration of the CMS Hadron-outer calorimeter. Eur. Phys. J. C57, 653-663 (2008). - Bose

D0 Collaboration. Search for Pair Production of Second Generation Scalar Leptoquarks. Phys. Lett. B 671, 224 (2009). – Butler, Heintz

G.W. Bennett et al. (Muon G-2 Collaboration). Search for Lorentz and CPT violation effects in muon spin precession. Phys. Rev. Lett. 100, 091602 (2008). – Carey, Miller, Roberts

A. H. Castro Neto. Pauling's Dreams for Graphene. Physics 2, 30 (2009).

G. Biroli, C. Chamon, F. Zamponi. Theory of the superglass phase. Physical Review B, Volume 78, Issue 22, Article Number 224306 (2008).

M. El-Batanouny. Symmetry and Condensed Matter Physics: A Computational Approach. Cambridge University Press; 2008.

F. H. Koklu, S. B. Ippolito, B. B. Goldberg, M. S. Ünlü. Subsurface microscopy of integrated circuits with angular spectrum and polarization control. Optics Letters, Vol. 34, pp. 1261 (2009).

Super-Kamiokande Collaboration. Search for matter-dependent atmospheric neutrino oscillations in Super-Kamiokande. Phys. Rev. D77, 052001 (2008). – Kearns, Stone, Sulak

E. Eichten and K. Lane. Low-scale technicolor at the Tevatron and LHC. Physics Letters B669, 235 (2008).

G. Ozaydin, K. Ludwig, H. Zhou, L. Zhou, R. Headrick. Transition behavior of surface morphology evolution of Si(100) during low-energy normal-incidence Ar+ ion bombardment. J. Appl. Phys. 103, 033512 (2008).

G. Zolfagharkhani, A. Gaidarzhy, P. Degiovanni, S. Kettemann, P. Fulde, P. Mohanty. Nanomechanical detection of itinerant electron spin flip. Nature Nanotechnology 3, 720–723 (2008).

R. Jackiw and S-Y. Pi. Persistence of zero modes in a gauged Dirac model for bilayer graphene. Physics Review B 78, 132104 (2008).

A. Polkovnikov and V. Gritsev. Breakdown of the adiabatic limit in low dimensional gapless systems. Nature Physics 4, 477 (2008).

J. Brannick, R. Brower, M. Clark, J. Osborn, C. Rebbi. Adaptive multigrid algorithm for lattice QCD. Phys. Rev. Lett. 100, 041601 (2008).

A. Clauset and S. Redner. Evolutionary Model of Species Body Mass Diversification. Phys. Rev. Lett. 102, 038103 (2009).

P. Bohn et al. Radiation damage studies of silicon photomultipliers. Nucl. Instr. Meth. A598, 722-736 (2009). - Rohlf

Bergo, V.B., et al. His-75 in Proteorhodopsin, a novel component in light-driven proton translocation by primary pumps. J. Biol. Chem. 284(5), p.2836-43 (2009). - Rothschild

C.-W. Liu, S. Liu, Y.-J. Kao, A. L. Chernyshev, A. W. Sandvik. Impurity-induced frustration in correlated oxides. Phys. Rev. Lett. 102, 167201 (2009).

M. Schmaltz and J. Thaler. Collective quartics and dangerous singlets in little higgs. JHEP 0903, 137 (2009).

T. Arnold, D. J. Payne, A. Bourlange, J.P. Hu, R. G. Egdell, L.F.J. Piper, L. Colakerol, P.-A. Glans, K.E. Smith, D. O. Scanlon, A. Walsh, B. J. Morgan, G. W. Watson. X-Ray spectroscopic study of the electronic structure of CuCrO2. Phys. Rev. B 79, 075102 (2009).

Y. Chen, G. Paul, S. Havlin, F. Liljeros, H. E. Stanley. Finding a better immunization strategy. Phys. Rev. Lett. 101, 058701 (2008).

O. K. C. Tsui; T. P. Russell, eds. Polymer Thin Films. Singapore: World Scientific; 2008. Chapter 11, Anomalous Dynamics of Polymer Films, pp. 267-294.

QCMT Visitors Program

The Quantum Condensed Matter Visitors Program, directed by Professor Antonio Castro Neto, was established in 2004 by then College of Arts and Sciences Dean Jeffrey Henderson and made permanent by Provost David Campbell in 2008, in order to bring prominent condensed matter theorists from around the world to collaborate with scientists in the Physics Department at Boston University. The program supports travel, lodging and local expenses for visitors, and has recruited more than 50 distinguished scientists from the most important research institutions in the United States, Europe, South America, Australia and Asia.

These visits have allowed the quantum condensed matter theory group to establish research collaborations with scientists in other institutions and to publish papers in the most distinguished journals in the world, in addition to benefiting the condensed matter experimentalists in the Physics Department. The visitors have also delivered seminars to the department, and have interacted closely with faculty and students during their stay in Boston.

Grant Activity

Our faculty continue to conduct active research programs, despite an unfavorable funding climate caused by the decline in non-defense federal research funding since 2004, and the shift of federal Research & Development resources to biomedical research beginning around 2000. We were awarded $15,452,390 this past fiscal year, which includes funding to PIs within our department that was counted solely through another unit or department. Recent changes in federal priorities resulted in significant budget increases for the Department of Energy and the National Science Foundation, the two primary sources of support for researchers in the physical sciences. This shift, plus the availability of funds through the American Recovery and Reinvestment Act of 2009, may augur a rosier funding climate in the near future. Our PIs have already begun to submit proposals in order to take advantage of these new opportunities.

For a complete list of awards and supplements for the 2009 fiscal year, please refer to the appendix.

Uses of Indirect Cost Recoveries

The Physics Department received $178,816 in indirect cost (IDC) return from the College of Arts and Sciences during FY2009. Since FY2006, the department has directed 50% of IDC return back to the researchers responsible for generating it.

Funds returned to principal investigators this year provided crucial financial support for ongoing projects not covered by research awards or other departmental resources. Other uses included student support, lab supplies and equipment, computing equipment and research travel.

The remaining 50% of IDC return ($89,408) was retained by the Physics Department for broader departmental initiatives. As in the past, these funds helped to offset necessary expenditures for which other support was not available. As mentioned previously in recent annual reports, the fraction of departmentally-held overhead return that must be directed toward staff support has declined since FY2004 from about 75% to about 9%. Consequently, we have been able to direct this important resource toward the unfunded needs we deem most pressing, instead of using most of it just to remain afloat operationally.

Approximately $9,000 of the department's portion of the IDC return was used for student support for which other resources were not available. About $10,000 funded the purchase, construction or repair of supplies and equipment for research and education projects not covered by other sources. Another $8,500 provided the department's share of support for activities such as UROP and the upcoming International Conference on Raman Spectroscopy (to be held in Boston next year). Approximately $7,500 was used for catering expenses for departmental events. Finally, about $93,000 was used—temporarily—to purchase custom electronics for one of our research groups. Although the federal sponsor is providing roughly four times this amount for the equipment in question, the funds were not available last summer, when the order needed to be placed. The availability of IDC return funding to seed this purchase was absolutely crucial in enabling our research group to meet its commitments to the project on schedule.

Teaching Facilities

The Metcalf Science Center and the Physics Research Building are equipped with laboratories in atomic, nuclear, low temperature, high energy, surface and biological physics, and Laser Raman spectroscopy. Major condensed matter physics and biological physics research laboratories are also located in the Photonics Center.

Research is aided by a precision instrumentation shop, an Electronics Design Facility, and a Computer Research Facility, all of which may be used by graduate students. Research is also carried out at the Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Stanford Linear Accelerator Center, CERN, National Synchrotron Light Source, the Advanced Light Source, Super Kamiokande (Japan) and the Stanford Synchrotron Radiation Laboratory.

An extensive network of computational facilities supports the research activities of the department. There are networked multiprocessor DELL and SGI servers and centralized Sun workstations available to departmental faculty, staff and students. Additional Unix and Linux servers and workstations, as well as many Windows PCs, are available to research groups.

For computationally intensive applications, students have access to supercomputing resources supported through the Center for Computational Science and the Office of Information Technology. In addition, the Departmental Computer Facility supports a wide range of software applications for physics data collection, analysis, simulation and visualization.

Undergraduate Teaching Laboratories

The Undergraduate teaching laboratories comprise of four general-purpose rooms and five specialized computer labs. The teaching laboratories staff provides equipment and facilities for the laboratory component of PY103, 105, 106, 211, 212, 241, 242, 251, 252, 313, 354, 371, 408, and 681 along with several School of Education/College of Arts and Sciences courses for high school physics teachers. Each of these courses has up to eight labs per semester. The laboratory rooms are set up to accommodate as many as 24 students (working in groups of two) and labs typically run from two to three hours.

Microcomputer Based Labs (MBLs) make up three quarters of the experiments done in the Intro I courses and approximately two thirds of the Intro II courses. This allows students to spend more time experimenting; letting the computers capture the data. Upgrading the computers used in these labs has been an ongoing project. Since much of the equipment in the labs can be used for multiple experiments, the laboratory staff has been busy ensuring that there is enough equipment available to accommodate all the classes at the same time with minimal scheduling changes. This has been particularly important since the decision to offer PY105 and PY106 both semesters.

The Advanced Lab, PY 581, has received additional attention this year and several of the experiments have been upgraded or repaired.

Undergraduate Lecture Demonstrations Facility

This academic year, the primary project has been the continued reorganization of the demonstration facility. Through rearranging and reorganizing the most used equipment the accessibility of the demonstration collection continues to improve, despite limitations of the existing space. The online database continues to grow to more accurately match our existing collection and to provide background information about the demonstrations. The database, a detailed list of the most popular demonstrations, has proved effective and helpful for faculty when preparing lectures.

The demonstration and laboratory staff has worked closely with Media Services and faculty to coordinate needed improvements in the lecture rooms to allow for the incorporation of more audio, video and student personal response systems in lectures. During the semester, the staff works hard to make classroom audiovisual systems as accessible and easy-to-use as possible.

Throughout the year, our demonstration and laboratory staff has lent equipment and expertise to a series of courses taught by Physics and School of Education faculty outside the department, primarily for Boston Public Schools. Requests from outside the department for equipment are gradually increasing from year to year. As part of BU's Freshman Fridays, the demonstration staff – together with faculty and graduate students – participated in developing and providing demonstrations. The demonstration and laboratory staff also assisted the Chemistry, Biology and Astronomy Departments, Core Courses, Boston University Academy, numerous local elementary

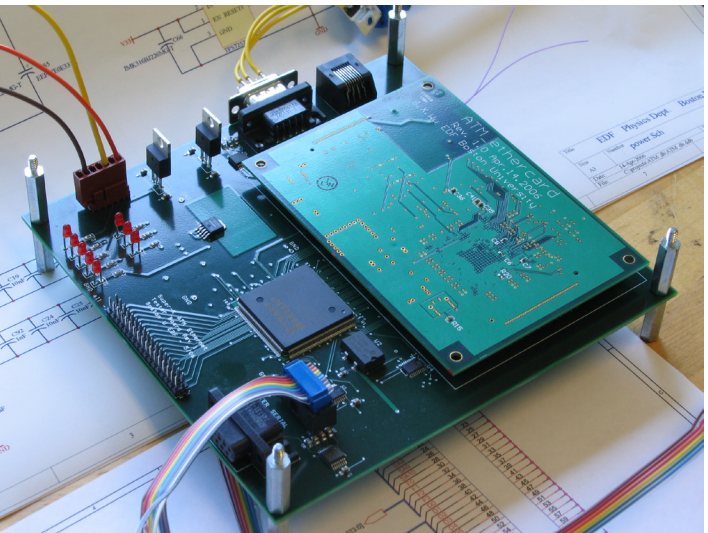
and high schools through the LERNet program and many individuals in the greater University community.

Supporting Facilities

The Physics Department administers two major university-wide facilities for the Boston University community: the Electronics Design Facility and the Scientific Instruments Facility.

Electronics Design Facility

The Boston University Electronics Design Facility designs and builds advanced electronics in support of research science and education. The EDF develops a broad range of instrumentation, from small "black box" circuits for a lab to large systems. Areas of specialty include RF, low-noise circuits, programmable logic and impedance controlled fine-line multi-layer printed circuit boards (PCB). Since 1986 the EDF has contributed to such experiments as Framingham Heart Study, MACRO, Super-Kamiokande, CMS, ATLAS, MuLAN and Muon g-2.



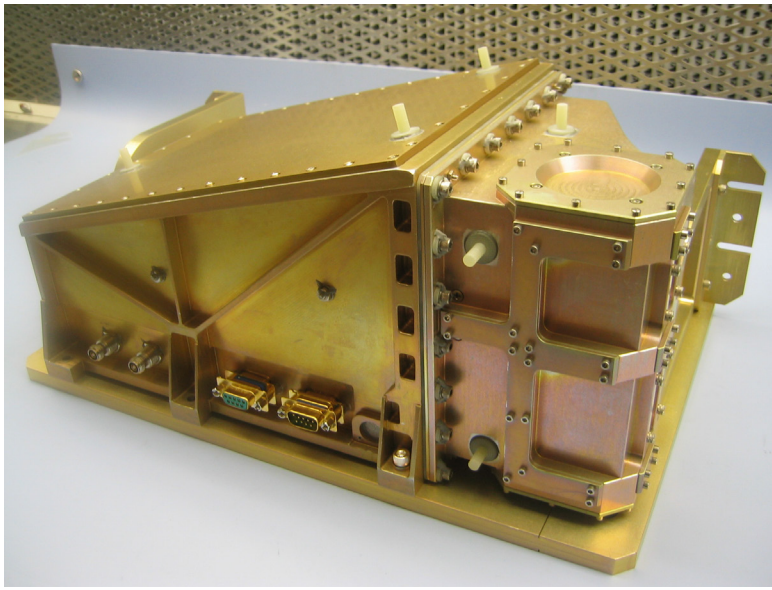
An ATM Ethernet Daughterboard. Photo courtesy of EDF.

Scientific Instruments Facility

The Scientific Instruments Facility (SIF) specializes in the highly accurate machining and fabrication of various types of experimental hardware, to meet the needs of university departments. Such examples include: vacuum chambers, telescopes, positioning tables, electron guns, manipulators, cryostats, and much more. SIF has been utilized by the Physics Department since 1987. The Scientific Instruments Facility has designed and built everything from parts for satellites and robotic lobsters, to mazes for ferrets.

SIF works with stainless steel, titanium, aluminum, nickel, copper, ceramic, and a wide variety of plastics. The facility has the ability to turn ideas and rough sketches into functional scientific hardware. SIF employs a staff of senior experimental machinists with many years of experience in CNC, as well as manual machining, CAD/CAM programming, and welding and fabrication. Services are available to anyone who may be in need of custom-machined parts. The facility is dedicated to providing timely, cost-effective, and practical solutions to anyone's hardware needs.

In the past year, SIF has been extensively involved with BUSAT (the student designed and built satellite). The facility has also been involved with facilitating the satellite construction for CSP, the LCI project, which has contracted with the Air Force research labs to design an energetic particle collector for a scientific research satellite, and much more.



Sensor housing for CRaTER, a joint project between researchers at BU and MIT that seeks to "characterize the global lunar radiation environment and its biological impacts." Photo courtesy of SIF.

One of the shop's more demanding projects was a 6"×9"×9" aluminum housing for CRaTER (Cosmic Ray Telescope for the Effects of Radiation). CRaTER was to be installed in a Lunar Reconnaissance Orbiter spacecraft being built and managed by the Goddard Space Flight Center. The telescope was a joint development of the engineering

departments of BU and Massachusetts Institute of Technology. Heitor Mourato, director of the SIF, said the engineers gave SIF a solid model created in SolidWorks, and the shop programmed the part in Mastercam X2.

In addition, The Scientific Instruments Facility have a new wire EDM machine, capable of cutting stainless steel to repeatable accuracies of 2 tenth of a thousandths of an inch (.0002″).

Their Student Training Center, started in Spring 2008, has been very well received, and has run 30 students through the class so far. SIF's objective is to teach doctoral science candidates the basics of mechanical drafting and design, and how a modern CNC machine shop operates, so that they may more effectively interact with such shops for their future scientific hardware needs. At present, the waiting list to get into the class is about 2 semesters.

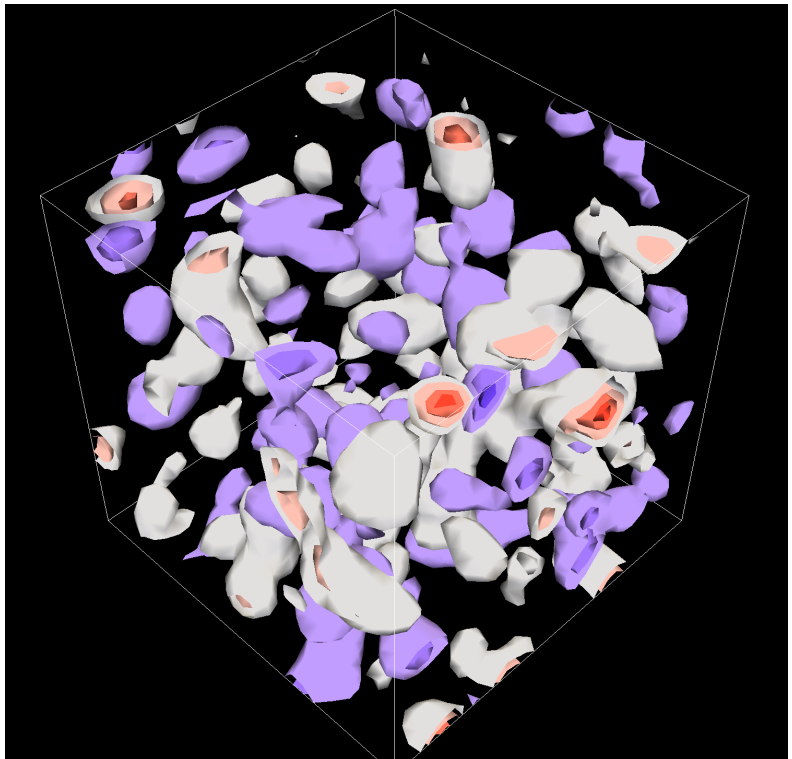
Research Computation Facility

The Physics Research Computation Facility, directed by Guoan Hu, provides systems support for departmental servers and assistance with workstations, and personal computers to our extensive group of faculty, staff, and student users. Hu also helps to configure and maintain computer clusters and servers for research groups within the department. The Systems Analyst, Richard Laskey, has developed our department website and its underlying systems, which includes additions to our departmental database and improvements to the code on which it relies. Laskey has also integrated alumni into our database to consolidate our many sources of data into one consistent scheme.

Center for Computational Science

The Center for Computational Science, under the direction of Professor Claudio Rebbi and working jointly with the Scientific Computing and Visualization Group of the Office of Information Technology, provides advanced computational facilities to all members of the Boston University research community. At the high end, these currently consist of an IBM BlueGene supercomputer with a peak capacity of 5.7 Tflops, an IBM BladeCenter and an Intel based Linux cluster. These resources are integrated into a well-endowed distributed computing and visualization environment, which includes a high resolution, stereographic display wall, a laboratory for immersive virtual environments, an Access Grid Conference Facility, the Computer Graphics Laboratory, Myrinet, Gigabit Ethernet and Fast Ethernet networks. A vast and diverse array of optical fiber connections to the NoX, Metro Ring and commercial ISPs provide multiple Gb/s of bandwidth and connectivity to the Internet, Internet2 and international research networks.

The center runs an interdisciplinary graduate training program called ACES (Advanced Computing in Engineering and Science), which offers a Certificate in Computational Science. This program has received support from an NSF IGERT grant, which provides funded traineeships for students pursuing a PhD in any of nine participating departments, including Physics. The IGERT grant will terminate this year, but the ACES training program will continue under the auspices of the Center.



Contours of constant topological charge density for a quantum field theory on a lattice. Image created by physics graduate student David Schaich and Ray Gasser of the Scientific Computing and Visualization group. Image courtesy of the SCV.

Major Renovations and Improvements

During 2007 and 2008, the University made a major investment in the replacement of the HVAC equipment in SCI. During July and August 2008, well over a hundred physicists and staff members who have offices and/or labs in the building had to be relocated temporarily to PRB and other locations. In addition, every office and lab was disrupted for a week or more to replace its duct work and mechanical equipment. The result is a new, non-leaky roof, and safer, more reliable HVAC equipment with noticeably improved air quality and much better humidity control. Also some rooms, and most public areas, were repainted and re-carpeted if that was needed.

In conjunction with this huge project, the Science Fare cafeteria was permanently closed. As a result, the opportunity exists to make new uses of the open atrium area, providing additional workspaces organized for clusters and workgroups of students, as well as keeping some of the existing tables where students study. This area ought to be included as part of the plans for rebuilding the 1st floor lecture halls, if and when that project is reactivated.

Next year the Physics Department has no specific plans for renovations. If one or more experimentalists are hired as faculty members, modest refurbishing of existing spaces is all that seems likely to be necessary. On the other hand, if our present space allocations in SCI are squeezed by expansion of the Chemistry Teaching Labs, or renovations of the Lecture Halls and Common areas, then compensating areas will need to be identified and appropriately refurbished.

Challenges and Needs

Teaching, research and administrative space is a major concern of the department. The graduate students and faculty's chief concern this year is the continued absence of a common room. We are however, seeking funds to support construction of such a room. We have identified sufficient space for this on the second floor (700 sq ft), although using the space for the common room will require relocation of an instructional laboratory.

We have been pleased to work with CAS, Biology and Chemistry to develop a new renovation plan for teaching space in the Metcalf Science Building. Renovation of that space is a very pressing need. Yet it is also clear that even after the renovation we will still have too few classrooms within reasonable access of our demonstration facility. The department also needs new active learning space designed specifically for studio-type teaching, and real needs for central facility upgrades, upgrades of the nanoscale research facility, and a new molecular biophysics facility.

Finding space with suitable infrastructure (power and cooling) to locate advanced computational equipment constitutes another very pressing need. Faculty have been successful in obtaining various types of equipment to support both computational and large data analysis tasks. However, as more and more computer equipment comes in, the problem of where to locate it becomes critical, to the point that equipment may remain unused, or be placed in substandard space where noise and vibration produce unacceptable disturbance to faculty and research staff in neighboring offices. This is a University wide problem and we are aware that the University Administration is studying the possibility of building an off-site data center to provide adequate data server space. We hope that this may become a reality soon, because the lack of data server space has become a critical issue in the department.

The front office is in desperate need of renovation and reorganization, similar to what was done in Biology several years ago. We are also developing a plan for future research laboratory space, and the consolidation of undergraduate teaching space into greater dual use. These changes will require the support of CAS and the Central Administration.

Events

Women in Physics Seminars

Through a series of biographical seminars held this year, BU's Women in Physics showcased the accomplishments of female scientists, and educated the physics community on relevant issues. Though the talks were given by women, about women, they attracted and engaged both sexes. In an environment where only 8 percent of faculty and 13 percent of graduate students are female, WIP continues to turn up the volume on a voice that has been relatively quiet.

Each seminar offered a rare glimpse at the experiences of women in science. In that sense, WIP member and graduate student Rachele Dominguez said they differed from the typical physics talk, centered on research. Featured speakers this year included Professors Rama Bansil and Tulika Bose.

In addition, the group holds dinners, bringing together both professors and students to talk about all aspects of their lives. These dinners "help to form a very close and supportive network between us women," says graduate student Jiayuan Luo. "We are few, but we are not alone."

Dean Edmonds Colloquium

This year's Dean Edmonds Colloquium series speaker was Geoffrey West, of the Santa Fe Institute. West gave a talk titled "The complexity, simplicity and unity of living systems from cells to cities." Later, West spoke at a banquet held in the School of Management. Approximately 90 people attended.

CTY Awards

The Johns Hopkins Center for Talented Youth (CTY) 2009 Awards Ceremony for Eastern Massachusetts was held on Saturday, May 23, 2009 in the Ballroom of the George Sherman Union at Boston University. The Ceremony was held to honor and award certificates and scholarships to students who excelled in their academic achievement. Grades 2 through 6 excelled on specially prepared CTY exams, while grades 7 and 8 received recognition if their SAT scores were equal to or exceeded those of the 12th grade average.

The Ceremony was organized by Winna Somers of the Physics Department, and Patricia Jorgensen from the Office of the Provost (which also provided the funds for the event). The event was first brought to Boston University in 1986 by Physics Professor Emeritus George Zimmerman, and returned this spring after a hiatus of several years. Approximately 400 awardees and 500 guests attended the event.

For a complete list of this year's colloquia and seminars, please refer to the appendix.

Educational Outreach

Boston University Upward Bound

As part of the Physics Department's $3.5M (cumulative) National Science Foundation Graduate Students in K-12 education (GK12), BU Physics graduate students taught in the BU Upward Bound program for Boston area youth struggling to complete high school and matriculate to college.

GK12 Boston Urban Fellows

Physics graduate students Kaca Bradonjic, Mikkel Jensen and Sebastian Remi received GK12 fellowships and were placed respectively in physics classrooms at English High School, Boston Latin Academy and the Boston Community Leadership Academy. They worked actively through the year to help develop new curricula for physics classes, add content expertise, help teachers in professional development, and most important, they gained invaluable experience in translating concepts in physics and from their research into effective lessons in an immersive, urban teaching environment.

LERNet

Throughout the school year, the teaching laboratories have worked in coordination with LERNet, BU's Learning Resource Network, to conduct educational and enrichment activities for local middle-school and high-school students, including BU Academy and Bedford High School. LERNet, run by Cynthia Brossman, also hosted a Physics Day for high school students in May (see below), and was the prime organizer of the 2009 Department Of Energy ScienceBowl. At the event, 30 teams vied for the opportunity to compete in the National Bowl in Washington, DC.

Physics Day at Boston University

The department participated in the fourth annual Physics Day at BU, which attracted 250 high school students and teachers from around the city. Andrew Duffy and Val Voroshilov performed a physics demo show titled "Under Pressure." In

addition, graduate students Rachele Dominguez and Mark Betnel, presented a session called "Experience the Sound." Another group comprised of Sebastian Remy, Kaca Bradonjic, and Mikkel Jensen developed a presentation on "Light and Magnetism" that opened with a light show accompanied by music. All the students and participants enjoyed a barbecue on Metcalf Plaza at the conclusion of the program.

Improving the Teaching of Physics

The goal of Project ITOP is to address a serious shortage of high school physics teachers. A large number of teachers who instruct physics in high schools do not have a solid background in the subject, and/or are not licensed by the state to teach physics. Through Project ITOP, teachers can take up to ten graduate-level courses (CAS NS540 through CAS NS549), which cover all the physics they need for their own classrooms, i.e. the conceptual history of physics, and selections from the Physics Education Research literature. These courses last two months, meeting once a week, with teachers taking five courses between the beginning of September until the end of June. The program began in 2004, and this year it was expanded to Chicopee, Massachusetts, with one set of teachers taking BU courses off-site at Chicopee Comprehensive High School.

Improving the Teaching of Physics (ITOP) is a joint effort between the Physics Department (co-PI: Andrew Duffy) and the School of Education (PI: Peter Garik), and also involves Arthur Eisenkraft of the Center for Science and Mathematics in Context (COSMIC) at the University of Massachusetts Boston. ITOP is funded by the Massachusetts Board of Higher Education. The project is currently in the second year of its second three-year state grant.

In 2008-09, our teaching labs provided space and laboratory equipment for all 10 of the ITOP courses, with the following schedule:

NS540 Concepts in Physics I: Force and Motion (*Fall 2008*)
NS541 Concepts in Physics II: Rotation and Gravitation (*Fall 2008*)
NS542 Concepts in Physics III: Fluids, Heat, and Thermodynamics (*Spring 2009*)
NS543 Concepts in Physics IV: Electrostatics and Magnetostatics (*Spring 2009*)
NS544 Concepts in Physics V: Harmonic Motion, Waves, and Geometrical Optics (*Summer 2009*)
NS545 Concepts in Physics VI: Electromagnetism, AC Circuits, and Physical Optics (*Fall 2008*)
NS546 Concepts in Modern Physics I: Quantum Physics (*Fall 2008*)
NS547 Concepts in Modern Physics II: Special Relativity (*Spring 2009*)
NS548 Computer Modeling of Physical Phenomena (*Spring 2009*)
NS549 Everyday Applications of Physics (*Summer 2009*)

In 2008-2009, there were a total of over twenty teachers enrolled in the program, in three different groups. One group met every Monday in the BU Physics Department, and was taught by Lecturer Manher Jariwala. A second group met every Thursday in Chicopee, and was taught by Professor Andrew Duffy. A third group, which started in 2007, took more advanced courses this year and met every Friday in the BU Physics Department; they were taught by Nick Gross of BU's Center for Integrated Space Weather Modeling.

The involvement of the Physics Department in Project ITOP continues to be a major outreach effort. Courses from Project ITOP have now been taken by approximately 50 teachers, many from Boston Public Schools, but with others from Revere, Newton, Holliston, Franklin, Brookline, Manchester-Essex, Quincy, Chicopee, Springfield, Orange, and Agawam, among others. With such a large number of teachers having taken these courses, the Physics Department has made an important contribution to schools in the Boston area and across the state in the teaching of physics.

Immersion for Elementary Teachers

In the summer of 2007, the undergraduate labs hosted an intensive two-week workshop for elementary teachers, covering light and optics. This workshop, called Immersion in Geometrical Optics, was privately funded by a three-year grant from Stephen Bechtel. In July 2007, 15 elementary teachers attended the workshop (enrolling in a two-credit graduate-level School of Education course, SED SC531), which ran for 7 hours a day, every day, for two weeks.

In early 2008, Professors Bennett Goldberg and Glenn Stevens (Math) won a major new grant from the Massachusetts Board of Higher Education in the STEM Pipeline program, to expand the teacher immersion program. That summer, immersion expanded to two workshops, each begun with five three-hour pre-workshop sessions in May and June (hosted by the undergraduate physics labs). The intensive two-week session in July was

supplemented with classroom follow-up visits and formal evaluation. Several papers in physics education are in the works. Each course is now associated with a four-credit graduate-level School of Education course. These courses are SED SC532 (Immersion in Geometrical Optics, one section of 15 teachers) and SED SC533 (Immersion in Green Energy, two sections of 15 teachers each). The Optics workshop is covered by Goldberg's Bechtel grant, while the Green Energy workshop is funded by the Massachusetts Board of Higher Education grant. This summer, we are expanding further, developing a new course, Immersion in Global Energy Distribution, which will cover issues in energy creation and distribution and global warming.

Research Internship Program

The BU Research Internship Program in Science and Engineering, co-founded by Professor Emeritus George Zimmerman, entered its 31st year of immersing high school students in the world of scientific research. Featured in the BU Metropolitan College newsletter, the program enlists faculty mentors in Physics, Chemistry, Biology, Medicine, Engineering and Psychology to help students explore their scientific interests and prepare for the rigor of college-level study and research.

Alumni Initiatives

The Physics Department held its second Graduate Alumni Reunion on Friday, May 1 and Saturday, May 2, 2009. Seventy-five alumni, faculty and current students discussed contemporary physics, caught up on years passed, and discussed careers inside and outside of physics.

The day began in the Metcalf Science Center, where alumni, students and faculty gathered over lunch. From there, the group proceeded to a large classroom in the building for a session with alumni speakers Vidya Madhavan ('00), Adam Martin ('07) and Paul Mankiewich ('93). Many attendees praised the talks, which touched on current research, and "life as a physicist." A career panel was held in the afternoon by Madhaven, Martin and Arvind Marathay ('63) to advise current Boston University graduate students on the possibilities of careers in physics. The evening ended with a lovely cocktail reception and dinner, where the group was able to mingle.

On Saturday morning, the current graduate students got to take advantage of the mock job interviews done by Masako Yamada ('03). This event was followed by another career panel consisting of Bell Herzog ('94), Aaron Schweiger ('07) and Terry Russel ('98). Event organizer and assistant to the Chairman, Kelly Lyons, reported that the event was a great success and that everyone enjoyed themselves. The majority of alumni in attendance hailed from Massachusetts, but others traveled from New Hampshire, Wisconsin and beyond. The idea of having the reunion in the fall, adjoined with the undergraduates, was presented this summer, and will most likely occur in 2010.

Graduate students, past and present, mingle bewteen talks at the department's second Graduate Alumni Reunion.

Media Strategy

Both print and online media are vital avenues for our department's communication with the greater physics community. Our media is comprised of our website, undergraduate, graduate and research brochures, Alumni Newsletter, and Annual Report. This year, we continued to build upon our media, and to find ways to address the needs of our many constituencies.

The department website is our most critical medium, as the information on it can be instantly updated, and holds a large audience. Our homepage includes modules for displaying news and events, and our "Student Spotlight", which has been an effective way of portraying the lives of

BU Physics students. It also includes an improved, printable directory which is automatically updated on a daily basis.

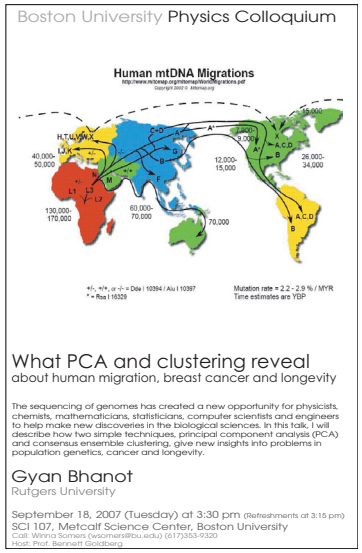
We are currently developing a mailing list management system, which would allow people who aren't in the department, particularly alumni, to sign up to receive announcements regarding departmental events and news.

Also in development is a media archive, which would include digital video recordings of important department events, like graduations, lectures and alumni reunions.

In terms of our internal online capabilities, the department has continued to update our admissions database with new functionality, as well as improve usability in our existing database interfaces. Also, we now have an availabilities application for scheduling group appointments, and the ability to store and manage website documents via the Web. In addition, work has begun on a new graduate database and a forms archive.

In keeping up with current trends in the global online community, the Physics Department can now be found on Facebook and Twitter. These avenues allow us to pass information on to our younger constituents, specifically, current students and recent alumni.

In the coming year, we hope to improve and build upon our existing media in ways that allow us to be more relevant and savvy with our communication.


Boston University Physics Colloquium

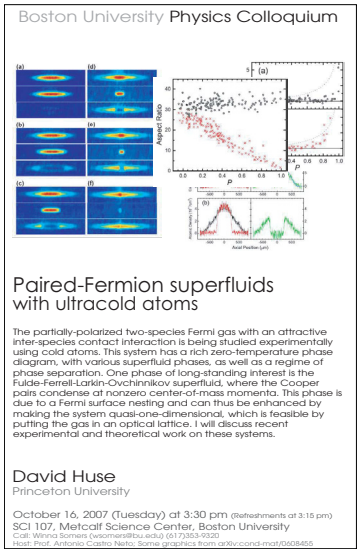
Human mtDNA Migrations

What PCA and clustering reveal
about human migration, breast cancer and longevity

The sequencing of genomes has created a new opportunity for physicists, chemists, mathematicians, statisticians, computer scientists and engineers to help make new discoveries in the biological sciences. In this talk, I will describe how two simple techniques, principal component analysis (PCA) and consensus ensemble clustering, give new insights into problems in population genetics, cancer and longevity.

Gyan Bhanot
Rutgers University

September 18, 2007 (Tuesday) at 3:30 pm (Refreshments at 3:15 pm)
SCI 107, Metcalf Science Center, Boston University
Call: Winna Somers (wsomers@bu.edu) (617)353-9320
Host: Prof. Bennett Goldberg

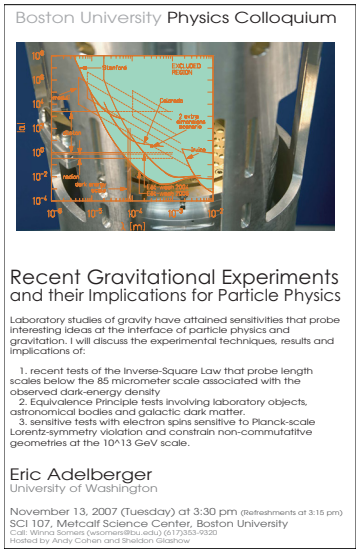

Boston University Physics Colloquium

Paired-Fermion superfluids
with ultracold atoms

The partially-polarized two-species Fermi gas with an attractive inter-species contact interaction is being studied experimentally using cold atoms. This system has a rich zero-temperature phase diagram, with various superfluid phases, as well as a regime of phase separation. One phase of long-standing interest is the Fulde-Ferrell-Larkin-Ovchinnikov superfluid, where the Cooper pairs condense at nonzero center-of-mass momenta. This phase is due to a Fermi surface nesting and can thus be enhanced by making the system quasi-one-dimensional, which is feasible by putting the gas in an optical lattice. I will discuss recent experimental and theoretical work on these systems.

David Huse
Princeton University

October 16, 2007 (Tuesday) at 3:30 pm (Refreshments at 3:15 pm)
SCI 107, Metcalf Science Center, Boston University
Call: Winna Somers (wsomers@bu.edu) (617)353-9320
Host: Prof. Antonio Castro Neto; Some graphics from arXiv:cond-mat/0608455


Boston University Physics Colloquium

Recent Gravitational Experiments
and their Implications for Particle Physics

Laboratory studies of gravity have attained sensitivities that probe interesting ideas at the interface of particle physics and gravitation. I will discuss the experimental techniques, results and implications of:

1. recent tests of the Inverse-Square Law that probe length scales below the 85 micrometer scale associated with the observed dark-energy density
2. Equivalence Principle tests involving laboratory objects, astronomical bodies and galactic dark matter.
3. sensitive tests with electron spins sensitive to Planck-scale Lorentz-symmetry violation and constrain non-commutative geometries at the 10^13 GeV scale.

Eric Adelberger
University of Washington

November 13, 2007 (Tuesday) at 3:30 pm (Refreshments at 3:15 pm)
SCI 107, Metcalf Science Center, Boston University
Call: Winna Somers (wsomers@bu.edu) (617)353-9320
Hosted by Andy Cohen and Sheldon Glashow

Sample of department colloquium posters

Fundraising, Gifts and Grants

The Physics Department has several projects and initiatives in fund raising, briefly mentioned here.

We held the first graduate alumni reunion in the spring of 2007 and the first undergraduate alumni reunion in the spring of 2008. Both events were a great success, and we are in the process of continuing our relationships with alumni to develop fund raising opportunities.

The Physics Department received two anonymous gifts this past year: one for $3000 which will become part of the Marin Memorial Scholarship to support a graduate student in high energy physics, and the other for $10,000 to help graduate students travel to international conferences. We continue to seek funds to build the Marin Scholarship to a level sufficient for endowment; we expect to reach that level this year.

We continue on our major fundraising initiative to raise money to build a common space. Initially, we had a commitment of $40k for the 'Sulak Common Room' but lost that commitment late last year. We have received approval to work with several past and present members of the board, and will try to raise new funds for the common room.

Goals

Our vision is of a department diversified in its fields of interest, outstanding in its teaching, congenial in its decision making, and strong in its research output. We are starting from an excellent basis, with a faculty that is dedicated to teaching and active in research. Currently however, research focus is too narrow, centered mostly in condensed matter physics and particle physics, and to a lesser extent in biophysics. We consider it extremely important to increase the breadth of research and education into at least two new areas, the first one identified as biological physics. We have requested permission for faculty searches in this field, and we feel that being able to add at least one new faculty in biological physics is crucial for the fulfillment of our goals. On a longer range, realizing our goals of diversification will require an appropriate targeting of replacement faculty positions, as our most senior faculty will retire. We have begun a discussion within the faculty, aimed at achieving broad consensus on this important matter. Another high priority is to continue growth in interdisciplinary education, with new courses and research programs at the undergraduate and graduate level, especially those that connect to other departments, centers, and programs in CAS and ENG.

Infrastructure

In terms of additional departmental needs, staffing is two positions down from several years ago. Our current staff has done wonders, albeit reduced in numbers, to accomplish all of the departmental functions. Still, we feel that in spite of their excellent performance, some staff are not adequately compensated, and we would like to remedy this with off-cycle salary increases. Also, we would like to upgrade the position of program coordinator of the graduate program, bringing this staff into a management position. The purpose is to advance the career of an excellent staff member, who has served the department for 13 years and has significantly increased their portfolio to include many minor projects and personnel management.

Teaching, research and administrative space are major concerns of the department. Our needs for a common space, additional classrooms, expanded laboratories, data server space and upgrades to the physics office have been documented in the "Challenges and Needs" section of the chapter on Facilities and Infrastructure. This section serves as reference for a more detailed account of the department's needs.

Recent PhD Recipients

NAME	DISSERTATION TITLE	COMMITTEE (Chair in **bold**)
Ronald Babich	Aspects of Baryon Structure in Lattice QCD	Rebbi, Katz, **Lane**, Kearns, Chamon
Yiping Chen	Study of Complex Networks Using Statistical Physics Methods	Stanley, Skocpol, **Erramilli**, Carey, Ludwig
Yu Chen	Silicon Nanowire Field Effect Transistor for Biosensing	Mohanty, Erramilli, **Tsui**, Miller, Polkovnikov
Leyla Colakerol	Electronic Structure and Quantized Surface Electron Accumulation of Narrow Band Gap Semiconductors	Smith, Ludwig, **Castro Neto**, Moustakas, Kearns
Mehmet Dogan	Interference Techniques in Fluorescence Microscopy	Goldberg, Unlu, Swan, **Chamon**, Ahlen
Fanny Dufour	L/E Analysis with the Super-Kamiokande Detector	Kearns, Bose, **Roberts**, Glashow, Sandvik
Chang-Yu Hou	Charge Fractionalization in Two-Dimensional Dirac Fermions	Chamon, Pi, **Rebbi**, Polkovnikov, Averitt
Maksim Kitsak	Organization of Complex Networks	Stanley, Klein, **Ludwig**, Redner, Miller
Joel Kralj	Infrared Studies of the Molecular and Structural Changes of Proteorhodopsin	Rothschild, Erramilli, **Averitt**, Redner, Miller
Marco Mazza	Thermodynamics and Dynamics of Supercooled Water	Stanley, Averitt, **Skocpol**, Ludwig, Heintz
Le Qiu	Confocal Light Absorption and Scattering Spectroscopic (Class) Imaging: From Cancer Detection to Sub-cellular Function	Perelman (BIDMC), Erramilli, **Ahlen**, Skocpol, Jara (MED)
Andrew Walsh	Exciton Behavior in Carbon Nanotubes: Dielectric Screening and Decay Dynamics	Swan, Goldberg, **Redner**, Unlu, Kearns
Fengzhong Wang	Statistical Physics Approaches to Financial Fluctuations	Stanley, Skocpol, **Erramilli**, Carey, Ludwig
Xihua Wang	Nano-Electronic and Nano-Optic Biosensing	Erramilli, Mohanty, **Chamon**, Ahlen, Altug (ENG)
Zhenyu Yan	Anomalies of Water and Simple Liquids	Stanley, Skocpol, **Ludwig**, Kearns, Klein
Jun Zhou	Nonlinear Excitations in Lattices	Campbell, Castro Neto, **Rebbi**, Sandvik, Erramilli

New Awards and Supplements

PRINCIPAL INVESTIGATOR(S)	AWARD PERIOD	AMOUNT (DOLLARS)	TITLE	AGENCY
Ahlen	9/1/08 - 8/31/09	98,385	ARI-SA: Development of a Direction Sensitive Neutron Detector	Dept of Homeland Security
Ahlen, Butler	3/1/07 - 1/31/10	32,106	U.S. ATLAS Research Program: Empowering U.S. universities for Discoveries at the Energy Frontier (Subcontract via Columbia University)	NSF
Ahlen, Butler	2/1/07 - 1/31/10	25,000	Research in Particle Physics/Task A2; Colliding Beams - ATLAS	DOE
Ahlen, Butler, Shank	2/1/07 - 1/31/10	18,000	Research in Particle Physics/Task A2: Colliding Beams - ATLAS	DOE
Ahlen, Butler, Shank	2/1/09 - 1/31/10	376,000	Research in Particle Physics/Task A2: ATLAS	DOE
Averitt	5/8/07 - 9/30/09	61,659	Metamaterials for Threat Reduction Applications: Imaging, Signal Processing and Cloaking (Subcontract via Los Alamos National Laboratory)	DOE
Averitt, Erramilli, Rothschild, Ziegler (Chemistry)	10/1/08 - 9/30/11	565,926	MRI: Development of an Ultra-Fast Optical Spectroscopy System for Multi-Disciplinary Studies (in conjunction with Photonics Center)	NSF
Bansil	10/10/08 - 4/9/09	35,000	Protein Solution Phase Separation Evaluation (in conjunction with Center for Polymer Studies)	Amgen Inc.
Bansil	9/1/08 - 8/31/09	207,705	IPA: NSF Program Director for the Materials Research Science and Engineering Centers (MRSEC) Program	NSF
Bansil	9/1/08 - 8/31/09	1,391	IPA: NSF Program Director for the Materials Research Science and Engineering Centers (MRSEC) Program	NSF
Bansil, Stone	2/1/09 - 5/31/09	12,361	PhD Training with Professor Lev Perelman (Subcontract via Beth Israel Deaconess Medical Center)	HHS /NIH /NIBIB
Bansil, Stone	9/1/08 - 1/31/09	15,450	Graduate Student Support (L.Qiu) (Subcontract via Beth Israel Deaconess Medical Center)	HHS /NIH /NIBIB
Brower, Rebbi	3/15/08 - 3/14/09	198,300	National Computational Infrastructure for Lattice Gauge Theory	DOE
Butler	9/1/08 - 5/31/09	26,000	Memorandum of Understanding for the Exchange of Professor Butler from Boston University to Centre National de la Recherche Scientifique in France	Commissariat a l'Energie Atomique (France)
Butler	9/1/08 - 6/30/09	10,000	Memoradum of Understanding for the Exchange of Professor Butler from Boston University to Centre National de la Recherche Scientifique in France	Commissariat a l'Energie Atomique (France)
Butler	9/1/07 - 7/31/10	10,000	Construction of a Prototype Section of a Digital Hadron Calorimeter (Subcontract via Univeristy of Oregon)	DOE
Butler, Heintz	2/1/07 - 1/31/10	181,000	Research in Particle Physics / Task A1: Colliding Beams - D0	DOE

New Awards and Supplements

continued

PRINCIPAL INVESTIGATOR(S)	AWARD PERIOD	AMOUNT (DOLLARS)	TITLE	AGENCY
Carey, Miller, Roberts	5/1/08 - 4/30/09	25,200	Precision Measurements in Intermediate Energy Physics	NSF
Carey, Miller, Roberts	5/1/08 - 4/30/09	50,001	Precision Measurements in Intermediate Energy Physics	NSF
Castro Neto	9/1/08 - 8/31/09	110,000	The Physics of Graphene	DOE
Chamon	9/1/08 - 8/31/09	104,000	Quantum Nanowire Multi-Connections (in conjunction with Center for Nanoscience and Nanobiotechnology)	DOE
El-Batanouny	1/1/09 - 12/31/09	191,628	Structure and Dynamics of Surface Electron Spin Systems of Antiferromagnetic Insulators, Using Helium and Metastable Helium	DOE
Erramilli, Mohanty	6/13/08 - 12/12/08	84,531	Gate-Controlled Silicon Based Nanoscale Processor for Multiple Analyte Assay	Ninth Sense
Goldberg	3/1/09 - 2/28/10	161,369	Graphene Membranes as Micro- and Nano- Pressure Sensors	AEC
Goldberg, Stanley	6/1/06 - 5/31/09	310,469	National Computational Infrastructure for Lattice Gauge Theory	NSF
Goldberg, Stanley	6/1/06 - 5/31/10	269,213	GK12 Track II: Boston University Urban Fellows Project (in conjunction with Science and Math Education Center)	NSF
Goldberg, Stevens (Math)	12/9/08 - 12/8/09	100,000	Summer Immersion Institutes	Stephen Bechtel Fund
Grossberg (Cognitive and Neural Systems), Stanley	10/1/08 - 9/30/09	2,354,925	Science Learning and its Application to the High School Setting	NSF
Heintz	7/1/08 - 6/30/09	18,905	Fermilab support for Dr. Dookee Cho (subcontract via Fermi National Accelerator Laboratory)	DOE
Heintz	2/1/07 - 1/31/09	4,500	Research in Particle Physics/Task A1: Colliding Beams D0	DOE
Katz	1/1/09 - 12/31/09	80,000	CAREER: Electroweak and Strong Coupling Physics	NSF
Kearns, Stone, Sulak	2/1/09 - 1/31/10	23,000	Research in Particle Physics/Task C1: Particle Astrophysics Group	DOE
Kearns, Stone, Sulak	2/1/09 - 1/31/10	588,000	Research in Particle Physics/Task C1: Particle Astrophysics Group	DOE
Klein	12/1/08 - 11/30/09	296,779	Collaborative Research: Failure of Rock Masses from Nucleation and Growth of Microscopic Defects and Disorder	DOE
Klein	2/1/07 - 1/31/12	10,000	Emergent Modes on Earthquake Fault Systems: Illuminating the Relationship between Observable Data and the Underlying Dynamics of Fault N	NSF
Krapivsky	9/1/08 - 8/31/11	210,000	Collaborative Research: EMT/MISC-Behavior-Based Molecular Robotics	NSF
Krapivsky	9/15/05 - 2/28/09	17,000	Collaborative Research: Center for Molecular Cybernetics	NSF
Lane	2/1/07 - 1/31/09	58,000	Research in Particle Physics/Task E: Theoretical Particle Physics	DOE
Lane, et al	2/1/09 - 1/31/10	739,000	Research in Particle Physics/Task E: Theoretical Particle Physics	DOE

New Awards and Supplements

continued

PRINCIPAL INVESTIGATOR(S)	AWARD PERIOD	AMOUNT (DOLLARS)	TITLE	AGENCY
Miller, Roberts	6/15/08 - 6/30/09	13,006	Simulation and Light Guide Work for the SNS Neutron EDM Experiment (subcontract via Los Alamos National Laboratory)	DOE
Mohanty	4/1/09 - 3/31/10	85,000	CAREER: Nanomechanics in the Quantum Regime	NSF
Mohanty	9/1/08 - 6/30/09	105,000	Accurate Time Measurement Using Nonlinearly Coupled Resonators	Sand 9
Mohanty	9/15/08 - 8/31/11	299,997	EMT/NANO: Computation Using Nanomechanical Oscillator Networks	NSF
Polkovnikov	12/1/08 - 11/30/09	137,566	Dynamics and Thermodynamics of Many-Particle Cold Atom Systems	DOD/Air Force
Polkovnikov	9/16/09 - 9/15/11	50,000	Alfred P. Sloan Fellowship	Sloan
Roberts	6/15/08 - 6/30/09	14,178	Simulations and Light Guide Work for the SNS Neutron EDM Experiment (Subcontract via Los Alamos National Laboratory)	DOE
Rohlf	1/1/07 - 12/31/11	296,329	U.S. CMS Research Operations at the LHC (year 3) (Subcontract via Univeristy of California/Los Angeles)	NSF
Rohlf	1/1/09 - 12/31/09	296,329	U.S. CMS Research Operations at the LHC (year 3) (Subcontract via Univeristy of California/Los Angeles)	NSF
Rohlf, Sulak	2/1/09 - 1/31/10	226,000	Research in Particle Physics/Task K1: CMS Very Forward Calorimeter	DOE
Sandvik	8/1/08 - 8/31/10	240,000	Simulation Studies of Ground State Phases and Criticality in Correlated Quantum Matter	NSF
Shank	2/1/09 - 1/31/10	339,900	U.S. ATLAS Research Program: Empowering U.S. universities for Discoveries at the Energy Frontier (Subcontract via Columbia University)	NSF
Shank	3/1/07 - 1/31/10	600,000	U.S. ATLAS Research Program: Empowering U.S. universities for Discoveries at the Energy Frontier (Subcontract via Columbia University) (in conjunction with Center for Computational Science)	NSF
Shank, Youssef	10/1/04 - 9/30/09	375,000	ITR: Collaborative Research: (ASE + ECS)-(INT+DMC+SPC)-Environmental Computing for Global Grids	NSF
Smith	1/1/08 - 12/31/08	8,167	Synchrotron radiation Spectroscopic Studies of Niobium Oxides (A. DiMsi) (Subcontract via Jefferson Laboratory)	DOE
Smith	12/15/08 - 12/14/09	120,000	Electronic Structure in Low Dimensional and Correlated Solids	DOE
Smith	7/1/08 - 6/30/09	130,000	Surface, Interface and Bulk Electronic Structure of Nano-Scale Thin Film Organic Semiconductors	NSF
Smith	9/1/08 - 8/31/09	90,454	Spectroscopic Studies (subcontract via Case Western Reserve University)	NSF
Smith	9/1/08 - 8/31/09	4,083	Synchrotron radiation Spectroscopic Studies of Niobium Oxides (A. DiMsi) (Subcontract via Jefferson Laboratory)	DOE
Stanley	1/1/09 - 12/31/09	35,000	Physical Laws of Oil-Containing Porous Media	Schlumberger

New Awards and Supplements

continued

PRINCIPAL INVESTIGATOR(S)	AWARD PERIOD	AMOUNT (DOLLARS)	TITLE	AGENCY
Stanley	10/1/08 - 11/30/11	374,981	Threat Networks and Threatened Networks Phase III: Terrorist Networks	DOD/Navy
Stanley	10/1/08 - 9/30/09	109,328	Understanding Static and Dynamic Heterogeneities in Confined Water	NSF
Stanley	11/1/08 - 10/31/09	450,000	Physical Conditions Triggering onset of Alzeimer's disease	Bechtel
Stanley	12/1/08 - 11/30/09	667,854	Circadian Role in Diurnal Pattern of Cardiovascular Risk	NIH
Stanley	4/1/08 - 3/31/09	195,000	The Problem of Company Growth and Collapse	Merck Foundation
Stanley	4/1/08 - 3/31/09	250,000	Understanding Formation of Neurotoxic Oligomers in Alzheimer's Disease	Zenith Awar / Alzeimer's Association
Stanley	4/20/09 - 4/19/12	450,000	Robustness, Dynamical Transport Capabilities and Recovery of Critical Networks Subject to WMD Attack	DOD / DTRA
Stanley	6/1/08 - 5/31/09	331,532	Estimation of Uncertainty in Gas Breakthrough Using Methods Derived from Percolation Theory	British Peteroleum
Stanley	7/1/08 - 6/30/09	160,000	Collaborative Research: Ordering Processes in Water, Aqueous Solutions, and Water-Biomolecule Systems	NSF
Stanley	8/1/08 - 7/31/09	301,290	Project 4: Ab Initio Molecular Dynamics Simulations of A-beta Folding and Assembly (subcontract via University of California/Los Angeles)	HHS / NIH / NIA
Stanley	8/15/08 - 7/31/09	246,803	Quantitative Analysis of Cerebral Cortex in Aging monkeys	HHS / NIH / NIA
Stanley	9/1/08 - 8/31/09	228,790	An Econophysics and Behavioral Approach to Financial Fluctuations	NSF
Tsui	9/10/08 - 5/31/10	100,000	Surface Capillary Waves on Polymer Films Studied by Atomic Force Microscopy	NSF
Youssef	11/8/07 - 9/30/09	375,000	Terepaths at Boston University	DOE
Youssef	9/1/06 - 3/31/09	65,000	Sustaining and Extending the Open Science Grid: Science Innovation on a Petascale Nationwide Facility	NSF

Total Funding during FY09 (in dollars): 15,452,390

Colloquia

DATE	SPEAKER	TITLE
Apr. 21	Geoffrey West (Santa Fe Institute)	The Complexity, Simplicity, and Unity of Living Systems from Cells to Cities: A Physicist's Search for Quantitative, Unified Theories of Biological and Social Structure and Organization*
Apr. 7	Margaret Geller (Smithsonian Astrophysical Observatory, Harvard University)	Newton Meets Einstein: A Test of Weak Lensing
Apr. 2	Yuhai Tu (IBM T. J. Watson Research Center)	From molecules to behavior: E. coli's memory, computation and motility
Mar. 31	Gabriel Kotliar (Rutgers University)	Strongly Correlated Electron Systems: a Dynamical Mean Field Theory Perspective
Mar. 24	Bulbul Chakraborty (Brandeis University)	Fluctuations, Response, Entropy and "Temperature" in Granular Packings
Mar. 24	Dr. Michael Salamon (NASA Headquarters)	Physics of the Cosmos: NASA's program to understand the Universe's origin and fate
Feb. 24	Alan Litke (UC Santa Cruz)	What Does the Eye Tell the Brain?: A Journey from High Energy Physics to Neural Systems
Feb. 10	Sarah Eno (University of Maryland)	Searching for New Particles at the LHC
Feb. 3	Lazlo Barabasi (Center for Complex Network Research and Department of Physics at Northeastern University. Department of Medicine, Harvard Medical School)	The Physics of Human Mobility and What It Tells Us About Cell Phone Viruses
Jan. 27	Ed Kearns (Boston University)	The Neutrino Matrix
Dec. 2	L. Mahadevan (Harvard University)	Geometric mechanics: from the atomic to the tectonic
Nov. 18	Erik Katsavounidis (MIT)	Searches for gravitational waves with the LIGO interferometers
Nov. 4	David Weiss (Pennsylvania State University)	Experiments with gases in 0D, 1D and beyond
Oct. 28	Richard Wolfson (Middlebury College)	Global Warming: State of the Science
Oct. 21	Denise Freed (Schlumberger)	The Physics of Crude Oils: What downhole nuclear magnetic resonance can tell
Oct. 7	Gene Stanley (Boston University)	Liquid Water: New Results in Bulk, Nanoconfined, and Biological Environments
Sep. 23	Doyne Farmer (Santa Fe Institute)	Are there quantitative mathematical laws underlying financial markets?
Sep. 16	Ken Dill (University of California at San Francisco)	Small-numbers dynamics in biology and nanotech: the Maximum Caliber approach to nonequilibrium statistical mechanics

* Dean Edmonds Colloquium

Biophysics | Condensed Matter Seminar

DATE	SPEAKER	TITLE
Jun. 23	Otto Glatter (University of Graz, Austria)	Nanostructured Lipid Droplets
May. 14	Srikanth Sastry (Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India)	Discovery of a Liquid-Liquid Phase Transition in Supercooled Silicon (an analog of supercooled water)
May. 8	Eric Akkermans (Yale University)	Dicke superradiance and Anderson localization of photons
Apr. 17	Jon Celli (Wellman Center for Photomedicine, MGH, Harvard Medical School)	Studying the effects of tumor microenvironment on migration, assembly and therapeutic efficacy in a 3D model of ovarian cancer
Apr. 10	Walter Reisner (Brown University)	Conformational Sculpting of DNA: Nanofluidics for Single Molecule DNA Analysis and Manipulation
Apr. 3	Erik Luijten (Northwestern University)	Self-assembly of rod-like polyelectrolytes: from materials to cystic fibrosis
Mar. 12	Orion Penner (University of Calgary)	Connection between DNA sequence alignment and information theoretic similarity measures.
Feb. 27	Narayanan Menon (UMASS Amherst)	Wrinkling, folding and crumpling of thin elastic sheets
Feb. 26	Wonmuck Hwang (Texas A & M)	Mechanical Design of the Kinesin Motor
Feb. 13	Ying Ran (UC Berkeley)	Helical Metal Inside a Topological Band Insulator
Feb. 12	Plamen Ivanov (Boston University)	Scale-invariant aspects of physiologic dynamics
Feb. 6	Brian LeRoy (Arizona State University)	Local electronic properties of graphene
Feb. 5	Fiorenzo Omenetto (Tufts University)	Silk Optics
Feb. 4	Marcia Barbosa (University of Rio Grande do Sul, Porto Alegre, Brazil)	Connection between Interaction Potential and Phase Behavior of Water
Jan. 22	Michael Hagan (Brandeis University)	Viruses as adaptable containers--modeling the simultaneous assembly and encapsulation of flexible polymers and solid nanoparticles by viral capsid proteins.
Jan. 15	Allison L. Stelling (SUNY Stony Brook)	Vibrational studies of biological chromophores: Raman spectroscopy of the Yellow Fluorescent Protein and ultrafast infrared spectroscopy of the bacterial blue light sensing protein, AppA.
Dec. 5	Xi Lin (Boston University)	Computing viscosity of supercooled liquids
Dec. 4	C. Austen Angell (Arizona State University)	Control of protein folding and misfolding in ionic liquid media, and a conjecture on early earth biology
Nov. 21	Nick Bonesteel (Florida State University)	Braiding and Entanglement in Non-Abelian Quantum Hall States
Nov. 20	Al Crosby (UMASS Amherst)	Wrinkling, Crumpling, and Snapping Polymer Surfaces
Nov. 13	Bulbul Charkraborty (Brandeis University)	What can minimal models tell us about the function of biopolymers?
Oct. 31	Alioscia Hamma (Perimeter Institute)	Lieb-Robinson bounds and the speed of light from topological order
Oct. 30	Eric Dufresne (Yale University)	Optical Tweezers Shed Light on Cell Biology
Oct. 24	Nuh Gedik (MIT)	Ultrafast structural dynamics observed with atomic scale resolution
Oct. 17	Matthew Grayson (Northeastern University)	Novel boundaries for quantum Hall fluids: The bent quantum Hall junction

Biophysics | Condensed Matter Seminar

continued

DATE	SPEAKER	TITLE
Oct. 15	Ivan Brovchenko (University of Dortmund)	Physics of Peptide Aggregation
Oct. 10	Michael Pustilnik (Georgia Tech)	One-dimensional fermions beyond the Luttinger liquid paradigm
Oct. 3	Senthil Todadri (MIT)	Critical Fermi surfaces and non-fermi liquid metals
Sep. 23	Hong Ding (Institute of Phsyics, Chinese Academy of Sciences)	The New Iron-Based High Tc Superconductors
Sep. 19	Vidya Madhavan (Boston College)	Superconducting gaps and Pseudogaps: spectroscopic evidence for two competing, coexisting phases below Tc
Sep. 12	Ehud Altman (The Weizmann Institute of Science)	Hidden order in low dimensional Bose insulators and possible implications for quantum magnets

Condensed Matter Theory Seminar

DATE	SPEAKER	TITLE
Apr. 23	Lars Fritz (Harvard University)	Hydrodynamic transport properties of graphene
Apr. 16	Krishnendu Sengupta (Saha Institute of Nuclear Physics)	Aspects of many-body physics in graphene
Apr. 9	Sasha Chernyshev (University of California, Irvine)	Frustrated, degenerate, and breaking apart: the Bright Side of Life in triangular lattice
Apr. 2	Eduardo Fradkin (University of Illinois at Urbana-Champaign)	Entanglement Entropy at 2D quantum critical points and topological fluids
Apr. 1	Mukund Vengalattore (Cornell University)	Supersolidity in a quantum degenerate dipolar spinor gas
Mar. 12	Alessandro Silva (ICTP, Triste, Italy)	The statistics of the work done in quantum quenches
Feb. 26	Joseph Thywissen (University of Toronto)	Ultracold fermions and bosons in Toronto

High Energy Experiment Seminar

DATE	SPEAKER	TITLE
Apr. 30	Graduate Student Presentations	LHC Physics Symposium 3:30 - 5:30 PM
Apr. 16	Ulrich Heintz (Boston University)	Observation of single top quark production
Apr. 9	Kara Hoffman (University of Maryland)	IceCube: The first kilometer scale neutrino telescope
Mar. 26	Kevin Lynch (Boston University)	MuLan: The Fermi Constant to 0.5 part per million
Feb. 26	Ketevi Assamagan(Brookhaven National Laboratory)	What can we learn about the Higgs with 10 fbˆ-1 at the LHC?
Feb. 25	Dan Duggan (Florida State University)	Recent results of the photon plus heavy flavor jet cross sections at D0
Feb. 12	Edgar Carrera (Florida State University)	Physics with single photon plus missing energy final states at D0
Feb. 11	Jim Hirschauer (University of Colorado)	CP violation in hadronic penguins at BABAR
Jan. 29	Lawrence Sulak (Boston University)	First Light in Antares Neutrino Telescope, and on to Km**3

Particles and Fields Seminar

DATE	SPEAKER	TITLE
May. 4	Andreas Ross (Yale University)	Effective Field Theory for Gravitational Bound States
Apr. 27	Clifford Cheung (Institute of Advanced Study)	The S Matrix in Twistor Space
Apr. 23	Kimball Milton (The University of Oklahoma)	Exact Multiple Scattering Results: Applications of Quantum Vacuum Forces
Apr. 20	Walter Goldberger (Yale University)	AdS/CFT duality for non-relativistic field theory
Apr. 13	Patrick Fox (Fermilab)	Leptophilic Dark Matter
Mar. 30	Sergei Dubovsky (Stanford University)	Superluminal travel in two dimensions
Mar. 23	Douglas Finkbeiner (Harvard University)	A Theory of Dark Matter: PAMELA positrons, DAMA, and a New Force in the Dark Sector
Mar. 16	Chris Herzog (Princeton University)	Continuing Developments in Holographic Superconductivity and Superfluidity
Mar. 2	Tao Han (University of Wisconsin)	The Test of the Seesaw Mechanisms at the LHC
Feb. 23	Thomas Levi (NYU)	When Worlds Collide
Feb. 17	Richard Hill (Fermilab)	The anomalous baryon current and neutrino-photon interactions
Feb. 9	Natalia Toro (Stanford University)	First Characterization of New Physics at the LHC
Feb. 2	Philip Schuster (SLAC)	Collider and astrophysical Signatures of Composite Inelastic Dark Matter

Particles and Fields Seminar

continued

DATE	SPEAKER	TITLE
Jan. 26	David Poland (Harvard University)	DAMA results and candidates for Inelastic Dark Matter
Dec. 15	Paolo Giromini (Laboratori Nazionali di Frascati)	Study of multi-muon events at CDF
Dec. 8	Can Kilic (Johns Hopkins University)	Phenomenology of Multijet Resonances at the Tevatron and the LHC
Dec. 1	Rakhi Mahbubani (Fermilab)	A simple, stable model of brane inflation
Nov. 24	Lisa Randall (Harvard University)	
Nov. 17	Bob Holdom (University of Toronto)	The conservative case for a fourth family and new strong flavor interactions
Nov. 10	Juan Maldacena (Institute for Advanced Study)	Scattering amplitudes in N=4 SYM: lessons from strong coupling
Nov. 3	Alejandro Jenkins (MIT)	Quark masses: an environmental impact statement.
Oct. 27	Sean Hartnoll (Harvard University)	Holographic superconductors
Oct. 20	Andreas Weiler (Cornell University)	Flavor violation in warped extra dimensions: GIM, RS-GIM and flavor symmetries
Oct. 14	David Poland (Harvard University)	The Dark Top
Oct. 6	Simon Catterall (Syracuse University)	Supersymmetric lattices: theory and applications
Sep. 29	Howard Georgi (Harvard University)	Fun with 2D Unparticle Physics
Sep. 22	Brock Tweedie (Johns Hopkins University)	Tagging Hadronic Tops at High Pt
Sep. 15	Witold Skiba (Yale University)	Low-scale Gaugino Mediation.
Sep. 8	Matthew Schwartz (Harvard University)	The world's best measurement of alpha_s at LEP and some collider physics implications.

Women in Physics Seminar

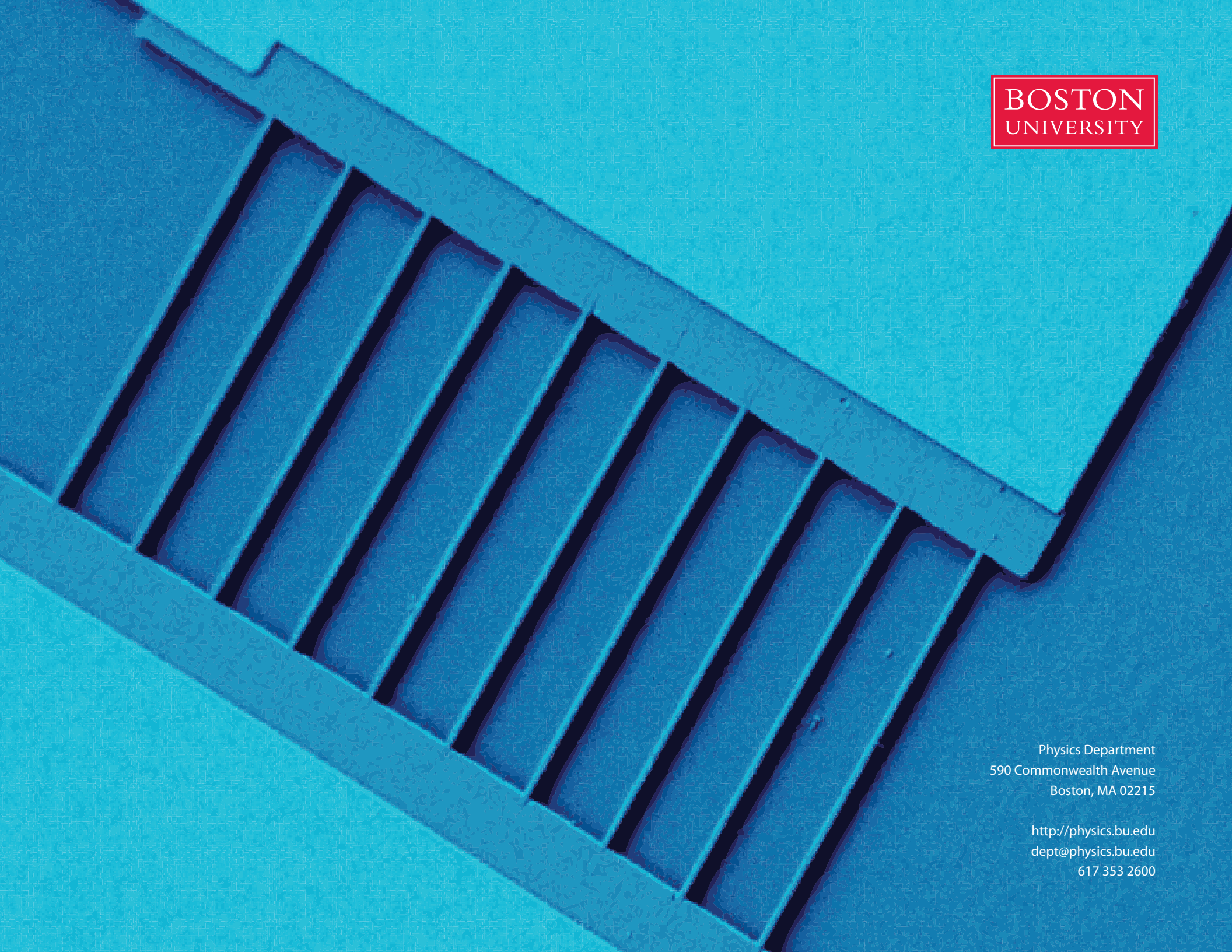
DATE	SPEAKER	TITLE
Jun. 22	Gene Stanley (Boston University)	Why are there so few women in physics?
May. 27	Tulika Bose (Boston University)	A journey in search for new physics: from India to the LHC
Mar. 24	Bulbul Chakraborty (Brandeis University)	Snapshots of my life as a Woman Physicist
Feb. 4	Marcia Barbosa (Institute of Physics Rio Grande University Brazil)	Women in Physics Tea
Oct. 9	Rama Bansil (Boston University)	A fresh perspective on careers beyond the Ivory Tower

Cover
Nanomechanical spin-torsion resonator
photo courtesy of Raj Mohanty

Back
Nanoelectronic glucose sensor
photo courtesy of Raj Mohanty

Boston University Physics Department
2008-2009 Annual Report

Produced and edited by Claudio Rebbi, Courtney Clark, Kelly Lyons and Solomon Posner,
with contributions from Erich Burton, Cynthia Brossman, Mirtha Cabello, Andrew Duffy, Bennett Goldberg, Anita Gupta, Ulrich Heintz, Guoan Hu, Richard Laskey, Jiayuan Luo, Rachel Meisel, Heitor Mourato, Bill Skocpol, Winna Somers, Jim Stone, Claire Thomas and George Zimmerman



BOSTON
UNIVERSITY

Physics Department
590 Commonwealth Avenue
Boston, MA 02215

http://physics.bu.edu
dept@physics.bu.edu
617 353 2600