Department of Physics

The MIT Department of Physics continues to be one of the largest and most successful physics departments in the world. The department has 75 tenure-track faculty slots, making it larger than most of our peers — though many of those institutions have a separate astronomy department. Because physics covers so many areas at MIT, the department has divided itself into four divisions: astrophysics; atomic, biophysics, condensed matter, and plasma physics; nuclear and particle theory; and nuclear and particle experiment. For the 10th straight year the MIT Department of Physics has been named the number one physics program by US News and World Report. The strength of the department comes from its unwavering devotion to both research and teaching. Over time faculty, staff, and alumni have collectively won 14 Nobel Prizes. Additionally, we have 23 National Academy of Science members within our current and emeritus faculty members, and three of our current faculty are MacArthur Fellows.

Faculty Count, Promotions, and Departures

As of June 30, 2011, the Physics Department had 71 appointed regular rank faculty members, consisting of 46 full professors, 13 associate professors, and 12 assistant professors.

Six faculty members were promoted this year. Robert Simcoe, Joshua Winn, and John McGreevy were promoted to associate professor without tenure; Senthil Todadri, Gunther Roland, and Marin Soljačić were promoted to full professor. These promotions will take effect July 1, 2011.

S. James Gates, Jr., from the University of Maryland was a Martin Luther King, Jr., Visiting Professor of Physics for the 2010–2011 academic year.

The 2011 faculty search process was both extensive and successful. Each of our divisions conducted a search, resulting in eight total offers (at least one to each division) resulting in five acceptances. Those five are Jeremy England in biophysics (starting July 1, 2011); Liang Fu in condensed matter theory and Paolo Zuccon in high energy experiment (starting January 16, 2012); and Anna Frebel in astrophysics and Michael Williams in experimental nuclear physics (starting July 1, 2012). Additionally, Nevin Weinberg joins our astrophysics division effective July 1, 2011. Nevin was offered a position in 2010 and deferred his acceptance.

Ulrich Becker and Tom Greytak both retired effective July 1, 2011, after years of dedicated service to MIT and the department. Sadly, this year we also lost James Elliot, who had a 25 percent faculty appointment with the department, to cancer. He will long be remembered by colleagues and students.

Administration

Edmund Bertschinger will continue as the department head and Krishna Rajagopal will remain as the associate department head for education.

The Physics Council membership remained as follows:

Edmund Bertschinger — department head

Krishna Rajagopal — associate department head

Deepto Chakrabarty — astrophysics division head

Patrick Lee — atomic, biophysics, condensed matter, and plasma physics division head

Peter Fisher — experimental nuclear and particle physics division head

Edward Farhi — director, Center for Theoretical Physics

Richard Milner — director, Laboratory for Nuclear Science

Jacqueline Hewitt — director, Kavli Institute for Astrophysics and Space Research

Matt Cubstead — administrative officer

Faculty Awards

Following are a few of the many honors and awards conferred upon faculty members during the 2011 academic year:

Nergis Malvalvala won a MacArthur Fellowship.

Jeff Gore won the Alfred P. Sloan Research Fellowship, was selected as a Pew Scholar in Biomedical Sciences, and won the award for UROP faculty mentor of the year.

Markus Klute won the Alfred P. Sloan Research Fellowship.

Nuh Gedik won the 2011 Department of Energy Early Career Research Award.

Krishna Rajagopal won the 2011 Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching.

Miklos Porkolab won the Fusion Power Associates "Distinguished Career Award."

Martin Zwierlein won the Presidential Early Career Award for Scientists and Engineers, the DARPA Young Faculty Award, and the David and Lucile Packard Fellowship.

Jesse Thaler won the 2011 Department of Energy Early Career Research Award.

John McGreevy was awarded the Class of 1992 Career Development Professorship.

Nergis Malvalvala, Isaac Chuang, and Jan Egedal-Pedersen were elected fellows of the American Physical Society.

Pablo Jarillo-Herrero won the 2010 IUPAP Young Scientist Prize in Semiconductor Physics and the 2011 Department of Energy Early Career Research Award.

Education

Two hundred ninety-four students pursued an SB degree in physics, and 94 SB degrees were awarded — an increase of 25 percent in majors and of almost 18 percent in degree recipients over the preceding year. Of the degree recipients, 78 percent chose the flexible degree option. We believe that the popularity of the flexible option is a major contributing factor to the continuing rise in our numbers of undergraduate majors; it was introduced in AY2001 to allow students to develop a strong foundation in physics and then build on this foundation as they prepare for career paths that may not involve a graduate degree in physics. Twenty-nine percent of our graduating seniors earned dual degrees. Twenty percent of degree recipients were nominated into Phi Beta Kappa.

Two hundred thirty-four students pursued graduate degrees in physics. One SM degree and 33 PhD degrees were awarded. The 2011 admissions cycle for graduate students continued to be very competitive, with the number of applications — 688 this year — growing by close to 10 percent over the previous year. Offers of admission were made to 88 applicants, 17 of whom were female. The overall yield rate also increased this year, from 43 percent to 45 percent.

Diversity

Diversity is a concern at all levels: undergraduate students, graduate students, postdoctoral fellows, and faculty. The Physics Department uses multiple strategies to recruit women and underrepresented minorities at all levels.

At the undergraduate level, we offer two options for the SB Physics degree: focused and flexible. The flexible option significantly increased the fraction of female physics majors after it was introduced. In 2011, 36 of our 94 undergraduate majors were women. Not only was this the highest number of women majors in our history, but the 38 percent makeup was also much higher than the national average of 21 percent reported by the American Institute of Physics in 2008.

In January 2011, MIT acted as one of four simultaneous hosts for the Sixth Annual Conference for Undergraduate Women in Physics. The goals of the conference were to give young women the resources, motivation, and confidence to apply to graduate school and to successfully complete a PhD in physics or a related discipline and to make undergraduate women in physics more aware of the wide range of career opportunities available to them. More than 130 students attended.

Recruiting and retaining women and underrepresented minorities to Physics faculty positions is a high priority. Search committees are actively seeking members of underrepresented groups by preparing and executing a pre-search plan to attract qualified candidates.

Throughout the recruitment process, advertising is targeted to reach these groups through diversity and organizational job boards and publications. Applicant data is closely tracked, and applications from qualified women and minority candidates are given consideration across all the divisions. The department actively encourages our faculty to reach out to potential underrepresented junior faculty candidates by encouraging young postdoctoral students to visit MIT to deliver research seminar talks.

The department also holds monthly lunches that are open to all faculty, postdocs, graduate students, and staff members to discuss broad topics associated with diversity and inclusion. These luncheons were well attended in in 2010–2011 and included topics such as implicit bias, managing across generations, and balancing work and family life while at MIT.

Finally, the department was pleased to cosponsor and lead in the organization of the MIT 150th Symposium, *Leaders in Science and Engineering: the Women of MIT*. This two-day symposium highlighted and celebrated the research accomplishments of some of the top minds in science and engineering, while also recognizing the progress that women have made in achieving recognition for their accomplishments in science. The event was woven around the 1996 and 1999 reports of the Faculty Committees on Women in Science. The speakers at the event included three winners of the National Medal of Science, two MacArthur Fellowship winners, and 10 members of the National Academies.

Research Highlights

Hong Liu and John McGreevy applied the mathematics of string theory to the behavior of high-temperature superconductors. The physics of these materials is poorly understood. The MIT research, published in the August 5, 2010, online edition of *Science*, is one of the first to show that gauge/gravity duality can shed light on a material's puzzling physical behavior.

Ernest J. Moniz, the director of the MIT Energy Initiative, was the cochair of a study that argued that uranium supplies will not limit the expansion of nuclear power in the US or around the world for the foreseeable future, challenging a view that had prevailed for decades.

Sara Seager led a group of astronomers in spotting an exoplanetary eclipse of a star only 40 light years away — right around the corner, astronomically speaking — revealing a "super-Earth."

John Winn analyzed the orbits of 19 "hot Jupiter"–like planets and noted that 11 were aligned with their host star and eight were misaligned. His analysis reveals that the misaligned planets orbit the hottest stars in the sample, which may be a clue that planets orbiting hot stars form differently from those orbiting cooler stars. Winn also suggests that perhaps the orbits of all hot Jupiters eventually become misaligned, and that planets orbiting cooler stars realign with their star's rotation over time.

Martin Zwierlein led a team of MIT physicists that created clouds of ultracold gases that bounce off each other like bowling balls, even though they are a million times thinner than air. This marks the first time that such impenetrable gases have been observed. Although this experiment involved clouds of lithium atoms cooled to near absolute zero, the findings could also help explain the behavior of other strongly interacting systems such as neutron stars, high-temperature superconductors, and quark-gluon plasma: the hot soup of elementary particles that formed immediately after the Big Bang.

Leonid Levitov was part of a collaboration that found a way to make wonder material graphene magnetic, opening up a new range of opportunities for the world's thinnest material in the area of spintronics. The collaboration showed that electric current — a flow of electrons — can magnetize graphene. The results are a potentially huge breakthrough in the field of spintronics.

Sam Ting led a decades-long project that resulted in the Alpha Magnetic Spectrometer (AMS) being launched with the space shuttle Endeavour and placed in its permanent perch on the International Space Station. The AMS is designed to study some of the universe's deepest secrets, including what happened to all the antimatter and what is dark matter.

Jeff Gore and his research group combined a computational model with experiments on the evolution of drug resistance in bacteria, and calculated, for the first time, the likelihood of a particular evolutionary adaptation reversing itself. They found that a very small percentage of evolutionary adaptations in a drug-resistance gene can be reversed, but only if the adaptations involve fewer than four discrete genetic mutations. This research opens the possibility of using biophysics to reverse evolution in genes.

Raymond Ashoori and Lu Li, a Pappalardo Fellow in his lab, together with a research team from the University of Augsburg, investigated the unusual physical system that results when lanthanum aluminate is grown on top of strontium titanate. The collaborators decided to measure the capacitance between that channel and a gate electrode on top of the lanthanum aluminate. Their findings hinted that an infinitesimal change in voltage will cause a large amount of charge to enter the channel between the two materials. Indeed, the material's capacitance is so high that the researchers do not believe it can be explained by existing physics. Ashoori feels it could be a new quantum-mechanical effect or some unknown physics of the material.

Pappalardo Fellows

A. Neil Pappalardo has made possible a program in the department to attract recent PhDs of exceptional promise. The purpose of the Pappalardo Fellowships in Physics is to identify and support unusually talented young physicists and to provide them with the opportunity to pursue research of their own choosing. The Pappalardo Fellows have complete freedom in their choice of research and are matched with a mentor chosen on the basis of their research interests. Fellows have special status in the department and are invited to attend faculty events. The first three fellows arrived in September 2000 and since then the program has supported 39 fellows. About 35 percent of all Pappalardo Fellows have been women, and the program has proved to be a strong source of our own faculty recruiting, with five members having joined the MIT Physics Department. In October 2010 the department celebrated the 10th anniversary of this successful program by inviting all the former and current fellows for a symposium and dinner.

Community/Upcoming Events

The Physics Department strives to create a community of scholars and endeavors to create opportunities for our faculty, students, and alumni to come together to share and explore ideas. The department continues to sponsor the following events designed to foster the exchange of ideas:

- Faculty lunches are held each week during the fall and spring semesters. All faculty are invited to join their colleagues for an informal meal and to hear a talk from one of their colleagues on his or her research.
- An afternoon colloquium series is held each week at which a physicist, often from outside MIT, is invited to give a talk on a topic of interest. This event is open to the MIT community. These talks are digitized and then made available to MIT physicists and students who are unable to attend the colloquia
- Twice a semester alumni are invited to a breakfast to hear about physics research being done by one of our outstanding faculty presenters.
- The Pappalardo Fellowship program sponsors a weekly lunch that brings Pappalardo Fellows and Physics faculty together for conversation.
- In the spring of each year, the department holds an Open House where area residents are invited to campus to view our Technology-Enabled Active Learning classrooms and witness various physics lab demonstrations, set up and administered by our Technical Services Group. In 2011, this Open House was part of the overall MIT 150th anniversary celebration; we also opened our Junior Lab to visitors, and presentations were given by the Laboratory for Nuclear Science, the Kavli Institute for Astrophysics and Space Research, and other groups across campus.

Edmund Bertschinger
Professor of Physics
Department Head