

# Physics Department 2008-2009 Annual Report

July 3, 2009

## Part 1: Executive Summary

The Physics Department continues to make measurable progress towards its goals of research prominence, challenging yet supportive undergraduate and graduate programs, and engagement with local, regional, and global communities.

This year saw the completion and culmination of the department's comprehensive *review process*. A high profile external review committee visited in September 2008 and noted the "very positive trajectory" of the department. According to the Committee, "This is largely due to the outstanding quality of recent hires and an exceptionally congenial atmosphere in the department." Amongst the challenges faced by the department, the Committee cited "inadequate operating funding" and "facilities that are both scarce and of poor quality".

*Learning.* Our student numbers continue to grow. Once the new freshmen and transfer students have arrived on campus, our program will number approximately 200 undergraduate and 75 graduate students. In the national comparison, such significant enrollment figures are usually found in departments with 40 or more faculty members. The Class of 2009 consisted of 20 students (17 BS, 3 BA). 2 PhD and 8 MS degrees were awarded; 5 additional PhD students are expected to complete their degrees this summer. A major rebalancing of our *undergraduate in-major curriculum* was completed this year. The changes include the addition of a new course in Mathematical Physics, a shift of several junior and senior courses to earlier points in the students' careers, and the conjoining of five graduate and undergraduate courses, resulting in a very attractive "senior suite" of topical electives. Undergraduate research continues to thrive in the department, with over 40 projects ongoing during the semester and nine summer interns from various universities, colleges, and high schools. We initiated a new series of *Teaching Brown Bags*. Scheduled at lunch time, these informal meetings are dedicated to sharing best practices and discussing new pedagogies in undergraduate teaching, especially in the demanding setting of the large introductory lecture course. Our *graduate program* now offers an informal seminar series, designed to help students learn about departmental research projects and identify advisors. The seminars come with free pizza as an incentive and consist of faculty research presentations, followed by open discussions and lab tours.

*Discovery.* October 2008 saw the announcement of this year's Nobel Prize in Physics. It was awarded to three theoretical physicists, Yoichiro Nambu, Makoto Kobayashi, and Toshihide Maskawa, for their insights into the profound role that symmetries and symmetry violations play in nature. This year's winners are closely linked to Virginia Tech. Physics Professor Leo Piilonen and his colleagues contributed to the experimental confirmation of Kobayashi's and Maskawa's predictions through their research at Japan's High Energy Accelerator Research Organization (KEK). The Nobel Prize winners' research, dating back to 1972, was validated conclusively in 2001 by measurements performed by the Belle experiment, a detector at the High Energy Accelerator Research Organization. In another connection, Lay Nam Chang, dean of the College of Science and a faculty member in the department, was one of Yoichiro Nambu's collaborators from 1969 to 1971. Those years formed part of a period when Nambu's ideas sparked a series of breakthroughs in the understanding of strong interactions, i.e., the forces controlling the binding of neutrons and protons in the atomic nucleus.

Despite severe budget cuts, the department attracted two new faculty members: Dr. Seong Ki Mun, hired as a tenured full professor, will lead a major program in medical imaging and informatics and build a new university focus in neuroscience. Assistant Professor Dr. Vito Scarola will strengthen our programs in computational condensed matter and materials physics.

Three new research thrusts are emerging from the department. First, there is considerable interest in a renewed emphasis on astrophysics. Led by Nahum Arav, a cluster proposal was submitted to the College of Science and was incorporated into a broader focus on "Innovative Technologies & Complex Systems", identified as one of the discovery domains in Virginia Tech's strategic plan. If successful, this initiative will open up significant new funding opportunities. Second, materials research directed towards applications in energy conversion, storage, and efficiency is becoming a growing strength of the department, in support of the discovery domain centered on "Energy, Materials, and the Environment". And third, continuing with the energy theme, the GEM\*STAR initiative will develop new technologies for nuclear energy, based on an accelerator-assisted molten salt reactor design. If successful, it will eliminate the need for uranium enrichment and so, alleviate nuclear proliferation concerns. Clearly, the two initiatives in the energy domain are closely aligned with stated priorities of the Obama administration.

In terms of standard metrics, the department's external research award funding continued its steep growth, to \$3,782,818 (FY08: \$2,750,670), corresponding to a 37.5% increase over FY 08. Our research expenditures are tracking these developments, showing an increase of 35.4%, from \$2,164,475 for FY08 to \$2,929,668 for FY09. The faculty published 142 book chapters, refereed articles and refereed journal proceedings and gave 81 invited and 62 contributed presentations and talks, in 17 different countries on four continents (America, Asia, Australia, and Europe). While the number of publications has remained essentially constant, the number of invited talks has increased significantly over the previous reporting period (81 compared to 55). The wide-ranging spread of

locations, in particular, demonstrates the completely international nature of the physics research community. One provisional patent application and one IP disclosure were filed.

*Engagement.* This year, physics faculty members are very visible as conference organizers on the national and international scene. From a regional workshop series on mathematical physics and string theory to the March Meeting of the American Physical Society, from a local workshop involving regional guests and alumni to a workshop held at a Max-Planck Institute in Dresden with attendees from all over Europe and the US, physics faculty proposed, organized, and led numerous meetings in their field. We continue to engage in a variety of ways with the university and the broader community, including appearances in local and regional media, public lectures, and K-12 outreach. The student-run Physics Outreach Team takes its wide-ranging choice of hands-on physics demonstrations to local and regional schools and participates in many on-campus outreach and recruitment events. Events for alumni, donors, and friends include a reunion at the March Meeting (the premier national conference for most of the department's faculty), the department's Awards Ceremony, and commencement. Sadly, the second "Fun with Physics" event at Virginia Tech's Northern Virginia Center had to be canceled due to inclement weather.

*Development.* This year saw the establishment of several new funds. The Bowden Essay Prize was awarded for the first time, recognizing the writing skills of rising juniors and seniors. The Clayton D. Williams Graduate Fellowship in Theoretical Physics recognizes an outstanding graduate student. The William E. Hassinger Jr. Chair in Physics is now fully endowed and will be awarded for the first time next year. A new donor expressed interest in supporting our Astronomy program, and we will continue to build the relationship. Overall, FY09 donations to the department nearly tripled, relative to FY08. While this looks impressive, one should note that it is due to a single, one-time large donation.

*Diversity.* Women are well represented at the faculty level, with four out of 27 faculty members (15%). This is considerably higher than the national average of 10% for physics departments in Ph.D. granting institutions. Following a very proactive recruitment effort directed at strong female international students, the percentage of women graduate students has now noticeably increased, from 18% last year to 23%, higher than the national average of 19%. At the undergraduate level, women still remain woefully underrepresented. Including the incoming students, women will make up around 12% of our undergraduate students, well below national trends (e.g., women earn 21% of US bachelor's degrees in physics). Numerous conversations with female applicants show that they are aggressively recruited by other, financially stronger institutions. The representation of minorities in the undergraduate population has improved this year. As of Fall 2009, we will have 8 minority students (out of 200) in the department (compared to 5 out of 171 the previous year). This brings us closer to the national averages (Hispanic-Americans earn 4% of BS degrees in physics, and African-American earn 3%). We will continue to work towards increased diversity, through aggressive recruiting and attentive mentoring.

*Honors and Awards.* Faculty, staff, and students received numerous honors and recognitions: Dr. Giti Khodaparast was awarded an NSF CAREER grant; Dr. John Simonetti was recognized with the University Wine Award and a College of Science Certificate for Teaching Excellence; he also received the College of Science Award for Outreach Excellence. Dr. T.S. “Roger” Chang won the 15<sup>th</sup> Annual Students' Choice Award for Faculty Member of the Year as well as the 2009 Sporn Award for Excellence in Teaching Introductory Engineering Subjects. Graduate Coordinator Ms. Chris Thomas was honored with the President’s Award for Excellence. PhD candidate Mike Kavac won the College of Science Outstanding Graduate Student Award, and graduating senior and Goldwater Scholar Kevin Finelli won the College of Science Outstanding Senior Award.

*Goals for 2009-10.* In the area of *Undergraduate Learning*, we will focus on building better career advising opportunities for students planning to work in non-academic environments. We will interface with existing services on campus (Career Services, etc), emerging initiatives (e.g., Experts in Action), and work with and through our own alumni. In addition to providing better career opportunities for our students, this will also strengthen our connections to alumni, donors, and corporate partners. In the area of *Graduate Learning*, we will develop recommended course tracks for graduate students, depending on their chosen research specialization. With the increasing emphasis on interdisciplinary team work across science and engineering and the emergence of new fields at the boundaries of traditional disciplines, we will also conduct a thorough review of our current graduate core courses. With regards to *discovery*, we plan to continue the strategic directions identified as part of our external review process: astrophysics, materials, energy, and soft matter physics, and neutrino physics. Key goals are to increase our external research funding further, to build the critical mass and expertise required for large interdisciplinary proposals, and to enhance our national and international visibility.

The external review committee noted the remarkable progress that the department has made over the past years and emphasized the importance of supporting our continued growth, even in times of limited resources. If resources are allocated strategically and partnerships are developed and cultivated, the department will climb noticeably in the national rankings in the near future. To consider just one ranking system, US News and World Report recently ranked our graduate program at 64 (out of 165 surveyed programs; latest data from 2008). Given the department’s current trajectory, it is entirely realistic to expect it to reach a rank near 40. Even a rank in the top 30 is an achievable goal but would require a massive investment of university or private resources.

Highlights of our activities are included in this report. Further details and relevant links may be found on <http://www.phys.vt.edu/>.

## **Part 2: Academic Accomplishments**

### **I. Learning**

#### **Undergraduate Program**

Our undergraduate program is characterized by its comprehensive course offerings, high standards, and emphasis on individualized student support and mentoring. Both faculty and staff are profoundly committed to these three foundations. To quote our External Review Committee, “The physics majors program represents a real success for Virginia Tech.” The reviewers commented favorably on the “small college feel, with excellent availability of faculty to students.” Undergraduate research continues to flourish, involving many of our own students as well as summer visitors. Student groups such as the Society of Physics Students, the Astronomy Club, and the Ladies of Robeson offer networking opportunities and social activities. Our student exit interviews highlight the breadth of undergraduate research and the supportive community atmosphere as special strengths of the department.

Our *in-major undergraduate program* is strong and enjoys healthy enrollments. Before graduation, our numbers stood at 167 (first and second) majors. With 52 incoming students (45 freshmen and 7 transfers), we expect to reach 200 students this fall. According to national statistics, published by the American Institute of Physics, this places the department into the top ten percent of the 763 degree-granting programs in the country, and into the top third of the 188 PhD granting programs. Compared with programs elsewhere in the country, our student-to-faculty ratio is much higher – approaching 7.4, compared to the more typical 3.6 (2007 Midwestern Physics Chairs data).

This year saw the completion of a significant restructuring of our in-major programs, initiated last year:

- A new course, Mathematical Physics (PHYS 2504) was added to the curriculum;
- A new 4-credit course, Modern Physics (PHYS 3324 – lecture and lab) merges two old courses, namely, Introduction to Quantum and Solid State Physics (PHYS3455) and Introduction to Nuclear and Particle Physics (PHYS 3504);
- Optics (PHYS 4614) is no longer required. The associated lab (PHYS 4624) will be discontinued; the most topical experiments will be incorporated into the Modern Physics Lab (PHYS 3324).
- Several core courses have been shifted to earlier points in the students’ progress towards the BS degree.
- A senior suite of topical electives has been established, designed to introduce students to some of the most exciting problems in fundamental and applied physics.

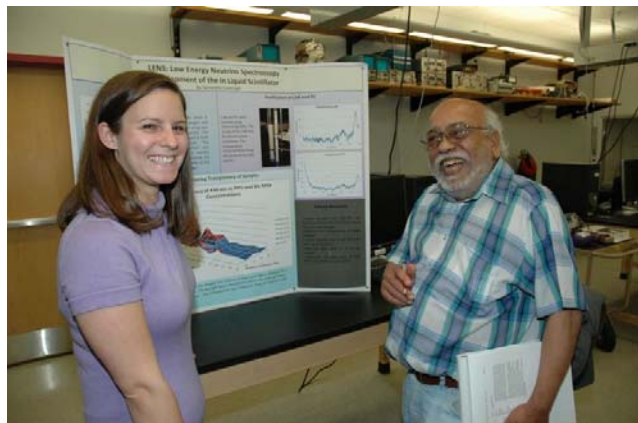
Once the new check sheets are approved, the students will take Intermediate Mechanics (PHYS 3355-3356), Thermal Physics (PHYS 3704), and Senior Quantum Mechanics (PHYS 4455-4456) one semester earlier in their academic careers. As a result, they will experience a better balance of their course loads over their Sophomore and Junior years, and find themselves better prepared for their GRE exams in the fall of their Senior year. The shift also frees up time in the Senior year for a “capstone” experience, such as undergraduate research and the offerings of the “senior suite”. The senior suite currently consists of eight courses: Astrophysics, Biophysics, Computational Physics, General Relativity, Nanotechnology, Optics, Solid State Physics, and Nuclear and Particle Physics. Computational Physics is technically a graduate course (PHYS 5794) but strong undergraduates are welcome to take it.

Five 4000/5000 level courses are now conjoint, carrying both undergraduate and graduate credit:

- PHYS 4504 & 5504 Nuclear and Particle Physics (combines 4504 and 5504)
- PHYS 4574 & 5574 Nanotechnology (previously, 4574)
- PHYS 4614 & 5514 Optics (previously, 4614)
- PHYS 4674 & 5674 Introduction to General Relativity (previously, 4674)
- PHYS 4714 & 5814 Introduction to Biophysics (previously, 4714)

Clearly, this benefits both our undergraduate and graduate programs.

*Undergraduate research* projects continue to be very popular with both faculty and students. Almost all of the faculty serve as mentors; over 40 students are currently engaged in a wide variety of projects. As a result, our students are highly competitive for national awards. This year, David Adams (BS in Physics and Computer Science 2007) won an NSF Graduate Research Fellowship. These are highly competitive fellowships for graduate study, awarded on the basis of a research proposal. David is a graduate student at the University of Michigan, working with Profs. Robert Ziff (Physics and Chemical Engineering) and Len Sanders (Physics) on highly efficient algorithms for percolation problems. While at Virginia Tech, David was involved in several undergraduate research projects with Physics Professors Beate Schmittmann and Royce Zia and Computer Science Professor Alexey Onufriev. In the same competition, Annalisa Pawlowsky (BS Physics 2007, now a graduate student in Health Sciences and Technology at MIT) and Kevin Finelli (BS Physics and Mathematics 2009, headed for graduate school at Duke University) received Honorable Mentions.



*Senior Samantha Cavanaugh and her advisor, Prof. Raghavan, at the Senior Lab Poster Session*

In addition to research opportunities during regular term time, a variety of summer projects are being offered. Typically, a dozen of our own students spend at least part of their summer in the department. In addition, we attracted nine summer research interns from other institutions, including Cornell, UC Boulder, U. Dallas, Bethune-Cookman U., Kenyon College, and several high schools. Max Moe from UC Boulder and Max Lavrentovich from Kenyon College spent two summers in the department (working with Nahum Arav and Royce Zia, respectively). Both won NSF Graduate Research Fellowships this year, for graduate study at Harvard. Out of nine interns, two are female and three are African-American. In order to provide more visibility and stable funding for our summer research programs, the department submitted a proposal to NSF to establish an REU site at Virginia Tech. At this time, the proposal is still pending.

The department delivers a significant *core and service teaching* load. All majors in engineering, building construction, chemistry (BS) and (most in) geosciences (BS) are required to take the four credit hour “Foundations of Physics” sequence (PHYS 2305 and 2306). This calculus-based sequence includes recitation and laboratory sections. The algebra-based two-semester sequence “General Physics” (PHYS 2205 and 2206) is required for Biological Sciences, Biochemistry, HNFE, and Chemistry (BA). About 80% of these students also enroll in the accompanying laboratory sections (PHYS 2215 and 2216). The enrollments for both sequences are large and growing (see data in Part 3). Clearly, such an effort cannot be handled by our “base” of 27 faculty and 26 GTAs. Using enrollment support funds, the department hires 16 additional GTAs and three instructors: T.S. Chang has a regular AY position while Joyce and Kim are term appointments. Even though these arrangements allow us to manage the load, they certainly do not provide for a high-quality teaching and learning environment: Term instructors may leave at short notice, the level of funding varies from year to year, and any medium- or long-term planning is essentially impossible.

We completed a thorough revision and revitalization of all teaching laboratory manuals for our introductory service courses. Contracts with custom publishers were negotiated, reviewed and approved by Legal Counsel, and the new materials will all be submitted to the publishers by the stated deadlines. This project will provide a modest amount of royalty income to the department.

Our *Astronomy program* continues to be very popular with students from a broad range of backgrounds and remains an important recruiting tool for incoming freshmen. Based on data and experiences from peer institutions, the two-semester introductory sequence (which includes a lab) might easily become one of the most attractive science courses on campus; its current enrollment of around 200 students is limited only by the availability of large lecture theaters. Discussions are underway to explore the potential for expansion.

A new initiative, an informal series of *Teaching Brown Bag Lunches*, was launched this year. Faculty and instructors meet regularly to share best practices, discuss new pedagogies, and provide practical advice, with a special focus on large introductory courses. Two kick-off events served to raise awareness for

some of the challenges. Dr. Ruth Howes from Marquette University gave a Special Colloquium on “Enhancing Undergraduate Science Majors: Lessons from Physics” in November 2008, and Dr. Jill Sible from Biological Sciences led a discussion on interactive science teaching. Dr. Howes was the deputy chair of the National Task Force on Undergraduate Physics, initiated by three professional organizations (AAPT, APS, and AIP) and charged with identifying the characteristics of successful undergraduate physics programs. Dr. Sible is the Associate Dean for Curriculum, Instruction, and Advising in the College of Science and a committed advocate of student-centered learning.

As in previous years, the department celebrated its *Awards Ceremony* in the Spring, on April 10, 2009. Nine awards, scholarships, and prizes were given to 28 undergraduates, and eight awards were given to ten graduate students. In all, \$69,500 in funds was distributed. Parents, donors, and friends of the department were invited. After the luncheon and the recognition of the awardees, most of our guests attended a key note lecture presented by Justin Krometis (BS Physics and MS Mathematics 2004), on “How my VT physics degree keeps me one step ahead of disaster”. Justin works for a consulting firm on catastrophic hurricane planning.

**Summary data (student numbers as of April):**

- The total number of physics majors stood at 167 (16 women, 4 minority students) as of April 2009, up 20% from last year (2007-08: 137 in all, 19 women and 1 minority).
- The number of physics minors stands at 13 (2007-08: 11).
- The number of astronomy minors is significant: 29 in total, including 10 females and one minority student (2007-08: 26 total).
- Our graduating class of May 2009 consisted of 20 students (17 BS, 3 BA). Two students received Minors in Physics, and 7 received an Astronomy Minor. Four students were female.
- 10 members of the Class of 2009 will be attending graduate school; one will enter the military; three will enter the general work force and 6 are still undecided.
- The graduating class of 2010 is expected to be quite large, at 27 students.
- About a quarter of our undergraduate students (44 at latest count) are involved in research projects with faculty in the department. As part of his project with Dr. Khodaparast, Justin Waugh spent a month at Hokkaido



*The Class of 2009*

University in Japan. Nine summer interns, including two females and three African Americans, came from other universities or high schools.

- Our current numbers for incoming students continue to be robust. For Fall 2009, 45 freshmen and 7 transfers have accepted admission to the Physics Department; 12 of these are women, and 4 are minority students. Last year, when we attracted 39 new freshmen and 7 transfers.
- We continue to recruit very actively. Diane Walker-Green, our undergraduate coordinator, hosted several Physics Open House and Hokie Focus events, and visited 32 high schools and community colleges in the Northern Virginia, DC, Richmond, and Tidewater areas. She also had the opportunity, thanks to a former summer research student, to visit three schools in Nashville, TN. Faculty and current students attend the on-campus recruiting events in large numbers and are always on hand to meet prospective students and their parents. The Department Chair contacted all admitted students with SATs over 1300, through numerous personal phone calls and e-mails.

### **Graduate Program**

Over the previous two years, the department focused strongly on enhancing our graduate recruitment activities and to provide much better mentoring and advising for students in the program. The activities of this reporting period were designed to solidify these changes and to ensure that all faculty are fully engaged.

Our graduate core curriculum in its current form remains unchanged. Its main purpose is to provide a solid foundation for more advanced study. Student progress towards degree is monitored very carefully, through annual student interviews, written progress reports (jointly completed by students and their advisors), and establishment of stricter time lines for various stages of a student's career. Faculty are strongly encouraged to find funding for additional RA positions and to mentor their students proactively in order to ensure satisfactory progress towards degree.

When interviewed by our External Review Committee, several graduate students requested more opportunities to learn about the available research programs. In response, we established an informal seminar series, held over pizza in the late afternoon. These consist of faculty research presentations, followed by open discussions and lab tours.

The graduate and the undergraduate electives are being aligned more closely. As described above, a suite of topical electives is now offered as conjoint 4000/5000 level courses. As a result, our graduate students now enjoy far more choices at the introductory level, and some faculty time is freed up. This time will be invested in teaching very advanced (6000 level) courses more frequently and with more variability. Recent 6000 level courses included Advanced Quantum Theory (6455-56), Advanced Solid State Physics (PHYS 6555), and General Relativity and Cosmology (PHYS 6675-76).

The quality of our incoming students allowed us to secure several competitive scholarships, namely, an ICTAS, a Cunningham, and a PhD2010 fellowship. PhD candidate Juliette Mammei competed successfully for a Jefferson Sciences Associates Graduate Fellowship.

On February 20-21, 2009, the department held its annual on-campus recruitment weekend for prospective students from the US. The date coincided with the campus-wide Graduate Preview Weekend, so that our visitors could avail themselves of the more general information provided by the Graduate School. The students met with different research groups, toured laboratories, and socialized with faculty and current graduate students.

### **Summary data (student numbers as of April):**

- The total graduate enrollment in physics stands at 68 (12 women, 1 minority), essentially unchanged from last year (66, 8, 1). Given current personnel, financial, and space resources, we are planning to hold our graduate enrollments relatively steady for the next two or three years. This follows two years of significant growth (see data in Part 3).
- There are now 63 students in the Ph.D. program (last year, 57; 2007: 44).
- Two students received their Ph.D. Thananart Klongcheongsan has returned to a position in his native Thailand; Brian Geist is planning to start his own company. Four other PhD degrees will be completed over the coming summer.
- Eight students obtained the M.S. degree. Three of these students are continuing towards the PhD.
- Our incoming class currently stands at 16 acceptances. Of these 16 students, eight come from the U.S. (including two minority students), and eight are international. This corresponds to a much larger fraction of U.S. students than in the previous class. Six students are female, resulting in a strong representation of women in the incoming class. The international students hail from Austria, China, Iran, and South Korea. Two of the eight are exchange students from Spain.
- 8 prospective graduate students were invited to visit the Department, either during our Graduate Preview Weekend or at other times. Three of the invitees will join us this coming fall.
- Of the incoming students, 12 will be supported as GTAs, and one is self-supporting. Three hold scholarships (ICTAS, Cunningham, and PhD2010). That brings the total ICTAS fellowships for the department to two. One student is an EIGER IGERT fellow. Senior graduate student Juliette Mammei competed successfully for a Jefferson Sciences Associates Graduate Fellowship.

## II. Discovery

The Department of Physics at Virginia Tech focuses on two broad areas: Condensed matter and materials physics on one hand, and particle and astrophysics, with a special focus in neutrinos, on the other hand. With 14 faculty members in the first group and 13 in the second, both groups are well balanced. Each comprises experimental and theoretical/computational research efforts. Research thrusts in condensed matter and materials physics focus on nanoscale phenomena in various devices and materials as well as studies of complex systems and self-assembly near and far from thermal equilibrium. Biological and medical physics are growing into larger components of this group. Naturally, this type of research lends itself easily interdisciplinary collaborations, with faculty in the life sciences and engineering. Research efforts in particle and astrophysics typically involve large international collaborations at off-campus facilities all over the world, e.g., Italy (the Borexino Collaboration at Gran Sasso), Japan (the Belle Collaboration at KEK in Tsukuba), and China (the Daya Bay Collaboration), and even in space, e.g., the Hubble Space Telescope and the XMM-Newton X-ray Observatory. These programs project an image of the department far beyond Blacksburg.

October 2008 saw the announcement of this year's Nobel Prize in Physics. It was awarded to three theoretical physicists, Yoichiro Nambu, Makoto Kobayashi, and Toshihide Maskawa, for their insights into the profound role that symmetries and symmetry violations play in nature. This year's winners are closely linked to Virginia Tech. Physics Professor Leo Pilonen and his colleagues contributed to the experimental confirmation of Kobayashi's and Maskawa's predictions through their research at Japan's High Energy Accelerator Research Organization (KEK). The Nobel Prize winners' research, dating back to 1972, was validated conclusively in 2001 by measurements performed by the Belle experiment, a detector at the High Energy Accelerator Research Organization. In another connection, Lay Nam Chang, dean of the College of Science and a faculty member in the department, was one of Yoichiro Nambu's collaborators from 1969 to 1971. Those years formed part of a period when Nambu's ideas sparked a series of breakthroughs in the understanding of strong interactions, i.e., the forces controlling the binding of neutrons and protons in the atomic nucleus.

The department's external research funding continued its steep growth, increasing by 37.5% relative to FY08 (see data in Part 3). Compared to, e.g., FY05, the department has more than doubled its grant income. Research expenditures and overhead returns are following steadily. For example, our research expenditures increased by 35.4%, from \$2,164,475 for FY08 to \$2,929,668 for FY09. Distributed over all research areas and almost all faculty in the department, these funding levels are not only sustainable but likely to grow much further, as various initiatives and collaborative efforts, such as energy-related materials research, the GEM\*STAR initiative, and the push towards a neuroscience program, reach their potential.

Bucking severe budget cuts, the department succeeded in attracting two new faculty members: Dr. Seong Ki Mun, hired as a tenured full professor, will lead a major program in medical imaging and informatics and build a new university focus in neuroscience. He brings broad and deep experience from his previous position at Georgetown University Medical Center as a Professor of Radiology and Associate Vice President for Special Programs. Assistant Professor Dr. Vito Scarola will strengthen our programs in computational condensed matter and materials physics. With a PhD from Penn State and postdoctoral experience at the University of Maryland, the University of California Berkeley, and ETH Zürich, he will build a research group focusing on quantum phenomena in strongly correlated matter and interactions in nanostructures.

Three new research thrusts are emerging from the department. First, there is considerable interest in a renewed emphasis on astrophysics. Led by Nahum Arav, a cluster proposal was submitted to the College of Science and was incorporated into a broader focus on “Innovative Technologies & Complex Systems”, identified as one of the discovery domains in Virginia Tech’s strategic plan. If successful, this initiative will open up significant new funding opportunities. Second, materials research directed towards applications in energy conversion, storage, and efficiency is becoming a growing strength of the department, in support of the discovery domain centered on “Energy, Materials, and the Environment”. We are exploring the possibility of pursuing some of our interests in soft condensed matter within this framework. And third, continuing with the energy theme, the GEM\*STAR initiative will develop new technologies for nuclear energy, based on an accelerator-assisted molten salt reactor design. If successful, it will eliminate the need for uranium enrichment and so, alleviate nuclear proliferation concerns. The GEM\*STAR group, led by Bruce Vogelaar from Physics and Mark Pierson from Mechanical Engineering, has received seed funds from central university sources and the college and is also aggressively seeking support through DOE stimulus funds and specifically, the new Advanced Research Projects Agency – Energy (ARPA-E) initiative. Clearly, these initiatives in the energy domain are closely aligned with stated priorities of the Obama administration.

Several other requests for stimulus funding are pending. The DOE-supported high energy group, led by Prof. Leo Piilonen, submitted a (solicited) proposal for approximately \$0.5M. The request involves \$125K for an upgrade of high voltage equipment for the Belle Collaboration, and \$400K for a major expansion of the department’s high performance infrastructure. If successful, the department will place its “Thunderbird” computing cluster on the OpenScienceGrid (OSG). The OSG is a national grid computing venture, jointly funded by NSF and DOE, and the Physics Department would be the first Virginia Tech participant in this growing enterprise. OSG membership will permit other DOE research programs to make use of this computing resource through their OSG Virtual Organizations, and in return, Virginia Tech will get access to the computing resources at other OSG institutions and the TeraGrid. The goal is to leverage local computing

resources nationally, to provide value to a much broader community of funded research groups.

A second proposal, requesting \$3.2M of NSF Academic Research Infrastructure funds for a partial renovation of Robeson, was submitted for internal review but unfortunately declined. The goal was to renovate the Robeson Hall Van de Graaff facility (“the Robeson Vault”) so as to accommodate three research laboratories, the department’s high performance computing training facility, as well as office space for graduate and undergraduate students engaged in research. The Robeson Vault used to house a vertical Van de Graaff accelerator for nuclear physics research. The accelerator was decommissioned and removed in 1975. The area has a foot print of 700 square feet and spans a height of four floors. An adjacent ground floor room covers 500 square feet and has a height of two floors. These spaces are currently unused. A renovation would add 3,300 square feet of research and research training space to Robeson Hall and provide a home for the “Complex Systems and Materials Group (CoSyMa Group)” whose research focuses on strategic university priorities in nanoscale materials, energy research, and nonlinear dynamic complex systems. We will pursue these opportunities further.

First initiated by Prof. Bruce Vogelaar as part of an attempt to attract a national laboratory for underground science to Virginia Tech, the Kimballton Underground Research Facility (KURF) continues to grow. Four universities (Duke through TUNL, NCSU, UNC, and Virginia Tech) currently conduct experiments in the space. Duke and UMD/NIST have requested additional space starting this fall. Princeton University has expressed interest in locating an Argon detector at KURF. A Users Group is being formed, and a shared cost structure to cover access, utilities, and a possible expansion of the facility is under discussion. At present, there are 12 research scientists and postdoctoral associates working with faculty in the department. They have a significant effect on our research productivity and form an essential component of every start-up package. Two further hires are in progress.

### **Summary data:**

- **Research Highlights:**
  - Dr. Nahum Arav, a recent hire in astronomy/ astrophysics, has built a strong and successful research group, including a senior research scientist, a postdoc, a graduate student and several undergraduate researchers. Dr. Arav moved some of his existing funding from UC Boulder to Virginia Tech and rapidly acquired significant amounts of new funding: \$342K for FY09, with an



*The Arav group is using the Hubble space telescope to determine the chemical composition of active galactic nuclei*

additional \$111K credited to his research scientist, Manuel Bautista.

- Our most recent hire, Dr. Patrick Huber, is the main author of the GLOBES software package, which has become the standard tool for planning and performance assessment of current and future neutrino oscillation experiments. He is continuing to develop this software. In particular, the ability to fit actual experimental data has been added and a new release is planned for Fall 2009.
- Assistant Professor Giti Khodaparast was awarded a highly prestigious CAREER award from the NSF, entitled "CAREER: Integrated Research and Education to Probe Coherent and Quantum States in the Presence of Strong Spin-Orbit Coupling."
- Dr. Rahul Kulkarni developed a novel computational approach for predicting new members of the quorum-sensing regulon in the *Vibrios*. In collaboration with Dr. Jay Zhu from the University of Pennsylvania, he was able to show that this approach leads to the discovery of far more (22) new direct targets and corresponding binding sequences of the quorum-sensing master regulator in *Vibrio cholera* than what had been possible before.
- As part of a Summer Faculty Fellowship at the National Center for Supercomputing at the University of Illinois at Urbana-Champaign, Dr. Kyungwha Park improved the parallelization of quantum transport code SMEAGOL. This code is distributed free of charge to all academic users.
- Prof. Michel Pleimling and Prof. Prof. Christian Binek from the University of Nebraska are collaborating on an experimental study on aging phenomena in artificial antiferromagnets, seeking experimental verification of Pleimling's theoretical predictions.
- On March 3, 2009, Dr. Leo Piilonen was elected Institutional Board Chair of the newly formed Belle II collaboration, the successor to the ongoing Belle collaboration. The Belle II collaboration will accumulate two orders of magnitude more data than Belle in its continuing study of heavy-quark and tau-lepton physics. As IB Chair, Piilonen will be in charge of policy formulation, new member applications, and election of the Belle II spokesperson.
- Dr. Pitt is a key member of the 12 GEV Moller Collaboration at the Jefferson Lab. The collaboration is developing a new Standard Model test planned for the JLAB 12 GeV upgrade. Pitt has been involved with this initiative since its beginning. The JLAB Program Advisory Committee approved it in January 2009.
- Led by faculty members Raju Raghavan and Bruce Vogelaar, a vigorous collaboration consisting of core groups at Virginia Tech, Louisiana State University, Indiana University, Brookhaven National Laboratory, the University of North Carolina and North Carolina State University submitted a \$2.2M proposal to NSF, to begin the engineering phase of a

- full scale detector for low-energy solar neutrino spectroscopy (LENS). LENS will form part of NSF's Deep Underground Science and Engineering Laboratory (DUSEL).
- Physics faculty members Hans Robinson and Randy Heflin, together with their colleague Rick Davis (ChemE), filed an IP disclosure on “Selective Functionalization and guided Assembly of Nanoparticle Molecules.”
  - Drs. Vicki Soghomonian and Jean Heremans, in collaboration with S. Priya (MSE), have developed a new class of ultracapacitors based on electrically conducting zeolite-like materials (e-ZLM). Ultracapacitors are a green alternative to batteries in a wide range of applications and have advantages that include reliability, temperature range, greater number of recharging cycles and shorter charging times. e-ZLMs promise to dramatically improve ultracapacitor capabilities by increasing both energy and power densities. Soghomonian and Heremans also submitted a US provisional patent application on their invention.
  - Physics faculty member John Simonetti and his ECE colleagues Ellingson and Patterson have constructed the *The Eight-meter-wavelength Transient Array (ETA)* of low-frequency radio antennas, with receivers and a cluster of real-time computing resources. The Virginia Tech team has initiated a collaboration with LIGO, in which the ETA will act as an “external trigger” for searches within the LIGO data for gravity wave signals. Possible events that would produce both a gravity wave signal and an electromagnetic signal include the in-spiral and coalescence of a compact-object pair (e.g., neutron star and neutron star), supernovae, gamma-ray bursts, and the cusps of superconducting cosmic strings. LIGO – which stands for Laser Interferometer Gravitational-Wave Observatory – is an international collaborations of about 50 universities and institutes dedicated to the detection of gravitational waves.
  - Publications and presentations (counts for CY 2008):
    - Since publications are by calendar year and counts for fiscal years are very difficult to produce, we report CY publications here. 142 journal articles, book chapters, and refereed proceedings were published in 2008. This productivity has stayed roughly constant since 2007.
    - Also for CY 2008, the physics faculty reported 81 invited and 62 contributed presentations and talks, in 17 different countries on four continents (America, Asia, Australia, and Europe). Here, we note a major increase relative to 2007 when 55 invited talks were reported. A few selected invited talks are listed below:
      - Nahum Arav, Munich Joint Astronomy Colloquium. Munich (Germany), March 2009
      - Djordje Minic, *University of Edinburgh workshop on Thermodynamics of Space-Time*. Edinburgh (UK), Summer 2008.

- Kyunghwa Park, *4th International Workshop on Nanomagnetism*. Coma-Ruga (Spain), July 2008
- Mark Pitt, *International Conference on Particles and Nuclei (PANIC08)*. Eilat (Israel), November 2008.
- Uwe Täuber, *Second Annual French Complex Systems Summer School*. Paris (France), August 2008.
- Royce Zia, *34th Conference of the Middle European Cooperation (MECO) in Statistical Physics*, Leipzig (Germany), March 2009; *Workshop on Steady States, Fluctuations and Dynamics of Nonequilibrium Systems*, Weizmann Institute and Technion (Israel), June 2009.
- Conferences, workshops, and distinguished lectures organized by Physics faculty:
  - Dr. Mario Livio, the Head of the Office of Public Outreach at the Space Telescope Science Institute, gave a very well attended public lecture, entitled “Is God a Mathematician?” The lecture on March 26, 2009 and the surrounding events were organized by Nahum Arav.
  - Minic and Sharpe are starting a series of regional meetings, focused on the intersection of mathematics and string theory. These meetings involve Virginia Tech, Duke University, the University of North Carolina and North Carolina State University. The first meeting took place at Duke in April 2009.
  - Pleimling, Täuber, Schmittmann and Kiang (Rice) are the scientific organizers of the *2009 Boulder School for Condensed Matter and Materials Physics on Nonequilibrium Statistical Mechanics: Fundamental Problems and Applications*, Boulder, CO, 6-24 July 2009.
  - Pleimling, together with colleagues from France, Israel, and Germany, was the organizer for the *Workshop on Many-Body Systems far from Equilibrium: Fluctuations, Slow Dynamics and Long-Range Interactions*, Max Planck Institute for Physics of Complex Systems, Dresden, Germany, 16-27 February 2009.
  - Schmittmann was one of 20 Program Chairs for the 2009 March Meeting of the American Physical Society. The March Meeting is the largest professional meeting of physicists in the US. It is attended by approximately 6,000 scientists.
  - Schmittmann and Zia organized an informal *Workshop on Non-Equilibrium Statistical Mechanics: A Bridge from Physics to Biology*, at Virginia Tech, 11 December 2008.
  - Many faculty members proposed and chaired sessions or served on panels at various national and international meetings, including Huber, Khodaparast, Kulkarni, Pleimling, Raghavan, Schmittmann, Sharpe, Täuber, and Zia.

### **III. Engagement**

Members of the physics department are engaged in a multitude of activities, reaching far beyond the boundaries of the department. Within the university, physics is a key player in the nanoscience and materials arena, through linkages within the College of Science, to ICTAS and the College of Engineering. Physics faculty members serve on college and university committees; they are members of several interdisciplinary centers or serve their collaborations in leadership positions; and they serve on advisory boards or executive committees for on- and off-campus partners.

It is equally essential to reach out beyond the campus and our immediate research environments. Relations with alumni, donors and friends of the department, major corporations, regional schools, and the media continue to be nurtured through a variety of events, activities and newsletters. Within their professional communities, faculty referee extensively for journals and funding agencies. Several of them have organized conferences and hold leadership positions in their professional organizations.

At a more educational level, our student-run outreach program, which brings physics to K-12 students in local schools, continues to thrive. Participating undergraduates usually return to their studies with more enthusiasm and motivation. The “Outreach Team” is frequently invited to support on-campus outreach events, such as the Johns Hopkins “Center for Talented Youth” programs, the College of Engineering “Engineering Camp”, or the “Higher Achievement” initiative. As part of our recruitment efforts, high school students and undergraduates from other institutions participate increasingly in summer research opportunities within the department.

A small reunion took place at the March Meeting of the American Physical Society, the premier US physics conference. About 20 alumni, current “Hokies” and friends gathered in a comfortable Italian restaurant in Pittsburgh, on March 17. Our second “Fun with Physics” event at Virginia Tech’s Northern Virginia Center was scheduled to take place on March 1. However, that day saw a major snow storm in the Northern Virginia area and we decided to cancel to keep everyone safe.

Some other highlights of our activities are listed below:

- The Physics Outreach Team organizes frequent visits to local and regional K-12 classes/student groups and gives informative and entertaining physics presentations with hands-on demonstrations. It also frequently contributes to on-campus events for K-12 groups, such as the Center for Talented Youth visit on March 22, 2009.
- Faculty members Jean Heremans and Vicki Soghomonian are developing a collaboration with Salem High Schools on cross-departmental as well as Physics Department scientific outreach to high school students. They are also

building an outreach pipeline to the Southwest Virginia Higher Education Center in Abingdon, VA. These activities are part of a partnership with the VT-STEM group and a MRSEC/STC proposal initiative to create a Center for Design and Delivery of Macromolecular Therapeutics.

- Dr. John Simonetti was part of a faculty team from the College of Science (Biological Science, Chemistry, Geosciences, Mathematics, and Physics) which prepared and submitted an NSF grant proposal for assistance to K-12 science teaching in this area of Appalachia: “*GK-12, Appalachian Partners Promoting Learning and Education in Science, Technology, Engineering, and Math (APPLESTEM)*.” The first submission was declined, but the team has focused its efforts and will resubmit this summer.
- John Simonetti serves on the Science Curriculum Advisory Committee for the Montgomery County Schools.
- Two important annual events are the Awards Ceremony (April 10, 2009) and Commencement (May 16, 2009). These celebrations highlight the achievements of our students to family members and friends as well as donors and alumni.
- The Physics Department hosted an Alumni Reunion at the APS March Meeting in Pittsburgh, PA (March 17, 2009).
- Research projects by physics faculty were featured in the national and regional media. Weblinks to all of these articles can be found in the *News* column at <http://www.phys.vt.edu>:
  - Prof. John Simonetti spoke on WSLS-TV about the Perseid Meteor Shower (August 2008)
  - WDBJ-7 interviewed Prof. Leo Piilonen regarding the Large Hadron Collider (September 11, 2008)
  - Recent work by Profs. Minic and Heremans was profiled in the *New Scientist* (October 2, 2008)
  - Prof. Patrick Huber’s research was featured in the *New Scientist* magazine (October 14, 2008)
  - The Kimballton Underground Research Facility was featured in the *New River Valley Magazine* (January 16, 2009) and the *Roanoke Times* (March 29, 2009)
  - Prof. Nahum Arav was profiled in a *Roanoke Times* article: “Professor works to bring stars a little closer” (January 20, 2009)
  - Prof. John Simonetti and his collaborators were featured on the Virginia Tech main page, under “Spotlight on Innovation: Virginia Tech physicists and engineers search for new dimension.” (April 2009)
  - The GEM\*STAR initiative was profiled in the *Roanoke Times* (May 5, 2009) and the *Los Alamos Monitor* (May 31, 2009)

- International engagement activities of Physics Faculty:
  - Djordje Minic was a Visiting Fellow of Merton College at Oxford University (Summer 2008).
  - Tetsuro Mizutani is part of a team of US physicists, including faculty from the University of Virginia, Vanderbilt, who will be visiting the University of Hue (Vietnam) in June 2009. He will be teaching a course on quantum mechanics to Hue students.
  - Tatsu Takeuchi was invited by the newly created *Institute for the Physics and Mathematics of the Universe* at the University of Tokyo. He spent November 2008 there, attending talks on astrophysics and especially, learning about new cosmic ray data collected by the PAMELA and ATIC experiments which could be evidence for the existence of an heretofore unknown dark matter particle.
- Physics faculty members presented numerous talks for general audiences:
  - In December 2008, Nahum Arav spoke to an audience of 250 retirees about “The Modern Universe”, at the Mediterranean Towers near Tel Aviv, Israel. In June 2009, he also gave a presentation on “Astronomy: Your Insight into the Sky” at the 2009 *Circle of Excellence Conference* to the *Women in Leadership and Philanthropy*.
  - Giti Khodaparast gave two lectures on modern topics in physics, including nanoscience, at the Roanoke Valley Governor’s School (Fall 2008)
  - In November 2008, Jonathan Link gave a public lecture at Bluefield State College (an HBCU), on “Particle Physics and Massive Neutrinos”. He also participated in the 2008 “Summer around the Drillfield” activities and gave a talk on nuclear energy.
  - Djordje Minic gave several popular lectures, at different institutions, on the “*Magic cube of Physics*”.
  - John Simonetti spent a day at the Astronomy Elderhostel at the Mountain Lake Hotel and Wilderness Conservancy and lectured on “Cosmology” (October 2008)
- The professional service activities of physics faculty members span a broad range:
  - Dr. Heflin serves as an Editorial Board Member of the *International Journal of Nanoscience*.
  - Dr. Heremans is active in the Forum on Industrial and Applied Physics (FIAP) which is one of the subdivisions of the American Physical Society.
  - Dr. Huber is Chairman of the Physics and Performance Evaluation Group of the International Design Study for a Neutrino Factory (IDS-NF); he is also an *ex-officio* member of the Steering Group of IDS-NF
  - Dr. Link serves on the Institutional Board of the Daya Bay Collaboration. He is also the Chair of the Talks Committee of the MiniBooNE Collaboration, and a member of the Talks Committee of the Daya Bay Collaboration.

- In March 2009, Dr. Piilonen was elected Institutional Board Chair of the newly formed Belle II collaboration, the successor to the ongoing Belle collaboration. The Belle II collaboration will accumulate two orders of magnitude more data than Belle in our continuing study of heavy-quark and tau-lepton physics. As IB Chair, he is in charge of policy formulation, processing of new member applications, and election of the Belle II spokesperson.
- Dr. Piilonen serves on the Ad Hoc Committee on Authorship in High Energy Physics, convened by IUPAP's C11 Commission on Particles and Fields.
- Dr. Pitt is a member of the Executive Committees of two leading experiments at Jefferson National Laboratories, G0 and Qweak.
- Dr. Pleimling continues to serve as reviewer and panelist for the European Commission's prestigious Marie Curie Fellowship program. He also served as panel member for NSF's *Office of Cyberinfrastructure*.
- Dr. Raghavan is a member of the International Advisory Committee for Neutrino Champagne, Reims (France)
- Dr. Schmittmann serves as Chair of the Group for Statistical and Nonlinear Physics of the American Physical Society (APS). She is an Editorial Board Member for *Physical Review E* and the *American Journal of Physics*.
- Dr. Täuber is a member of the Editorial Board of the electronic journal *Research Letters in Physics*, and an Advisory Panel member for the *Journal of Physics A*.
- A few highlights of university service are provided below:
  - Dr. Blecher serves on the Personnel Committee, College of Science.
  - Dr. Heflin serves on the ICTAS Sustainable Energy Group Steering Committee.
  - Dr. Heremans served on the ICTAS Faculty Advisory Board and the MicrON Group Executive Committee.
  - Dr. Khodaparast serves on the Executive ("Core", "Cluster") Search Committee, College of Science. Replacing Dr. Heremans, she now also serves on the ICTAS Faculty Advisory Board.
  - Dr. Piilonen chairs the College of Science Curriculum Committee.
  - Dr. Robinson served on the MicrON Cleanroom Executive Committee.
  - Dr. Simonetti served as Physics and College of Science Liaison in the ABET accreditation process for the College of Engineering.
  - Dr. Täuber serves on the Investigative Board and the Judicial Panel for the Graduate Honors System. He also serves on the Graduate Honor System Constitutional Revision Committee.

- Departmental service remains an important component of our activities:
  - Faculty members serve on one or more departmental committees. Departmental committees include standing committees: the Executive Committee, Faculty Evaluations Committee, Graduate Committee, Graduate Recruitment Committee, Undergraduate Committee, Undergraduate Committee, Shop and Safety Committee, Colloquium Committee, and the Seminar Committee. In addition, there are ad-hoc committees dealing with Outreach and K-12, Undergraduate Research, Cluster Hire Search/Screening, Computational Facilities and the Department Review.
  - Faculty members also serve in other capacities, individually: Astronomy Club Advisor (Dr. Simonetti), Demonstrations Supervisor (Dr. Pitt), Diversity Contact (Dr. Park), Martin Observatory Coordinator (Dr. Simonetti), Lab coordinator for ChemPhys Building (Dr. Pitt), Prices Fork Observatory Coordinator (Dr. Simonetti), Society of Physics Students Advisor (Dr. Soghomonian), Sigma Pi Sigma Advisor (Dr. Pitt), Webmaster (Dr. Takeuchi, with assistance from Ms. Betty Wilkins).

#### IV. Diversity Activities

Women are well represented at the faculty level, with four out of 27 faculty members (15%). This is considerably higher than the national average of 10% for physics departments in Ph.D. granting institutions. By Fall 2009 (i.e., counting the incoming class), the percentage of women graduate students will have increased noticeably compared to Fall 2008, from 18% to 23%. These numbers put us slightly above the national average of 19%. They reflect very pro-active recruiting of strong female international students. At the undergraduate level, women still remain woefully underrepresented. Including the incoming students, women will make up around 12% of our undergraduate students, well below national trends (e.g., women earn 21% of US bachelor's degrees in physics). Numerous conversations with female applicants make it clear that we are seriously disadvantaged by the lack of recruitment incentives for promising women.

The “Ladies of Robeson”, a networking group consisting of all women in the department (faculty,



*The Ladies of Robeson and friends at their end-of-term party*

students, and staff) continues to flourish. In our exit interviews, the “Ladies of Robeson” group is mentioned frequently as a source of support and information, regarding course work, research opportunities, and preparation for graduate school.

The representation of minorities in the undergraduate population has improved this year. As of Fall 2009, we will have 8 minority students (out of 200) in the department (compared to 5 out of 171 the previous year). This brings us somewhat closer to the national averages (Hispanic-Americans earn 4% of BS degrees in physics, and African-American earn 3%). We will continue to work towards increased diversity, through aggressive recruiting and attentive mentoring.

Some other highlights of our activities are listed below:

- In November 2008, Dr. Jonathan Link gave a public lecture at Bluefield State College (an HBCU), on “Particle Physics and Massive Neutrinos”.
- Mark Pitt’s student Juliette Mammei was awarded the Jefferson Sciences Associates Graduate Fellowship.
- Hispanic physics undergraduate Jose Umanzor-Alvarez was accepted into an NSF-funded REU program at Harvard’s School of Engineering & Applied Sciences. The program will take place in the summer of 2009.
- Our summer research internships attract women (two out of nine) and minorities (three out of nine). Dr. Arav hosted two female students from Cornell and UC Boulder; Dr. Soghomonian hosted two African American high school students. Dr. Schmittmann mentored a McNair Scholar.
- Dr. Schmittmann continues her work on behalf of the Virginia Tech *AdvanceVT* program. She serves as Co-PI on this NSF award (\$3.5M for 5 years, on NCE).
- Dr. Simonetti plays a lead role in the *Phoebe’s Field* project. Led by Mitzi Vernon from the Industrial Design department in CAUS, an interdisciplinary team of designers, engineers and physicists is developing a traveling exhibition, illustrating the concept of physical fields for elementary and middle school children, especially girls. A major proposal to NSF will be (re-) submitted this summer.
- Dr. Soghomonian established pipelines for graduate students, through the submission of collaborative grants with Virginia HBCUs. She also sought to build pipelines for undergraduate students in science and engineering from economically disadvantaged regions of the state, by leading workshops for high school teachers.
- As every summer, Dr. Takeuchi visited Ochanomizu Women’s University in Tokyo during the summer of 2008 to educate and recruit gifted female students. He also acts as English advisor there.

## V. Honors and Awards

At all levels, members of the physics department have been honored in a multitude of ways. Following are the highlights.

### Faculty

- Dr. Giti Khodaparast received an NSF CAREER Award, entitled “CAREER: Integrated Research and Education to Probe Coherent and Quantum States in the Presence of Strong Spin-Orbit Coupling.”
- Dr. T.S. “Roger” Chang received the 2009 Faculty Appreciation Day Students' Choice Award for Faculty Member of the Year. He also won the 2009 Sporn Award for Excellence in Teaching Introductory Engineering Subjects.
- Dr. John Simonetti was recognized multiple times, for his outstanding contributions to the university's learning and engagement missions: He received a College of Science Certificate of Teaching Excellence and also won the University Wine Award for Excellence in Teaching. In addition, he was honored with the College of Science Award for Outreach Excellence.

### Staff

- Graduate Program Coordinator Chris Thomas was awarded the President's Award for Excellence.

### Graduate Students

- Michael Kavic was named the 2008-2009 Outstanding Doctoral Student for the College of Science.
- An essay by graduate student Michael Kavic, Profs. Djordje Minic and Chia Tze, and Dr. Vishnu Jejjala received an honorable mention in the 2009 Gravity Research Foundation Essay Competition.
- Zach Lewis (Advisor: Tatsu Takeuchi) won the Commendation Award in the 2009 Graduate Teaching Assistant Excellence Award competition.
- Sven Dorosz (Advisor: Michel Pleimling) was recognized as the *Featured Graduate Student of November 2008*. He also received the College of Science 2009 Roundtable “Make-a-Difference” Scholarship for Graduate Studies.
- Mark Pitt's student Juliette Mammei was awarded the Jefferson Sciences Associates Graduate Fellowship.
- Eight graduate students were inducted into Sigma Pi Sigma, a national honor society for Physics Students, at a banquet attended by faculty, staff, parents, and family members. Dr. Piilonen gave a talk on “What is Science?”
- Eight departmental awards/scholarships were presented to eleven graduate students.

## **Undergraduate Students**

- Goldwater Scholar Kevin Finelli, Physics '09, is the College of Science Outstanding Senior for 2009.
- In February of 2009, the local Society of Physics Students chapter was named an Outstanding SPS Chapter for 2007-08. The SPS is a national organization for physics students, providing scholarships, networking opportunities and career advice.
- David Adams (BS in Physics and Computer Science 2007), currently at the University of Michigan, won an NSF Graduate Research Fellowship. These are highly competitive fellowships for graduate study, awarded on the basis of a research proposal. In the same competition, Annalisa Pawlowsky (BS Physics 2007, now a graduate student in Health Sciences and Technology at MIT) and Kevin Finelli (BS Physics and Mathematics 2009, headed for graduate school at Duke University) received Honorable Mentions.
- Nine departmental awards/scholarships were presented to 28 undergraduate students.
- Seven undergraduates were inducted into Sigma Pi Sigma, a national honor society for Physics Students.
- 39 Physics majors made the Fall 2008 Dean's List.

## **VI. Future directions**

Science is evolving into a seamlessly interdisciplinary, global endeavor integrating “upstream” fundamental research with “downstream” technology transfer. Physics, arguably more than many other fields, spans the whole breadth of this vast range. On the one hand, physicists are probing the very fabric of matter and space-time; on the other hand, they are at the forefront of addressing society’s most urgent problems, such as energy security, climate change, and public health. The challenge for a department such as ours will be to *integrate* these diverging directions, in an environment of *severely limited* resources. If it succeeds, its continued, and growing, vibrancy will be assured.

Our undergraduate programs are thriving, thanks to strong enrollments, high expectations, and a very supportive climate. The emphasis here will be on nurturing these strengths. Our graduate program has seen major growth in student numbers. In a next step, we need to review our curricular content and the professional development of our students, in order to prepare them for the interdisciplinary, global character of academic and private sector work environments.

In order to span the full range of research endeavors, from the fundamental to the applied, the department needs to develop its programs in astroparticle physics, in materials, and in biological and biomedical physics. Synergies and

cross-fertilizations between these fields exist (e.g., in detector development, data management, and biofunctionalized materials) and must be exploited; the Virginia Tech environment offers rich opportunities for collaborations.

The department is undergoing a significant generational change. Six faculty members are near the traditional retirement age. The impending transition poses major challenges, in terms of faculty hires, competitive start-up packages, and high-quality research space. These challenges will need to be managed carefully to avoid placing heavy burdens (of teaching or service) on younger faculty which might impact their research productivity.

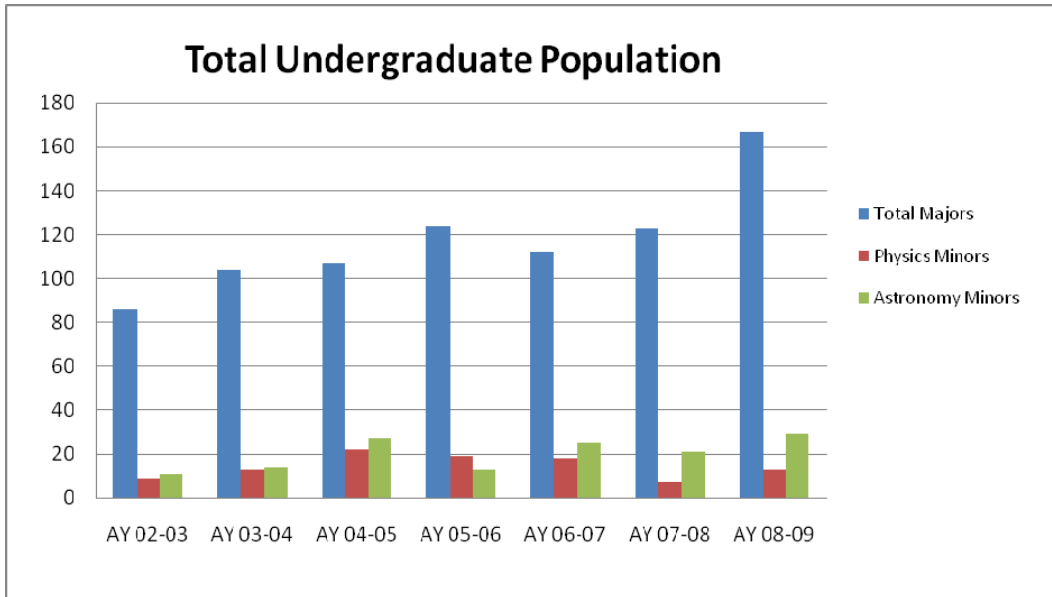
Pursuing large scale funding opportunities, especially in leading roles, will be a high priority for the department. To be competitive for a Materials Research in Science and Engineering Center (MRSEC) or a Physics Frontier Center (PFC), a unique research portfolio is essential. Other building blocks are also critical: outstanding faculty with strong funding records; accomplishments in student training (through successful REU and IGERT grants); strong university support, in terms of research space and large-scale shared experimental facilities, and vibrant K-12 outreach programs and diversity efforts. Other factors, such as corporate connections, partnerships with other universities or national labs, and international outreach, will also be key factors. Some of these components are already strong, others are evolving, and yet others will be actively developed over the coming years.

The external review committee noted the remarkable progress that the department has made over the past years and emphasized the importance of supporting our continued growth, even in times of limited resources. If resources are allocated strategically and partnerships are developed and cultivated, the department will climb noticeably in the national rankings in the near future. We are currently ranked in the top third of US PhD granting departments. For example, US News and World Report lists the department at 64 (out of 165 surveyed graduate programs; latest data from 2008). Given the department's current trajectory, it is entirely realistic to expect us to reach a rank near 40. Even a rank in the top 30 is an achievable goal but would require a massive investment of university or private resources, into faculty positions, graduate student stipends, and space.

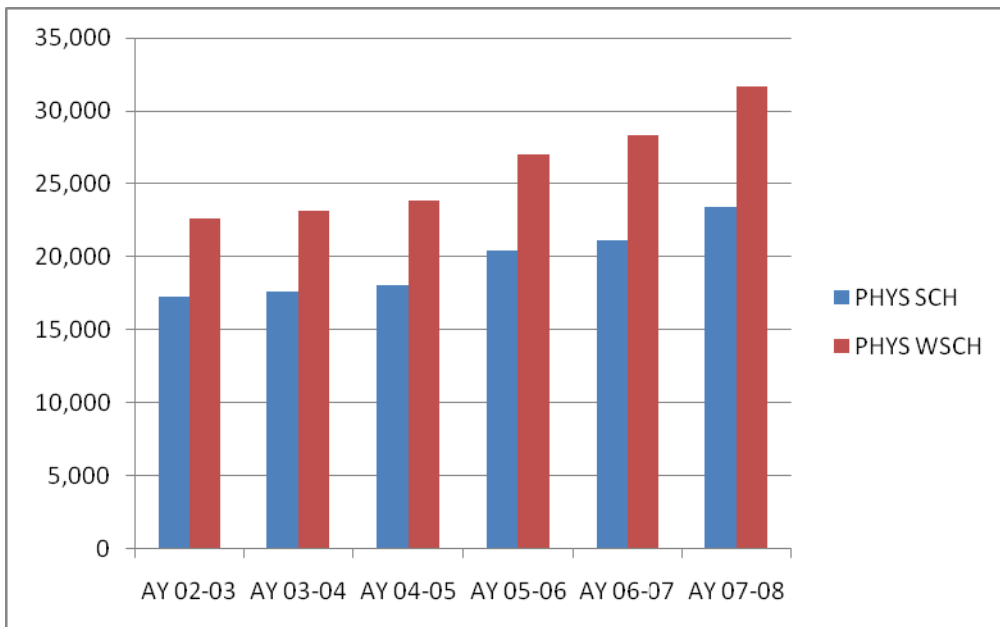
## Part 3: Data and Trends

### Enrollments:

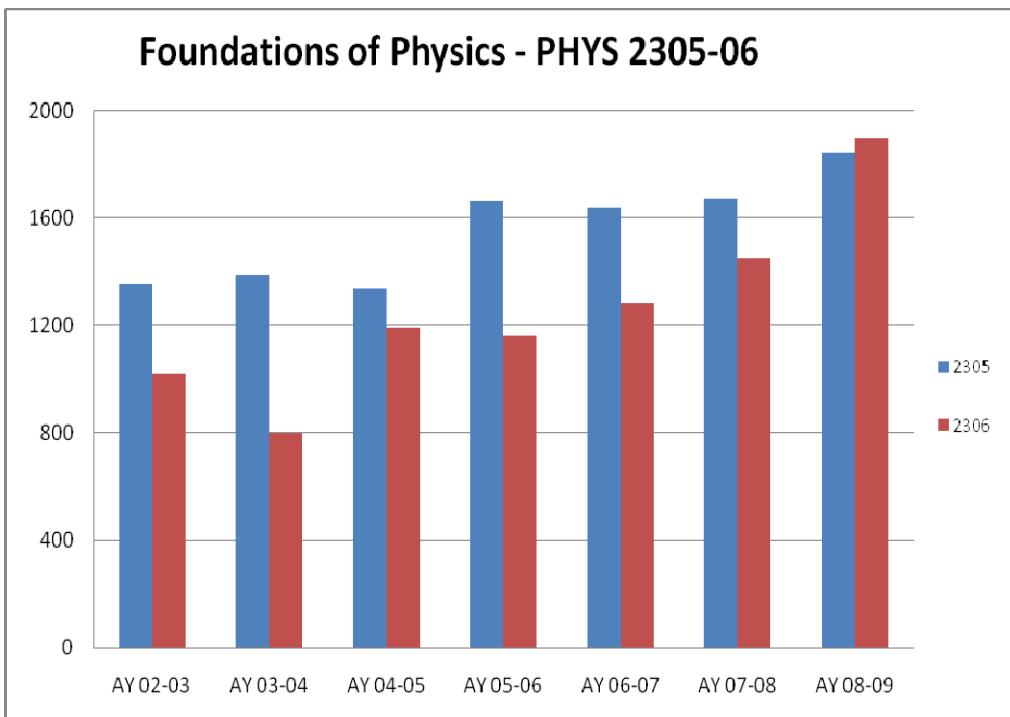
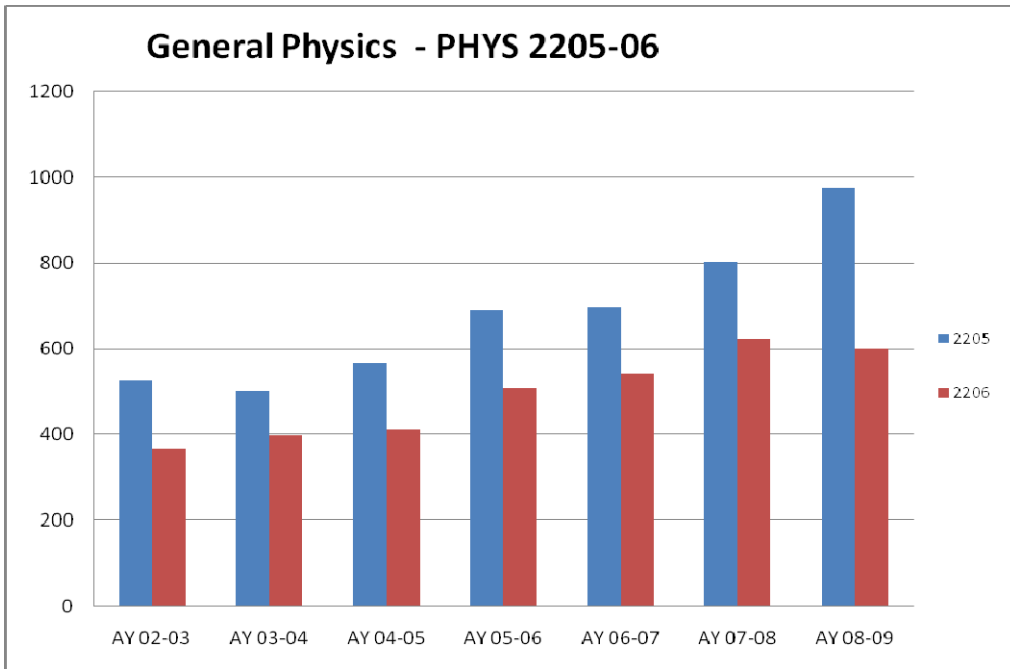
#### Physics majors (first and second), physics minors, and astronomy minors (department data)



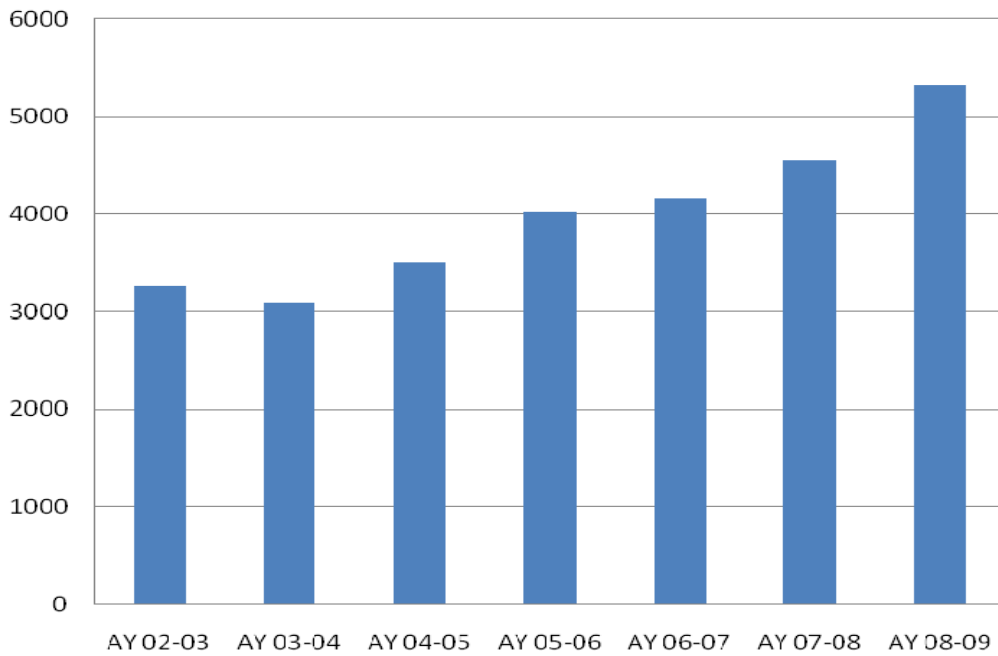
#### Student credit hours (data from Institutional Research)



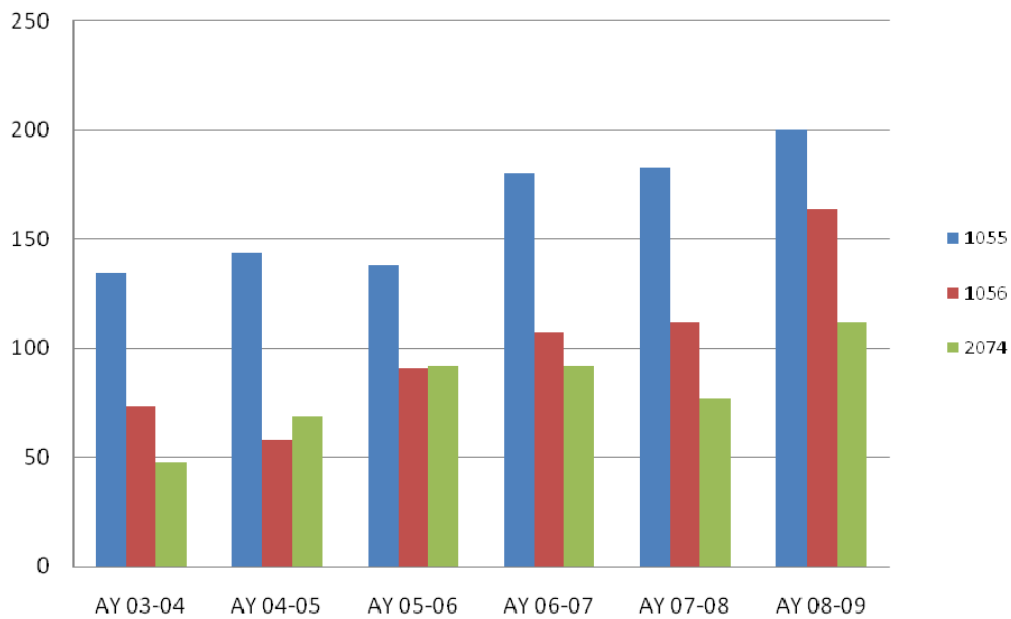
### Enrollments in core and service courses (department data)



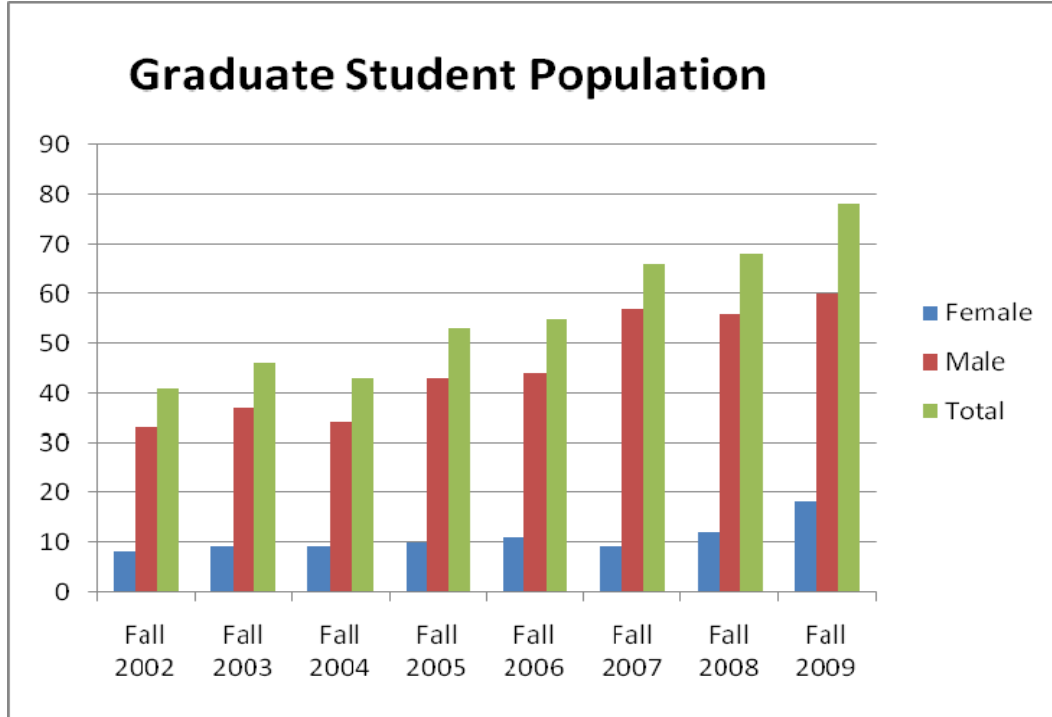
### Seats in PHYS 2205-06 and 2305-06, by year



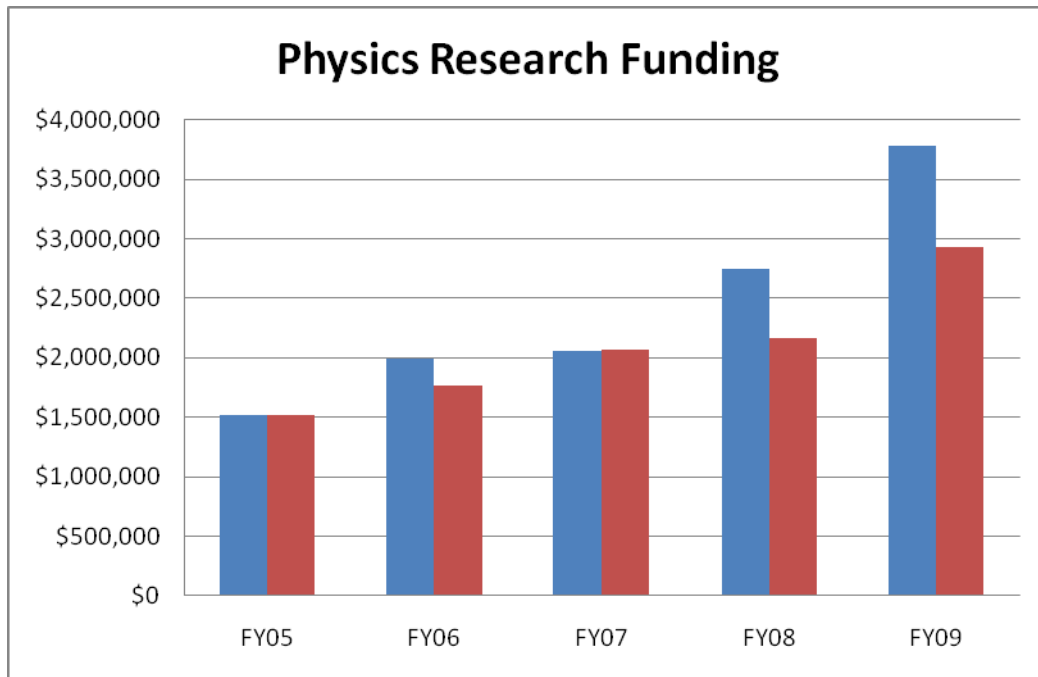
### Enrollments in Introductory Astronomy and Contemporary Physics



## Graduate Enrollments (department data)



## Research awards and expenditures:



The chart shows research funding in Physics over the past five fiscal years (from Data Warehouse). The blue (red) bars show new awards (research expenditures) for the indicated period.

Internal awards are not captured by these figures.

- Drs. Kulkarni and Schmittmann (until October 2008) are part of the EIGER project. Administered in Geosciences, this IGERT grant supports one graduate student in physics, including stipend, tuition, travel and support costs (~\$100K/student).
- Drs. Heremans, Khodaparast, Kulkarni, Ritter, and Robinson hold seed grants from ICTAS. Robinson, Schmittmann and Zia were awarded new seed grants, effective FY10.
- Dr. Heflin is part of a team which was awarded one of the first seed grants from the new Virginia Tech Carilion Research Institute.
- Dr. Simonetti's outreach efforts continue to be supported by the Horton Foundation and the Mary Moody Northen Endowment. These grants support activities at the Martin Observatory and the Mountain Lake Hotel.

## **Personnel:**

### **New Faculty**

- Dr. Patrick Huber, Assistant Professor (August 2008)
- Dr. Seong-Ki Mun, Professor (September 2008)
- Dr. Sanjib Agarwalla, Postdoctoral Associate (October 2008)
- Dr. Vito Scarola, Assistant Professor (August 2009)
- Dr. Kenneth Wong, Research Assistant Professor (February 2009)

### **Faculty Promotions and Retirements**

- Dr. Giti Khodaparast will be promoted to Associate Professor with tenure, effective August 10, 2009
- Dr. Guy Indebetouw retired on September 1, 2008.

### **Staff Hires, Promotions, and Retirements**

- New Business Manager: Lisa Stables (September 2008)