

# Physics Department 2009-2010 Annual Report

July 5, 2010

## Part 1: Executive Summary

All members of Virginia Tech's Physics Department are committed to advancing the frontiers of knowledge through research and discovery in an international and often interdisciplinary environment, and to providing undergraduate and graduate students with a rigorous and broad-based scientific education of the highest quality. Our commitment to these goals has a beneficial and lasting impact for the region, the nation, and the world.

We nurture a broad range of connections and partnerships with recognized research organizations, industry groups, businesses, alumni, donors, and friends. Our engagement with these groups helps us secure our position as one of the leading research departments nationally and internationally.

*(Current mission statement of the Virginia Tech Physics Department)*

**Learning.** Both our undergraduate and graduate programs are strong and vibrant. They are characterized by an unusually strong sense of community amongst faculty and students. Both faculty and staff share the vision of providing a "small college atmosphere" in the department, against the backdrop of a large research university such as Virginia Tech. Our exit interviews, conducted face-to-face with each graduating senior, confirm that we are very successful in making this vision a reality.

A new initiative was launched this year, consisting of three career-building events for all students, with a specific focus on careers outside the traditional academic track. As the program matures, we anticipate 3-4 alumni visits per year, interspersed with events focused on 'soft skills', resume preparation, expectations for graduate school, etc.

The Physics Department, with approval from the Graduate School, now offers accelerated undergraduate / graduate degree programs for a Bachelor of Science (B.S.) in Physics and both Master of Science (M.S.) and doctoral (Ph.D.) graduate degrees in Physics. This accelerated degree program is open to excellent Virginia Tech undergraduates majoring in Physics in their final year before completion of their Bachelor of Science degree. It allows the enrolled students to have at most 12 credits (no more than 6 at the 4000 level) counted towards both their undergraduate and graduate degrees, provided they earn a grade of B or higher.

***Undergraduate programs.*** Once the new freshmen and transfer students have arrived on campus, our student population will grow to 207 undergraduates (first and second majors). The Class of 2010 consisted of 26 students (24 BS, 2 BA). By degrees awarded, our undergraduate program ranks comfortably in the top third of programs in PhD granting departments in the U.S.<sup>1</sup>

High quality, learner-centered teaching is increasingly emphasized in the department, as a natural complement to the strong push towards research excellence. A series of *Teaching Brown Bag Lunches*, initiated a year ago, provides a forum to share best practices and brainstorm new pedagogies in undergraduate teaching, especially in the demanding setting of the large introductory lecture course. A major change is the switch to full-time instructors for these courses, necessitated by continuing enrollment growth and faculty losses due to budget cuts. As part of expanding our summer session offerings, we are committed to developing online versions of our two introductory courses, with the objective of increasing summer enrollments. PHYS 2305-06 is scheduled to go online first, in Summer 2011. Another key initiative concerns PHYS 1055-56, our *Introduction to Astronomy* course. A budget is in place and preparations are well underway to develop this course into a Virginia Tech signature experience for students from all majors and specifically freshmen, to be launched in August 2010. Responding to high enrollment growth, funds were secured to relocate the algebra-based teaching laboratories to newly renovated spaces in Derring, allowing us to increase the number of seats per section from 20 to 32.

Undergraduate research continues to be highly valued in the department. Approximately 60 students were engaged in research projects in 2009-10. Over the past couple of years, the second semester of the Senior Laboratory course (PHYS 4316) has been transformed into a capstone research experience. Many students are already engaged in research and expand and complete their project for credit in PHYS 4316; the remaining students are required to identify a faculty advisor and complete a semester project. A short report and a poster presentation serve as the final exam. As an outcome, every student graduating with a BS in Physics has participated in a research experience. Undergraduate research activities continue over the summer, including both our own students as well as summer interns from other institutions.

Our students received multiple honors through the year. Justin Waugh (BS 2010) was named College of Science Outstanding Senior. Kevin Finelly (BS 2009) received an honorable mention from the National Science Foundation Graduate Research Scholarship program. Siddharth Venkat (BS 2011) won a Sigma Xi Research Award. Finally, our Society of Physics Students (SPS) was named an Outstanding Chapter for 2008-09, by the national SPS organization.

On the faculty side, Dr. Leo Piilonen was honored with a College of Science Certificate of Teaching Excellence.

---

<sup>1</sup> The latest statistics, covering 2006-2008, are available from the American Institute of Physics at <http://www.aip.org/statistics/trends/reports/ugprogramsizedata.pdf>. Over this period, the department produced an average of 15.7 BS graduates per year (data from Virginia Tech Institutional Research).

**Graduate programs.** This fall, our graduate program will count 78 graduate students. 9 PhD and 5 MS degrees were awarded over this reporting period; several additional PhD students are expected to defend their theses this summer. 18 new students will be joining us this fall which is the largest incoming class on record.

To distribute the work load of the Graduate Committee more equitably, two subcommittees were established, for recruitment and admissions on the one hand, and curricular matters on the other. This appears to have worked well and will be continued this coming year. Our February Graduate Preview Weekend was well attended year and succeeded in attracting several strong students. The department was fortunate to garner an additional ICTAS scholarship (our third) as well as a Cunningham and a Diversity Scholarship for incoming graduate students.

The Graduate Committee, with input from the whole faculty, developed a set of recommended tracks for graduate students in order to guide them towards the best possible course preparation for their chosen research specialization. Current track recommendations include particle theory/experiment, astrophysics, and condensed matter theory/experiment. In the future, we anticipate additional tracks, focused towards more interdisciplinary options, e.g., biological physics, neuroscience, medical physics, etc.

Our progress reports system is very well established and carefully managed; it is so exemplary that the Graduate School uses it as a model for other departments.

Martin Rudolph, a PhD candidate, received an honorable mention from the National Science Foundation Graduate Research Scholarship program. Yen-Liang Chou won a Sigma Xi Graduate Research Award.

**Discovery.** The department's research programs continue to grow. This year saw an increase of 21.8% in new research awards (total \$4,604,435), and an increase of 28.4% in research expenditures (total \$\$3,687,339), compared to last year. This funding is well distributed over the different research groups creating a sustainable and stable profile. The faculty published 139 refereed articles, book chapters, and (refereed) journal proceedings and gave 85 invited and 67 contributed presentations and talks, all over the globe. These numbers have climbed gradually over the past few years. Applications for one patent and one provisional patent were filed.

Assistant Professor Patrick Huber received a DOE Early Career Research Award for his work in neutrino physics. Huber was one of only 69 awardees from a pool of approximately 1,750 applicants from universities and national labs. This brings the number of early career awards won by Physics faculty to 4, over the past three years.

Concluding a search initiated in AY 2008-09, Dr. Vito Scarola joined the department as a new Assistant Professor in August. Dr. Scarola received his Ph.D. from Pennsylvania State University and held postdoctoral positions with three

prestigious scientists: Sankar Das Sarma (U. Maryland), Birgitta Whaley (UC Berkeley) and Matthias Troyer (ETH Zürich).

The two largest research thrusts of the department are condensed matter and materials physics and nuclear and particle physics. Our astrophysics group is smaller in size but also enjoys solid funding and is eager to grow. In condensed matter and materials physics, our focus on energy-related research is expanding, with ongoing projects in organic photovoltaics, energy-harvesting materials, zeolites for energy storage, and energy generation via accelerator-driven nuclear reactors. The statistical physics group is internationally regarded as a leader in the study of far-from-equilibrium phenomena. Emerging research projects address biological and biomedical applications as well as the growing neuroscience focus on campus, through our NCR group and a joint appointment with VTCRI.

The nuclear and particle physics group has developed a strong focus on neutrino physics and plans to form a college level center later this summer. This new structure will enhance the group's visibility, both internationally and on campus and provide it with the resources to run its own seminar series and workshops. The group participates in a well-balanced portfolio of large international collaborations in the U.S., China, and Europe and is positioning itself to play a major role in the *Long Baseline Neutrino Experiment* which is developing into the leading neutrino experiment in the U.S., strongly supported by the DOE and Fermi National Accelerator Laboratory.

Over the past year, we have been involved in planning the design of four high quality optics and magneto-optics labs, along with appropriate prep rooms and office space, in the ICTAS II building. The spaces should be ready for occupation in January 2011.

The department is increasing its national and international visibility by hosting a series of conferences, symposia, and workshops. From June 21-July 2, the NSF-funded *Summer School on Mathematical String Theory 2010* will bring 5 speakers and 35 young mathematicians and physicists to campus, to study advanced mathematics related to string theory. This year, we completed the planning for an international symposium on *Complex Driven Systems: From Statistical Physics to the Life Sciences*, scheduled for October 1-3, 2010. Supported by the NSF, the Department of Physics, the College of Science, and ICTAS, 24 speakers from six countries will converge on Virginia Tech. Planning is in full swing for the *15th International Conference on Narrow Gap Semiconductors and Systems*, to be held here in July 2011. This conference takes place every two years and rotates between Europe, Asia, and the U.S. It will attract leading scientists and engineers in this field to Virginia Tech.

**Engagement.** The student-run Physics Outreach Team celebrates its 15<sup>th</sup> anniversary this year. This group of energized undergraduates takes its hands-on physics demonstrations to local and regional schools to excite the students about science and to support the physics teachers. The College of Science, the College of Engineering, and now also the School of Education frequently invite the team to participate in outreach and recruitment events.

Physics faculty are very active as conference organizers, serve on several editorial boards, and assume leadership roles in the American Physical Society (APS) or within their collaborations. The prestigious *2009 Boulder School for Condensed Matter and Materials Physics*, which is the premier summer school in this field in the U.S., was organized by three physics faculty members from our department and a colleague from Rice University; two physics faculty members were invited speakers, and several of our students and postdocs attended as participants. Events for alumni, donors, and friends include a reunion at the APS March Meeting (the premier national conference for most of the department's faculty), the department's Awards Ceremony, and commencement.

***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 (latest data from 2006). Women are also well represented amongst the graduate student population, at 24% (national average: 19%; latest data from 2007). At the undergraduate level, the picture is very different: By Fall 2010, women will make up just over 16% of our undergraduate students (up from 12% last year). While the increase is encouraging, these numbers remain significantly below national figures. For example, in 2007 (latest available data), women earned 21% of Physics bachelor's degrees in the U.S. We note that women are already underrepresented amongst the incoming freshmen, and the gap widens further over time. Clearly, we need to address both, recruitment and retention.

The representation of minorities in the undergraduate population remains small yet close to national averages. As of Fall 2010, we will have 6 minority students (out of 207) in the department (compared to 8 out of 200 the previous year). We have initiated a partnership with the Physics Department at the University of Texas at El Paso, a minority serving institution with 75% U.S. Hispanic enrollment. Two UTEP students will spend the summer here, working on undergraduate research projects. Our goal is to recruit minority students into our graduate program and to document a strong commitment to minority participation for an upcoming REU proposal.

***Goals for 2010-11.*** In the area of *Undergraduate Learning*, we will continue to develop a series of career advising opportunities for students planning to work in non-academic environments. The calculus-based *Foundations of Physics* sequence (PHYS 2305-2306) will be expanded to include a fully online version. We will continue our efforts to become an NSF-funded REU site; the corresponding proposal will be resubmitted to NSF in August with even stronger participation from minority serving institutions and a significantly redefined research focus. In the area of *Graduate Learning*, we will review our current course offerings and programs, with the objective of providing our graduates with a better preparation for interdisciplinary team work in academia and the private sector. With regards to *discovery*, we plan to continue the strategic directions identified as part of our external review process: astrophysics, materials 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. Since the College of Science anticipates several faculty searches this coming year, the department has specified its priorities. We seek one hire in materials physics, with a specific focus on energy-related applications, and a second hire in astrophysics, with a focus on data analysis and pattern recognition. Both hires fit well into the current clusters pursued by the College. Further, the coming year will see: (1) the establishment of a college-level center focused on neutrino physics, including an inaugural workshop; (2) two international conferences on campus, led by physics faculty; (3) the first hire into a new *Research Instrumentation Team*, designed to provide research support in electronics, systems integration, and vendor contacts.

Integrating across several dimensions, the College of Science has put forward plans to develop undergraduate degrees in neuroscience and nanoscience. The department intends to participate fully in the development of these programs, leveraging available and targeting new resources.

In summary, the department has seen remarkable progress in the face of massive external pressures: budget cuts, lay-offs, retirement incentives, and curtailed hiring. Yet overall, faculty and staff see the department on a positive trajectory, and their commitment to our students and research programs remains sincere and very strong.

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



*“Space and Time Entwined” by Sara Wickersham was shown in the “String/Not String: Fiber Arts Responds to String Theory” exhibition at the XYZ Gallery in March 2010. The students were inspired by a guest lecture by Prof. Djordje Minic on String Theory. Wickersham’s piece represents flexible and undulating spacetime with white crocheted netting, with golden globes representing mass which distorts and bends it creating the phenomenon of gravity. Photograph by Tatsu Takeuchi.*

## Part 2: Academic Accomplishments

### I. Learning

#### Undergraduate Program

Our undergraduate program offers the best of two worlds: on the one hand, it is characterized by a supportive small college feel in which faculty interact frequently and informally with students, and on the other hand, it carries all the advantages of a program in a large research university, such as comprehensive course offerings, international standards, and rich undergraduate research opportunities. 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 supportive community atmosphere and undergraduate research opportunities as special strengths of the department.

Our *in-major undergraduate program* continues to enjoy strong enrollments. Before graduation, our numbers stood at 188 (first and second) majors (previous year: 167). With 45 incoming students (38 freshmen and 7 transfers), we will exceed 200 majors 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 to programs with similar enrollments or degrees awarded, the size of our faculty is well below average.<sup>2</sup>

Responding to state budget cuts, the university offered an alternate severance option this year. As a result, three faculty members announced their intention to retire, effective July 2010, on top of two planned retirements (effective January and August 2011). A major emphasis this year was to plan for the corresponding loss of approximately 18 courses (or sections) per year. The fact that we had conjoined several 4000 and 5000 level courses in AY 2008-09 helped us offset five of these sections. A strategic decision was made to keep the teaching load of research active faculty at one course per semester, in order to protect their research programs. This implied shifting more responsibilities to instructors. By reallocating a few assignments, we could move most of the uncovered sections to lower division courses. At the introductory level, where we strive to meet the needs of large numbers of incoming students many of whom are still developing their study skills, dedicated and effective instructors can provide far better service than research-active faculty. Without research duties, a good instructor can offer several hours of support every day whereas a faculty member may only be available for a few hours per week.

---

<sup>2</sup> In the period 2006-2008, the department produced an average of 15.7 BS degrees per year (data from Virginia Tech Institutional Research). The average department size, corresponding to this output, is above 30, as can be gleaned from <http://aip.org/statistics/trends/highlite/other/phddept.htm>

At the current time, the department employs one full-time and several part-time instructors. Since part-time instructor positions offer little stability, and replacements can be difficult to find, especially at short notice, the department requested permission to hire 1-2 new full-time instructors. A national search resulted in two offers both of which were accepted. The two new instructors, Kriton Papavasiliou and Almas Khan, will assume their duties in August 2010. Subject to performance, we expect to renew, and eventually regularize, their contracts. We will still have to employ part-time instructors, to cover approximately 11 lecture sections and labs for the year, but the two new positions will provide much-needed stability.

Our summer session enrollments have seen steady declines over the past few years, with accompanying loss of revenue. Conversation with Virginia Tech's Institute for Distance and Distributed Learning as well as some of the data collected in the Summer Undergraduate Survey indicate that students would be interested in taking summer classes from Virginia Tech, provided these classes are offered online. This would allow the students to live at home and accept a summer job. This coming year, Physics faculty member Dr. Jon Link will need to travel to China frequently, as part of his research commitments for the Daya Bay Collaboration, and he has agreed to develop online versions of PHYS 2305 and 2306. This will constitute his regular teaching assignment. Support from the Enterprise Fund will be sought. The online courses are expected to go live in Summer 2011.

Another key initiative concerns PHYS 1055-56, our *Introduction to Astronomy* course, spearheaded by Physics faculty member Dr. Nahum Arav. With the support of Vice President and Dean for Undergraduate Education, Dr. Daniel Wubah, the vision is to turn the course into a Virginia Tech signature experience, available to all students and, in particular, freshmen. Such a course is a unique educational tool for teaching science in an integrated multidisciplinary context, including concepts from physics, chemistry, biology, history, and philosophy. For many Virginia Tech students, this may be their only exposure to science and thus, their only opportunity to gain a level of scientific literacy. Dr. Arav and a small team of experts from instructional design, learning technologies, and assessment are working together to create an intense classroom experience for up to 600 students per class. Advanced undergraduates with an interest in teaching will be trained as learning assistants (LAs) who will provide individual support to the students enrolled in the class. A budget is in place to pay for the LAs, a clicker system, and a library of high quality movies. The first pilot will be launched in August 2010.

Due to continued enrollment growth, our algebra-based teaching laboratories PHYS 2215 and PHYS 2216 are currently running until 8:40pm, several days a week. This is unpopular with students and parents and leaves little time to service the lab equipment. Since these labs are required for several popular majors (e.g., Biological Sciences and Biochemistry) as well as the pre-med, pre-dent, and pre-vet programs, further growth is likely. With the support of the College of Science, we requested stimulus funds to renovate Derring 4009 and 4029 as the future

location for these labs. These spaces accommodate 32 students per lab section, well above the current 20. The proposal was approved and the architectural designs are now completed. The actual demolition and renovation of the new spaces is scheduled to begin in early July and be completed in time for fall classes. The project creates well-designed spaces for these labs, which should house them comfortably for the next decade.

Undergraduate research continues to be highly valued in the department. Approximately 60 students were engaged in research projects in 2009-10. The projects ranged across all research groups and included both experimental and computational work. Several research projects involved collaborations with faculty from other departments at Virginia Tech, introducing the students to interdisciplinary teams at an early state of their careers. Over the past couple of years, the second semester of the Senior Laboratory course (PHYS 4316) has been transformed into a capstone research experience. Many students are already engaged in research and expand and complete their project for credit in PHYS 4316; the remaining students are required to identify a faculty advisor and complete a semester project. A short report and a poster presentation serve as the final exam. As an outcome, *every student* graduating with a BS in Physics has participated in a research experience.

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 twelve summer research interns from other institutions, including Cornell, UC Boulder, U. Dallas, Bethune-Cookman U., Georgia Tech, UT El Paso, and several high schools. Of these interns, three are female, three are African-American, and one is Hispanic. In order to provide more visibility and stable funding for our summer research programs, we continue to pursue an REU site. Our last proposal was declined, despite receiving rather good reviews. We will resubmit it in August, with a significantly redefined research focus. Our previous proposal included faculty funded through two different divisions at NSF (Physics and Materials) which triggers a review by two separate panels. The Physics panel would have funded the proposal while the Materials panel was more reserved. Following the advice of the Physics Program Director, we will now refocus the proposal towards neutrino and nuclear physics, with a much smaller participation of faculty engaged in materials research. As a consequence, the Physics Division will be able to review the proposal in house, without having to consult DMR. Our recruitment efforts and minority outreach will be even stronger than before, since our interactions with UTEP will be much closer.

In general, our graduating seniors report great satisfaction with our program in their exit interviews. When asked what the department could offer to improve the program further, the students repeatedly request more career advice, especially targeted at careers outside the academic sector. In response, a new series of career-building events for students was launched this year, to be developed further next year. As the program matures, we anticipate 3-4 alumni visits per year, interspersed with events focused on 'soft skills', resume preparation,

expectations for graduate school, etc. These events will be open to all interested students, at both the graduate and undergraduate levels.

Our series of *Teaching Brown Bag Lunches*, initiated last year, continued this year. Informal discussions are interspersed with visiting speakers. This year, we hosted two speakers: Mr. Greg Justice, MFA, from Virginia Tech's Department of Theatre Arts, and Dr. Ramon Lopez from the University of Texas, Arlington. Greg Justice teaches acting skills for business use, including movement and speaking techniques in educational settings. Dr. Lopez has been very active in science education, serving in leadership roles and on committees for the American Physical Society (APS), the American Association of Physics Teachers (AAPT), the American Geophysical Union (AGU), and the Society for the Advancement of Hispanics/Chicanos and Native Americans in Science (SACNAS).



*Jay Mettetal*

As in previous years, the department celebrated its *Awards Ceremony* in the Spring, on April 9, 2010. Many parents, donors, and friends of the department were invited and attended. A luncheon was followed by a key note speaker and the recognition of the awardees. This year's speaker was Jay Mettetal (BS Physics and Mathematics 2003). After receiving his PhD from MIT in 2008, Jay now works for Pfizer, developing mathematical model for biotherapeutics. Eleven awards, scholarships, and prizes were given to 32 undergraduates, and seven awards were given to twelve graduate students. In total, an amount of

\$59,251 was distributed. Compared to last year, this is about \$10,000 less, reflecting the loss in investment income due to poorly performing markets.

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

- The total number of physics majors stood at 188 (27 women, 4 minority students) as of April 2010, up 13% from last year (2008-09: 167 in all, 16 women and 4 minority students).
- The number of physics minors stands at 20 (2008-09: 13).
- The number of astronomy minors is significant: 44 in total, including 9 females (2008-09: 29 total, 10 females).
- Our graduating class of May 2009 consisted of 26 students (24 BS, 2 BA). Six students received Minors in Physics, and 18 received an Astronomy Minor. One student was female.

- 14 members of the Class of 2010 will be attending graduate school; one will enter the military; six will enter the general work force and four are still undecided.



*The Class of 2010*

- The graduating class of 2010 is expected to be sizable, at 21 students.
- About a quarter of our undergraduate students (60 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 University in Japan. Eight summer interns, including one female, three African Americans, and one Hispanic are coming from other universities or high schools.
- Undergraduate research projects often result in publications. To name just one example, Siddharth Venkat (Physics '11) co-authored an article in the prestigious Physical Review.
- On June 22, 2010, the Virginia Tech Physics Department and the Physics and Engineering Department at Washington and Lee University are holding their first Undergraduate Research Symposium in Lexington, supported by both Dean's Offices, Virginia Tech Physics, NSF, DOE, and HHMI.
- Our current numbers for incoming students continue to be robust. For Fall 2010, 38 freshmen and 7 transfers have accepted admission to the Physics Department; 8 of these are women, and 2 are minority students. Last year, we attracted 45 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 47 high schools and community colleges in the Northern Virginia, DC, Richmond, and Tidewater areas. Faculty and current students attend the on-campus recruiting events in notable numbers and are always on hand to meet prospective students and their parents, even if they drop in unannounced. The Department Chair contacted all admitted students with SATs over 1300, through personal phone calls and emails.

## **Graduate Program**

The total graduate enrollment in physics stands at 70 (17 women, no minority students), slightly up from last year (68 total, 12 women, 1 minority). The distribution of the students over the different research groups is as follows: Astrophysics – 6; nuclear and particle physics – 20 (13 experiment; 7 theory/computational); condensed matter physics – 40 (21 experiment; 13

theory/computational). Four students will be leaving this spring without a degree. Informal exit interviews do not indicate any systemic problems. Two students changed their career goals, and the other two did not anticipate the workload associated with graduate school.

After years of relatively low graduation rates, our Ph.D. and M.S. production is beginning to reflect the larger number of students in the program. Over the course of this reporting period, nine students received their Ph.D., and five obtained the M.S. degree. Extrapolating a couple of years into the future, we expect an additional 10 doctoral defenses before the end of 2010, 8 in 2011, and 12 in 2012.

Our graduate program is focused on three main priorities: Provide the highest quality education at an advanced level to our current students, with a strong focus on good progress to degree; recruit the best available American and international students into our program; and ensure adequate student support through GTA and GRA positions.

With regards to the first priority, Graduate Program Chair Dr. Uwe Täuber and his committee have established an excellent system of progress reports. These reports are written by both student and advisor and collected in a timely fashion. Clear timelines for identifying an advisor, passing the prelims, and progressing towards the final degree have been defined and are monitored. The students are also offered frequent opportunities to meet Täuber and to alert him to any issues that they might be facing. Our progress reports and advising system is very well established and carefully managed; it is so exemplary that the Graduate School uses it as a model for other departments. Upon invitation by Associate Dean Janet Rankin, Chris Thomas and Uwe Täuber presented it on March 15, 2010, to all Graduate Directors, as part of a panel discussion on “Tools to enhance graduate student success”.

To the extent possible, the department assigns some of its best teachers to the graduate core courses. A graduate research seminar takes place every Friday in the fall and during the earlier part of the spring semester, designed specifically for the first year graduate students. In an informal setting (free pizza), faculty meet with the students, discuss their research, and recruit for any openings in their groups.

The Graduate Committee, with input from the whole faculty, developed a set of recommended tracks for graduate students in order to guide them towards the best possible course preparation for their chosen research specialization. Current track recommendations include particle theory/experiment, astrophysics, and condensed matter theory/experiment. In the future, we anticipate additional tracks, focused towards more interdisciplinary options, e.g., energy, nanoscience, biological physics, neuroscience, etc.

The Physics Department, with approval from the Graduate School, now offers accelerated undergraduate / graduate degree programs for a Bachelor of Science (B.S.) in Physics and both Master of Science (M.S.) and doctoral (Ph.D.) graduate degrees in Physics. This accelerated degree program is open to excellent Virginia

Tech undergraduates majoring in Physics in their final year before completion of their Bachelor of Science degree. It allows the enrolled students to have at most 12 credits (no more than 6 at the 4000 level) counted towards both their undergraduate and graduate degrees, provided they earn a grade of B or higher. We will identify eligible promising students through their participation in our undergraduate research programs, among our recipients of undergraduate awards, and through recommendation by physics faculty. The students' research supervisors as well as a member of the departmental Graduate Committee will be assigned as temporary advisers and mentors for each student, to meet with them regularly and monitor their academic progress.

Turning to the second priority, we continue to recruit aggressively, through personal visits, our preview weekend (February 19-20, 2010), and various other online and print media. International applicants are contacted by phone.

Promising students who are currently in the U.S. are invited to our Graduate Preview Weekend and participate in various activities at the



*Poster Session at the Preview Weekend*

Graduate School and in the department. The departmental sessions include an introduction to our program, a poster session organized by all research groups and attended by faculty and current graduate students, meetings with faculty and lab tours, and a social evening with current students. 14 prospective graduate students were invited, and seven of them accepted our offer to join us this coming fall. That is an excellent yield.

Our incoming class consists of 18 students (3 women, 2 minorities). Slightly over half (10) are from the US, 6 are from China, and one each come from Spain and Iran. The larger representation of US students is an outcome of our recruitment efforts, targeted towards strong US graduates. Of the incoming students, 16 will be supported as GTAs, and two hold scholarships (ICTAS and Cunningham). We secured a minority scholarship for a promising Hispanic applicant, but the student withdrew his acceptance to attend RPI. The total number of ICTAS fellowships is now three.

With regards to the third priority, the number of GTA and GRA positions has increased significantly over the past few years. This is due to stable enrollment support and significantly increased grant funding. For Fall 2009, we were able to offer 48 GTA and 24 GRA positions, for a total of 72; for comparison, for 2005 the numbers were 32 and 15 (Data source: Virginia Tech Institutional Research, Physics Fact Book). For Fall 2010, the number of GTA positions will remain roughly the same, and the number of GRA positions will be approximately 30.

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

- The total graduate enrollment in physics stands at 70 (17 women, no minority students), slightly up from last year (68, 12, 1). The distribution of the students over the different research groups is as follows: Astrophysics – 6; nuclear and particle physics – 20 (13 experiment; 7 theory/computational); condensed matter physics – 40 (21 experiment; 13 theory/computational). Four students will be leaving this spring without a degree. Informal exit interviews do not indicate any systemic problems. Two students changed their career goals, and the other two did not anticipate the workload associated with graduate school.
- Nine students received their Ph.D. since the last annual report. We expect an additional 10 defenses before the end of the calendar year.
- Five students obtained the M.S. degree. Four of them are continuing towards the PhD.
- Our incoming class consists of 18 students (3 women, 2 minorities). Slightly over half (10) are from the US, 6 are from China, and one each come from Spain and Iran. The larger representation of US students is an outcome of our recruitment efforts, targeted towards strong US graduates.
- Of the incoming students, 16 will be supported as GTAs, and two hold scholarships (ICTAS and Cunningham). We secured a minority scholarship for a promising Hispanic applicant, but the student withdrew his acceptance to attend RPI. The total number of ICTAS fellowships is now three.
- 14 prospective graduate students were invited to visit the Department as part of our Graduate Preview Weekend. Seven of them accepted our offer to join us this coming fall.
- Of the incoming students, 16 will be supported as GTAs, and two hold scholarships (ICTAS and Cunningham). We secured a minority scholarship for a promising Hispanic applicant, but the student withdrew his acceptance to attend RPI. The total number of ICTAS fellowships is now three.



*Juliette Mammei (center), her husband Russell (right) and her advisor, Dr. Mark Pitt (left), displaying Juliette's PhD thesis.*

## 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. Each area comprises experimental and theoretical/computational research efforts. Our astrophysics group is smaller in size but also enjoys solid funding and is eager to grow.

In condensed matter and materials physics, our focus on energy-related research is expanding, with ongoing projects in organic photovoltaics, energy-harvesting materials, zeolites for energy storage, and energy generation via accelerator-driven nuclear reactors. The statistical physics group is internationally regarded as a leader in the study of far-from-equilibrium phenomena. This includes studies of complex networks, aging phenomena in materials, aspects of game theory, and biological and biomedical physics. Thanks to the expertise of this group, our NCR presence, and a recent joint appointment with VTCRI, the department is well positioned to play a key role in the emerging neuroscience focus on campus.

The nuclear and particle physics group has developed a strong focus on neutrino physics. This will serve us extremely well in the near and medium-term future since neutrinos have now emerged as the primary strategic focus of the U.S. particle physics community. On the national and international scene, neutrino physics merges two traditionally separate areas of physics, namely, nuclear physics (traditionally funded by NSF) and high energy physics (traditionally funded by the DOE). Within the department, both fields are already well represented. On the nuclear physics side, Raghavan and Vogelaar are exploring the physics of low-energy (solar) neutrinos and are funded by NSF, while Link focuses on the high energy end of neutrino physics and is supported by the DOE. Huber, as a theorist, bridges both fields very naturally. The remaining members of our particle and nuclear physics group also contribute expertise which touches upon neutrino physics. Since neutrinos also have critical astrophysical and cosmological implications, the group may eventually grow to encompass the astronomy/astrophysics efforts in the department.

Following extensive discussions this spring, the group has decided to structure itself as a college level center. A charter document is currently being written. The new structure will enhance the group's visibility, both internationally and on campus and provide it with the resources to run its own seminar series and workshops. Moreover, the cohesion and commitment implied in the center structure will allow the group to leverage its existing strengths and to compete for far bigger projects than before. The group already participates in a well-balanced portfolio of large international collaborations in the U.S., China, and Europe and is positioning itself to play a major role in the *Long Baseline Neutrino Experiment* which is emerging as the leading neutrino experiment in the U.S., strongly supported by the DOE and Fermi National Accelerator Laboratory.

Discussions with Fermilab are underway, to pursue “bridge positions” jointly funded by Fermilab and Virginia Tech.

The department’s research programs continue to grow. This year saw an increase of 21.8% in new research awards (total \$4,604,435), and an increase of 28.4% in research expenditures (total \$\$3,687,339), compared to last year. This funding is well distributed over the different research groups creating a sustainable and stable profile. The faculty published 139 refereed articles, book chapters, and (refereed) journal proceedings and gave 85 invited and 67 contributed presentations and talks, all over the globe. These numbers have climbed gradually over the past few years. Applications for one patent and one provisional patent were filed.

Assistant Professor Patrick Huber received a DOE Early Career Research Award for his work in neutrino physics. Huber was one of only 69 awardees from a pool of approximately 1,750 applicants from universities and national labs. This brings the number of early career awards won by Physics faculty to four, over the past three years.

Concluding a search initiated in AY 2008-09, Dr. Vito Scarola joined the department as a new Assistant Professor in August. Dr. Scarola received his Ph.D. from Pennsylvania State University and held postdoctoral positions with three eminent scientists: Sankar Das Sarma (U. Maryland), Birgitta Whaley (UC Berkeley) and Matthias Troyer (ETH Zürich). He is a computational physicist in the area of quantum materials physics and quantum information theory. His main interests are new states of matter in graphene and other carbon nanostructures and using cold atom optical lattices as “laboratories” for tuning quantum interactions. He is also developing extremely efficient algorithms for exploring novel fractional quantum Hall states which were recently discovered experimentally.

Due to the challenging budget climate, there were no faculty searches this year. Instead, we are managing an unusually large number of retirements. Two faculty (Ritter and Zia) are taking regular retirements, and three faculty members (Blecher, Mizutani, and Slawny) are retiring in response to the Alternate Severance Option (ASO) put forward by the university. The main consequences of these retirements will be felt in the area of learning. With regards to discovery, the effects are, fortunately, minimal. Zia will remain research active and continues to be supported by NSF; Blecher will continue his involvement with the PIENU collaboration at TRIUMF; and Mizutani, Ritter, and Slawny already had smaller research efforts which will also continue at some level.

Even in tight years, however, opportunities can emerge through partnerships with other units on campus. Since the university has committed to developing its presence in the medical and biomedical arena, through the Virginia Tech Carilion School of Medicine and the Virginia Tech Carilion Research Institute (VTCRI), the department has sought to engage with these initiatives. Very recently, Dr. Read Montague, an extremely successful neuroscientist, has been offered a tenured appointment in the department, in support of his being recruited into

VTCRI. Together with the growing strength of our NCR group, led by Dr. Seong Ki Mun, the department is now well positioned to play a significant role in the emerging neuroscience initiative at Virginia Tech. Heflin and Kulkarni have already received seed grants from Carilion, demonstrating our growing presence in this critical area.

Another research initiative with considerable potential is the GEM\*STAR project. It proposes to develop new technologies for nuclear energy, based on an accelerator-assisted molten salt reactor design. If successful, a GEM\*STAR reactor will be able to burn unenriched uranium or spent fuel from conventional reactors, thus alleviating nuclear waste and 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; its corporate partner, ADNA, is pursuing venture capital. Most recently, the initiative has received valuable support through a partnership with Jefferson Lab. In response to President Obama's multibillion-dollar push into energy research, Jefferson Lab has identified accelerator-driven sub-critical nuclear reactors as one of its three strategic thrusts in this area, the key asset being Jefferson Lab's expertise in accelerator technology. As part of this thrust, GEM\*STAR has attracted considerable interest at Jefferson Lab. Through various channels, GEM\*STAR has been brought to the attention of high-ranking government officials. There is a significant opportunity here to influence the energy policies and solutions of the U.S.

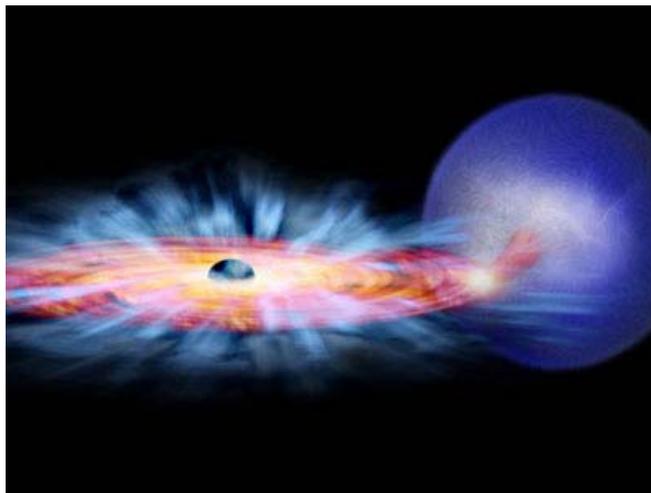
For the coming year, the budget situation appears to be more encouraging, and the department has specified its hiring priorities. We seek one hire in materials physics, with a specific focus on energy-related applications, and a second hire in astrophysics, with a focus on data analysis and pattern recognition. Both hires fit well into the current clusters pursued by the College as well as the strategic priorities of the university, in the discovery domains of *Energy, Materials, and the Environment* and *Innovative Technologies and Complex Systems*.

For an experimental science such as physics, excellent research support staff and facilities are essential. The equipment and instrumentation needed for frontline research is usually extremely innovative and "one of a kind". In some instances, research equipment has to be designed from scratch; in other cases, the challenge arises when equipment needs to be integrated into larger systems in highly unconventional ways. The 2008 External Review of the department indicated that the Physics Machine Shop is well equipped to meet these demands; in contrast, the services of our Electronics Shop were called into question. Over the course of spring, summer, and fall 2009, the department conducted a thorough analysis of current and anticipated needs vs. available services in the area of electronics. It was determined that departmental needs have evolved significantly in the past few years and are no longer well aligned with the available services. Working with Human Resources and the College of Science, we decided to close the current Electronics Shop, effective July 1, 2010. A position description for a *Lab and Research Specialist II* was developed, with a much stronger focus on the design of customized equipment, systems integration, and liaison with vendors

and off-campus research sites; we anticipate filling the new position in January 2011. Eventually, existing staff and new hires will be integrated into a *Research Instrumentation Team*, working collaboratively with faculty, students, and external partners.

Good quality research space remains at a premium, especially as the research efforts of the department continue to grow. We have been allocated four high quality optics and and magneto-optics labs, along with appropriate prep rooms and office space, in the ICTAS II building. The planning and design of these spaces took place over the last couple of years; they should be ready for occupation in January 2011.

The department is increasing its national and international visibility by hosting a series of conferences, symposia, and workshops. From June 21-July 2, the NSF-funded *Summer School on Mathematical String Theory 2010* will bring 5 speakers and 35 young mathematicians and physicists to campus, to study advanced mathematics related to string theory. The organizers are Dr. Eric Sharpe from our department and his colleagues Ron Donagi and Tony Pantev from the Department of Mathematics at the University of Pennsylvania. Support for the summer school is provided by NSF. This year, we completed the planning for an international symposium on *Complex Driven Systems: From Statistical Physics to the Life Sciences*, scheduled for October 1-3, 2010. Supported by the NSF, the Department of Physics, the College of Science, and ICTAS, 24 speakers from six countries will converge on Virginia Tech. The meeting is organized by Drs. Michel Pleimling and Beate Schmittmann. Planning is in full swing for the *15th International Conference on Narrow Gap Semiconductors and Systems*, to be held here in July 2011. This conference takes place every two years and rotates between Europe, Asia, and the U.S. It will attract leading scientists and engineers in this field to Virginia Tech. Sponsorship from various publishers, scientific instrumentation companies, and science and technology consulting firms will be sought. The local organizers are Drs. Jean Heremans and Giti Khodaparast from Physics and Dr. Lou Guido from MSE.



*An artist's illustration of "wind" coming from an accretion disk of a stellar mass black hole. Such phenomena are studied in Nahum Arav's group.*

## Summary data:

- Research Highlights:
  - Assistant Professor Patrick Huber received a DOE Early Career Research Award for his work in neutrino physics. Huber was one of only 69 awardees from a pool of approximately 1,750 applicants from universities and national labs. This brings the number of early career awards won by Physics faculty to four, over the past three years.
  - Jean Heremans, Djordje Minic, Kyungwha Park, and Vito Scarola are exploring the possibility of a new state of matter in a topological insulator phase. Topological insulators are a recent discovery: In these systems, the bulk of the material is electrically insulating, while the surface can be electrically conducting (more technically, there are surface states which carry delocalized electrons with unique topological properties, akin to edge states in the quantum Hall effects). In bismuth-based materials, it is possible that the properties of these surface states may induce entirely new quantum forms of matter. In addition to these very fundamental issues, these materials are also of great technological interest for quantum information processing, data storage, and spin electronics.
  - Leo Piilonen spent Fall 2009 on a research leave at the KEK National Laboratory in Japan where he is a leading member of the Belle Collaboration. The collaboration investigates the violation of a fundamental symmetry (CP-asymmetry) in the decay of  $B$  and  $D$  mesons. His primary focus was a major reanalysis of all Belle data and the development of the forthcoming Belle II experiment. The U.S. DOE has been briefed, and the Japanese government has provided partial funding, in anticipation of a major upgrade of the KEK facilities to the KEK Super  $B$  Factory.
  - Mark 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 Director's Review approved the project in January 2010. The project now goes to the DOE for further review and approval.
  - Hans Robinson and Randy Heflin, together with their colleague Rick Davis (ChemE), filed a provisional patent on "Selective Functionalization and guided Assembly of Nanoparticle Molecules."
  - Vicki Soghomonian and Jean Heremans filed a patent for a new electrical energy storage material, entitled "Electrically Conducting Microporous Frameworks."
  - John Simonetti, Mike Kavic (College of New Jersey), and Tanmay Vachaspati (Institute for Advanced Study, Princeton) are collaborating on determining the possible event rate of observable "sparks" (radio outbursts) from superconducting cosmic strings, the polarization of such

- sparks, and other observable characteristics of these events. The detection of cosmic strings or the ability to place observational limits on their existence would help elucidate some key issues in string theory.
- The KURF (Kimballton Underground Research Facility), directed by Bruce Vogelaar, is now used by six different research groups, from Duke, UNC, NCSU, U. Maryland, Princeton, and Virginia Tech. The projects include various aspects of neutrino physics and dark matter searches, as well as the testing of various materials requiring a low-background environment.
  - Bruce Vogelaar and Physics alumnus Charles Bowman co-authored a chapter on “Molten Salt Reactors” for the *Handbook of Nuclear Engineering*, published by Springer in June 2010.
  - At present, there are 14 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. Several additional hires are in progress.
  - Publications and presentations (counts for CY 2009):
    - Since publications are by calendar year and counts for fiscal years are very difficult to produce, we report CY publications here. 139 journal articles, book chapters, and refereed proceedings were published in 2009. One patent application and one provisional patent application were filed.
    - Also for CY 2009, the physics faculty reported 85 invited and 67 contributed presentations and talks, on five continents (Africa, America, Asia, Australia, and Europe). A few selected invited talks are listed below:
      - Nahum Arav spoke at the International Astronomical Union Symposium 267 (Summer 2009, Brazil)
      - Randy Heflin presented his work on polymer-fullerene photovoltaics to the Commonwealth Nanoscience Meeting on Energy and the Environment (Charlottesville, July 2009)
      - Patrick Huber gave a plenary lecture at LAUNCH 09, Max-Planck-Institut für Kernphysik (Heidelberg, Germany, November 2009)
      - Giti Khodaparast was invited to speak at the SPIE Photonic-West Conference (San Francisco, January 2010)
      - Djordje Minic spoke at Queen Mary College, University of London (May 2010)
      - Kyungwha Park visited the University of Konstanz and the University of Stuttgart, Germany, to speak about her research on electron transport through single-molecule magnets (August 2009)
      - Michel Pleimling and Royce Zia were both invited lecturers at the 2009 *Boulder School for Condensed Matter and Materials Physics: Nonequilibrium Statistical Mechanics – Fundamental Problems and Applications* (Boulder, July 2009)

- Raju Raghavan presented two invited lectures at NUTech 09 (ICTP Trieste, Italy, July 2009)
- Vito Scarola was an invited speaker at a workshop *on Ab-initio Modeling of Cold Atomic Gases* at the ETH Zurich (November 2009).
- Beate Schmittmann gave an invited talk at the 2010 March Meeting of the American Physical Society (Portland, OR, March 2010)
- Eric Sharpe presented at the workshop on *Correlation functions and the AdS/CFT correspondence* (Johannesburg, South Africa, April 2010)
- Vicki Soghomonian presented a talk on “High Energy Ultracapacitors” to the Virginia Innovation Partnership program (Summer 2009, Charlottesville)
- Uwe Täuber lectured at the *3<sup>rd</sup> Workshop on Model and Data Hierarchies for Simulating and Understanding Climate: Simulation Hierarchies for Climate Modeling* (University of California at Los Angeles, May 2010)
- Conferences, workshops, and distinguished lectures organized by Physics faculty:
  - Jean Heremans, Giti Khodaparast and Lou Guido (MSE) are the organizers of the *15th International Conference on Narrow Gap Semiconductors and Systems* (Virginia Tech, July 2011).
  - Patrick Huber was one of the organizers of the *4th Plenary Meeting of the International Design Study for a Neutrino Factory*, at the Tata Institute for Fundamental Research in Mumbai, India, October 12-14, 2009.
  - Djordje Minic is one of the organizers of the *Miami Annual International Conference on Fundamental Physics* in Fort Lauderdale.
  - Kyungwha Park is co-organizing a CECAM workshop on *Transport Phenomena in Molecular Nanostructures* (Lausanne, Switzerland, June 2010) with Prof. Evers (Karlsruhe, Germany) and Dr. Frederiksen (San Sebastian, Spain).
  - Michel Pleimling, Uwe Täuber, Beate Schmittmann and Ching-Hwa Kiang (Rice) were 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.
  - Michel Pleimling and Beate Schmittmann are co-organizing an International Symposium on *Complex driven systems - From Statistical Physics to the Life Sciences* (Virginia Tech, October 1-3, 2010).
  - Michel Pleimling, together with his colleagues Malte Henkel (Nancy, France), David Mukamel (Rehovot, Israel), and Gunter W. Schütz (Jülich, Germany) is also planning a workshop on *Large Fluctuations in Non-Equilibrium Systems* (Max-Planck-Institut für Komplexe Systeme, Dresden, Germany, July 4-15, 2011).

- Eric Sharpe and his colleagues Ron Donagi and Tony Pantev (University of Pennsylvania) are running an NSF-funded *Summer School on Mathematical String Theory 2010* (Virginia Tech, June 21-July 2, 2010) the NSF-funded *Summer School on Mathematical String Theory 2010*
- Kenneth Wong chairs the SPIE Medical Imaging conference on Visualization, Image Guided Procedures, and Modeling, for the next three years.

### 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.

The student-run Physics Outreach Team celebrates its 15<sup>th</sup> anniversary this year. This group of energized undergraduates takes its hands-on physics demonstrations to local and regional schools to excite the students about science and to support the physics teachers. The College of Science, the College of Engineering, and now also the School of Education frequently invite the team to participate in outreach and recruitment events.

Physics faculty are active in their professional societies, serve on editorial boards, or assume leadership roles within their collaborations.

Events for alumni, donors, and friends include a reunion at the APS March Meeting (the premier national conference for most of the department's faculty), the department's Awards Ceremony (April 9, 2010), and commencement (May 15, 2010). These celebrations highlight the achievements of our students to family members and friends as well as donors and alumni.

Some other highlights of our activities are listed below:

- Randy Heflin serves as a member of the Scientific Advisory Board of Techulon, Inc. Techulon is a private technology transfer initiative providing start-up support and venture capital to support commercialization of intellectual property.
- Dr. John Simonetti has begun a collaboration with a corporate partner, *Science Applications International Corporation (SAIC)*. SAIC is supporting Simonetti's graduate student, Sean Cutchin, to work on radio transient signals.



*The stage party at the dedication of Hahn Hall North. Dr. and Mrs. Hahn are to the left of the easel.*

- Physics faculty and students – notably the Physics Outreach Team – participated in the naming of Hahn Hall North, previously ChemPhys, on October 16, 2009. Hahn Hall North is named for Dr. T. Marshall Hahn Jr., Physics Department Chair 1954-1959, and University President 1962-1974 (October 16, 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>:
  - Nahum Arav was interviewed by Fred Echols, from WVTF & Radio IQ, regarding suicidal planets – i.e., planets that fall into their central star at the end of their life time. The interview aired on September 16, 2010; excerpts were broadcast again a day later (September 2009).
  - Patrick Huber’s research on using neutrinos to communicate with submarines was featured in *The New Scientist*, on the MIT technology review blog, on the IOP News website, and in blogs in at least 5 different languages (October 2009)
  - Huber was also interviewed by WVTF radio about his software package GLOBES which is used internationally to plan major experiments in neutrino physics (November 2009).
  - Rahul Kulkarni was interviewed by the science reporter Lynne Lederman. An article profiling the work of his group appeared in the journal *BioTechniques* (November 2009).

- John Simonetti was interviewed for the WVTF program “With Good Reason”, on the search for astrophysical signs of extra spatial dimensions. The program aired in November 2009.
- Selected international engagement activities of Physics Faculty:
  - Djordje Minic was a Visiting Fellow of Merton College at Oxford University (May 2010).
  - Tetsuro Mizutani is part of a team of US physicists, including faculty from the University of Virginia, Vanderbilt, and Virginia Tech, visiting the University of Hue (Vietnam) in June 2010. He will be teaching a course on quantum mechanics to 25 selected students from Hue University.
  - Michel Pleimling continues to serve as reviewer and panelist for the European Commission’s prestigious Marie Curie Fellowship program.
  - Physics faculty members presented numerous invited and contributed talks all over the world; they also serve as organizers for international summarized in the “Discovery” section.
- Physics faculty members presented numerous talks for non-physics audiences:
  - Patrick Huber (pictured below on left) was one of the guests at the Café Scientifique in Blacksburg, with a lecture on the important yet elusive nature of neutrinos: “Project Poltergeist”.
  - Giti Khodaparast (shown below on right) gave several lectures at the Roaoke Valley Governor’s School, on modern topics in physics (October and November 2009)
  - Rahul Kulkarni gave a presentation at Kipps Elementary School (December 2009)
  - Djordje Minic gave a popular lecture on string theory to the Art and Art History Department. This lecture inspired an art show at the XYZ gallery (March 2010).
  - John Simonetti was a lecturer in a one-day program held as part in the Astronomy Elderhostel given at the Mountain Lake Hotel and Wilderness Conservancy. He also mentored his graduate student, Sean Cutchin, who lectured in the same program, on a different topic (October 2009).



- Royce Zia gave a public lecture in Boulder, Colorado, to the local community, entitled *What is Physics? - A personal perspective*. His lecture was part of the outreach activities associated with the *2009 Boulder School for Condensed Matter and Materials Physics* (July 2009).
- 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.
  - Dr. Piilonen chairs the Institutional Board of both, the long-standing Belle and the newly formed Belle II collaboration. As IB Chair, he is responsible for policy formulation, processing of new member applications, and election of the spokespersons.
  - Dr. Pitt is a member of the Executive Committees of two leading experiments at Jefferson National Laboratories, G0 and Qweak. He is also on the steering committee for the new JLAB 12 GeV MOLLER experiment.
  - Dr. Schmittmann serves as Chair of the Group for Statistical and Nonlinear Physics of the American Physical Society (APS). She served on the Editorial Board Member for *Physical Review E* until December 2009 and continues on the board of the *American Journal of Physics*.
  - Dr. Täuber is a member of the Editorial Board of the electronic journal *Research Letters in Physics*, now renamed *Physics Research International*, and an Advisory Panel member for the *Journal of Physics A*.
- A few highlights of university service are provided below:
  - Nahum Arav and Bruce Vogelaar represent the Department of Physics in the Faculty Senate.
  - 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. Soghomonian serves as the faculty advisor of the local chapter of the Society of Physics Students. Once again, our local chapter received the “Outstanding Chapter Award” from the national parent organization.

- Dr. Täuber serves as faculty representative and facilitator for the *Graduate Honor System* (GHS). He also served on the GHS *Chief Justice Selection Committee*, summer 2009.
- 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 Hahn North (Dr. Pitt), Prices Fork Observatory Coordinator (Dr. Simonetti), Society of Physics Students Advisor (Dr. Soghomonian), Sigma Pi Sigma Advisor (Dr. Pitt), Webmaster and Photographer (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 (latest data from 2006). Women are also well represented amongst the graduate student population, at 24% (national average: 19%; latest data from 2007). At the undergraduate level, the picture is very different: By Fall 2010, women will make up just over 16% of our undergraduate students (up from 12% last year). While the increase is encouraging, these numbers remain significantly below national figures. For example, in 2007 (latest available data), women earned 21% of Physics bachelor's degrees in the U.S. We note that women are already underrepresented amongst the incoming freshmen, and the gap widens further over time. Clearly, we need to address both, recruitment and retention.

The "Ladies of Robeson", a networking group consisting of all women in the department (faculty, students, and staff), has seen little activity this year, due to overcommitted student leadership. We are confident that it will revive in the coming year and will resume its role 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 remains small yet close to national averages. As of Fall 2010, we will have 6 minority students

(out of 207) in the department (compared to 8 out of 200 the previous year). We have initiated a partnership with the Physics Department at the University of Texas at El Paso, a minority serving institution with 75% U.S. Hispanic enrollment. Two UTEP students are spending the summer here, working on undergraduate research projects. Our goal is to recruit minority students into our graduate program and to document a strong commitment to minority participation for an upcoming REU proposal.

Some other highlights of our activities are listed below:

- Djordje Minic gave a lecture in the Africana Studies Department on prominent African American theoretical physicists.
- Our summer research opportunities attract women and minorities from other universities and high schools. Three of our interns are female and four are minorities (three African Americans and one Hispanic).
- 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). The award officially ends this summer.
- Drs. Takeuchi and Simonetti play lead roles in the “Fields Everywhere” project lead by Prof. Mitzi Vernon (Department of Industrial Design). The objective is to develop a museum exhibit which explains the concept of a “field” to middle school aged children, with a special emphasis placed on engaging girls. A major proposal (\$2.7 million for four years) is under review at NSF’s Informal Science Education program.
- Dr. Soghomonian continues her outreach activities with the Southwest Virginia Higher Education Center (Abingdon, VA), in collaboration with VT-STEM. She served as participant and workshop leader in the 2009 Summer STEM Institute, July 21-23. The workshop carried the title “Science and Technology for Energy”.
- As every summer, Dr. Takeuchi visited Ochanomizu Women’s University in Tokyo during the summer of 2009 to support 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**

- Assistant Professor Patrick Huber received a DOE Early Career Research Award for his work in neutrino physics. Huber was one of only 69 awardees from a pool of approximately 1,750 applicants from universities and national labs.

- Dr. Leo Piilonen was honored with a 2010 COS Certificate of Teaching Excellence.
- Professor emeritus Royce Zia received a renewed invitation from the Alexander-von-Humboldt Foundation, to continue his collaborations in Germany. He spent March-May 2010 in Germany and France and presented five invited colloquia and seminars during that period.
- An essay by Professor Djordje Minic and Professor emeritus Chia-Hsiung Tze received an honorable mention in the Gravity Research Foundation 2010 Essay Contest.
- Dr. Nahum Arav was a finalist for the 2010 Sporn Award for Excellence in Teaching Introductory Subjects.
- Prof. Tatsu Takeuchi was Virginia Tech Scholar of the Week for May 2-8, 2010.

### **Graduate Students**

- Uli Dobramysl won the Erwin Wenzl Prize for his diploma thesis, completed at the University of Linz in his native Austria, before coming to Virginia Tech (November 2009)
- Ph.D. student Yen-Liang Chou won a 2010 SigmaXi Research Award for his work with Professor Michel Pleimling, on non-equilibrium surface growth processes.
- In April, graduate student Martin Rudolph and alumnus Kevin Finelli (BS Physics and Mathematics 2009, now a graduate student at Duke University) received honorable mentions from the prestigious NSF Graduate Research Fellowship Program.
- Six graduate students were inducted into Sigma Pi Sigma, a national honor society for Physics Students, at a banquet attended by faculty, family members, and friends. Dr. Pleimling gave a talk on “Flocks of birds, cloud patterns, and all that - the physics of complex systems”.
- Seven departmental awards/scholarships were presented to twelve graduate students in a ceremony on April 9, attended by family and friends, donors, faculty, and staff.

### **Undergraduate Students**

- Double major (Physics and ECE 2010) Justin Waugh was named the College of Science Outstanding Senior for 2010.
- Once again, the local Society of Physics Students chapter was named an Outstanding SPS Chapter for 2008-09. The SPS is a national organization for physics students, providing scholarships, networking opportunities and career advice.

- Junior Siddharth Venkat received a 2010 SigmaXi Research Award for his work on mobility and asymmetry effects in rock-paper-scissors games (February 2010)
- Sophomore William Love received the “First Place Texas Instruments Prize” for the best NanoJapan research poster presentation at the 2009 Rice Quantum Institute Summer Research Colloquium. William spent the summer of 2009 in Japan, as part of Rice University’s NanoJapan program, working with T. Taira and M. Yamamoto from the Division of Electronics at Hokkaido University on a project entitled “Half-Metallic Heusler Alloy Based Magnetic Tunnel Junctions”.
- Eleven departmental awards/scholarships were presented to 33 undergraduate students in a ceremony on April 9, attended by family and friends, donors, faculty, and staff.
- Ten undergraduates were inducted into Sigma Pi Sigma, a national honor society for Physics Students.
- 39 Physics majors made the Fall 2009 Dean's List.

## VI. Future directions

Today, science is an 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 *limited* resources. If we succeed, continued and growing vibrancy will be assured.

Our undergraduate programs remain a true strength of the department, thanks to strong enrollments, high expectations, and a very supportive climate. The emphasis here will be on nurturing these strengths. Special attention will be given to our extensive core and service courses which are continuing to see steep enrollment growths. Our vision is to develop a team of dedicated, effective instructors who can devote considerable time to the large numbers of students in these courses. Two recent instructor hires will advance us towards this goal. We also intend to increase the scope of both the calculus- and algebra-based courses, by developing online versions. Initially, these will be targeted towards summer sessions, but eventually we also envisage attracting new students during the regular semester, e.g., by offering continuing education credits to teachers. Our graduate program has seen major growth in student numbers. While we do not anticipate significant further growth, recruitment will remain a critical priority, focused on student quality rather than numbers. We also 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. Contacts with alumni, from academia as well as the private and government sectors, will be nurtured and expanded in order to provide graduate and undergraduate students with essential networking experiences.

With regards to our research projects, we plan to continue the strategic directions identified as part of our external review process: astrophysics, materials 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. Since the College of Science anticipates several faculty searches this coming year, the department has specified its priorities for the coming year. We seek one hire in materials physics, with a specific focus on energy-related applications, and a second hire in astrophysics, with a focus on data analysis and pattern recognition. Both hires fit well into the current clusters pursued by the College. Further, the coming year will see: (1) the establishment of a college-level center focused on neutrino physics, including an inaugural workshop; (2) two international conferences on campus, led by physics faculty; (3) the first hire into a new *Research Instrumentation Team*, designed to provide research support in electronics, systems integration, and vendor contacts.

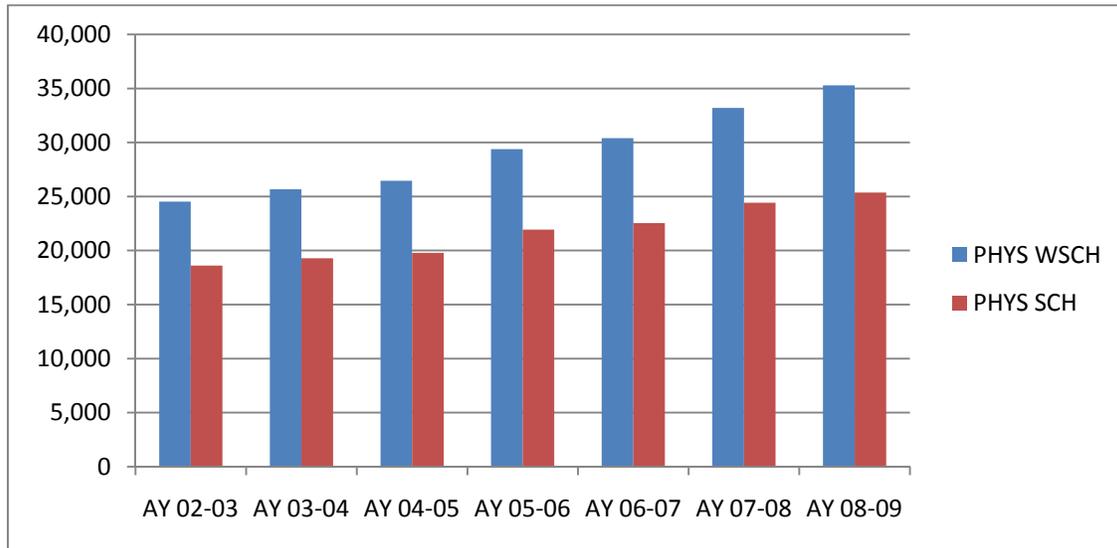
Integrating across several dimensions, the College of Science has put forward plans to develop undergraduate degrees in neuroscience and nanoscience. The department intends to participate fully in the development of these programs, leveraging available and targeting new resources.

In summary, the department has seen remarkable progress in the face of massive external pressures: budget cuts, lay-offs, retirement incentives, and curtailed hiring. Yet overall, the department follows a strongly positive trajectory, and both faculty and staff remain sincerely and deeply committed to the continued success of our research and educational programs.

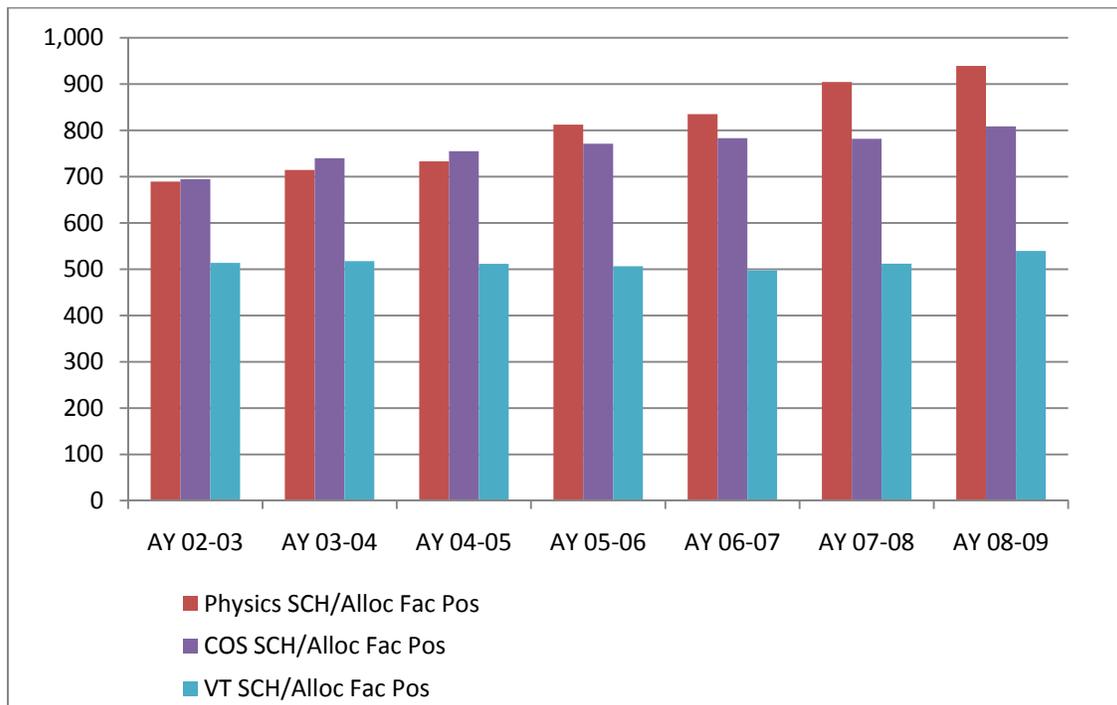
## Part 3: Data and Trends

### Enrollments:

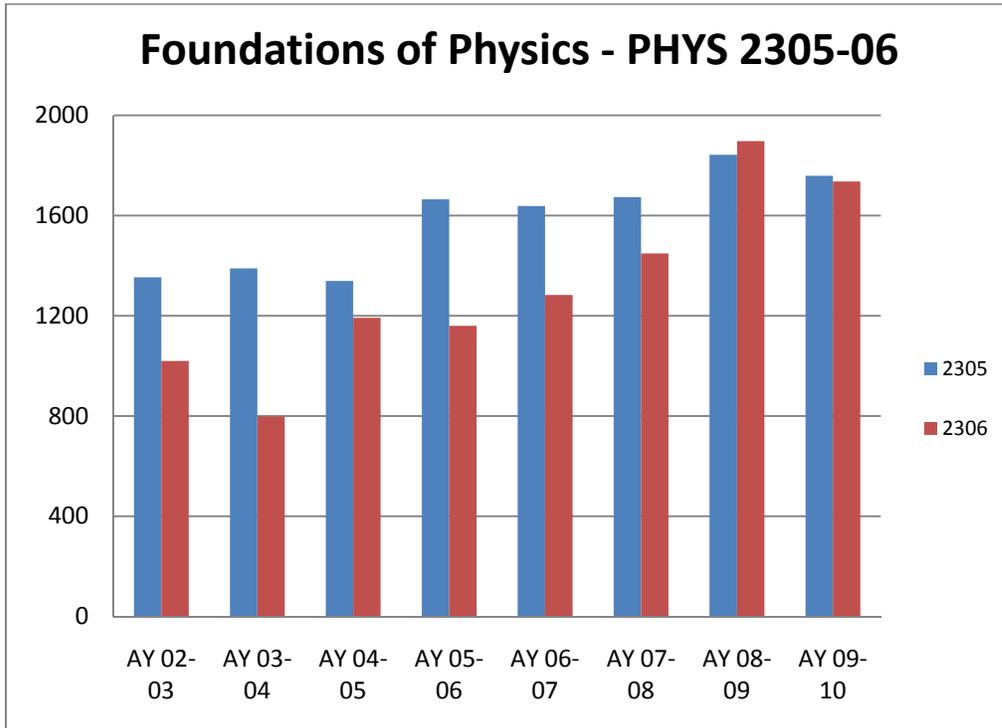
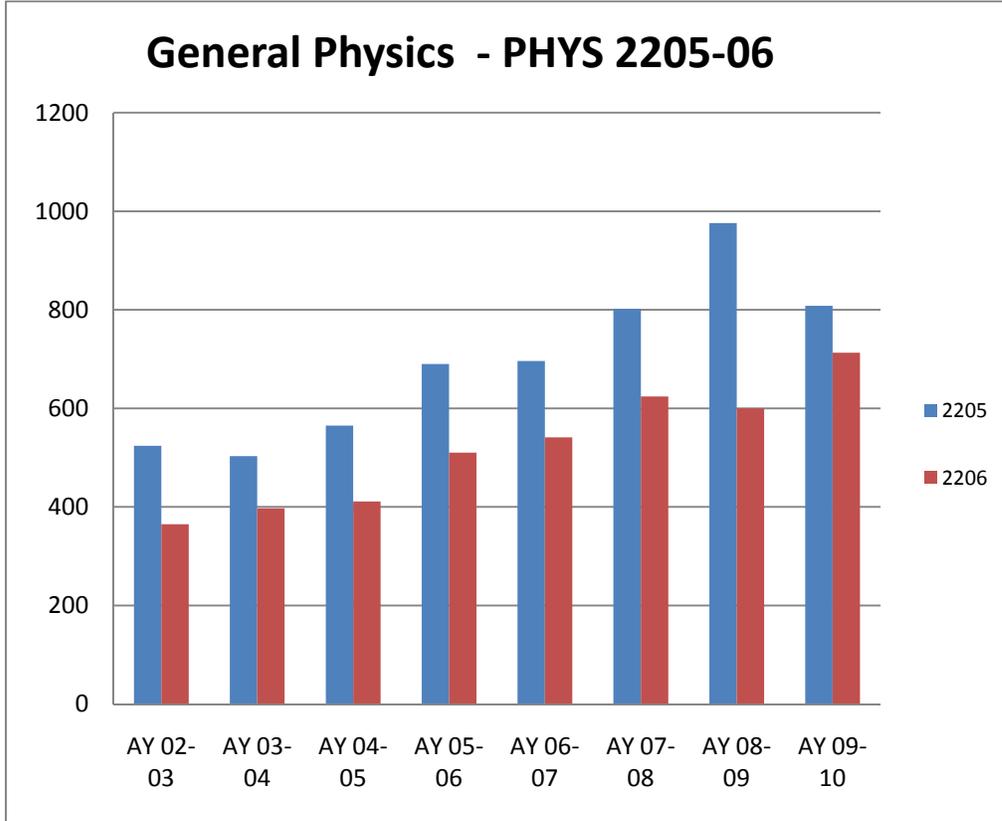
**Annual student credit hours (SCH) and weighted student credit hours (WSCH) delivered by Physics (IR data):**



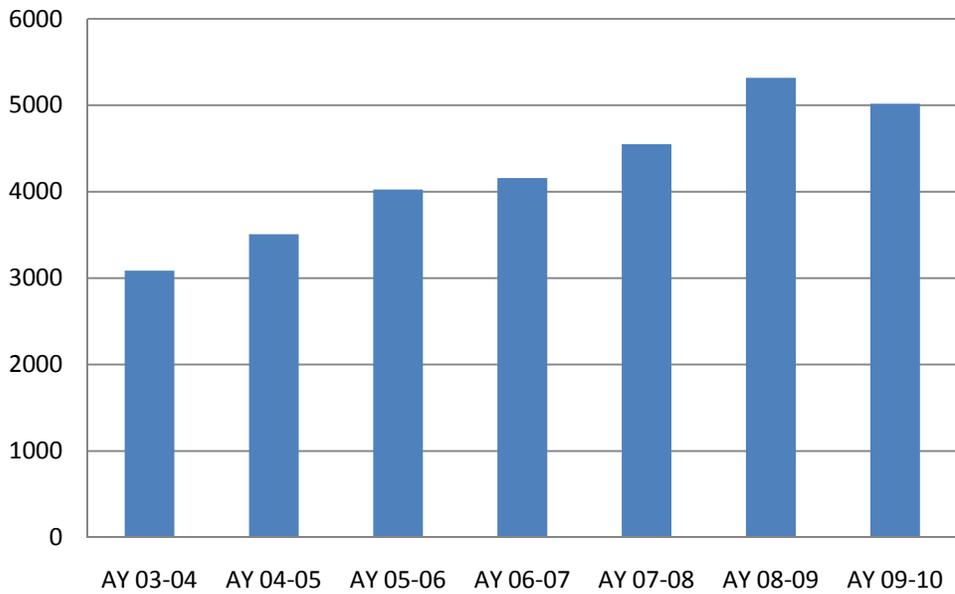
**Annual student credit hours per allocated faculty position, for Physics, the College of Science, and Virginia Tech (IR data):**



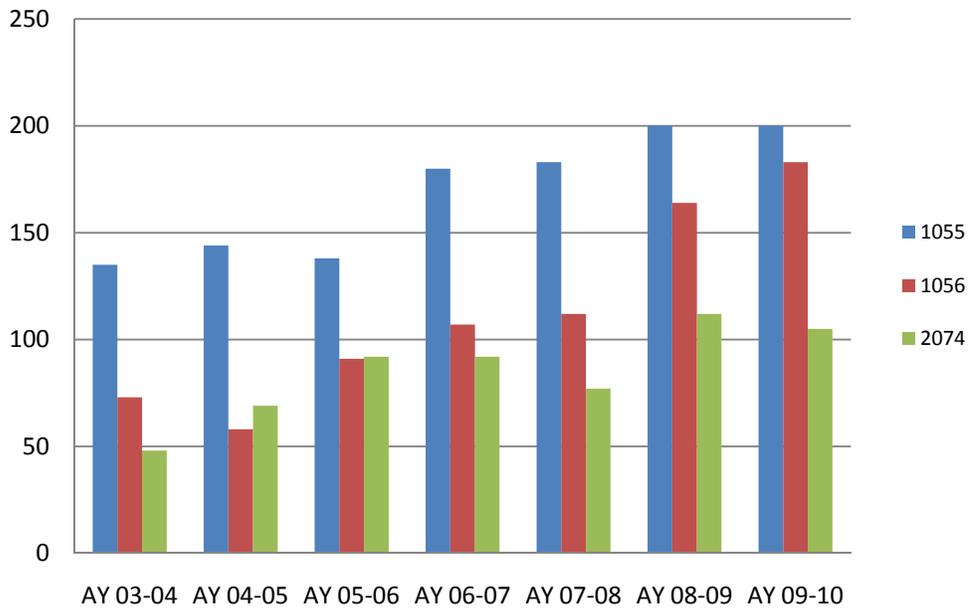
**Enrollments in core and service courses (department data):**



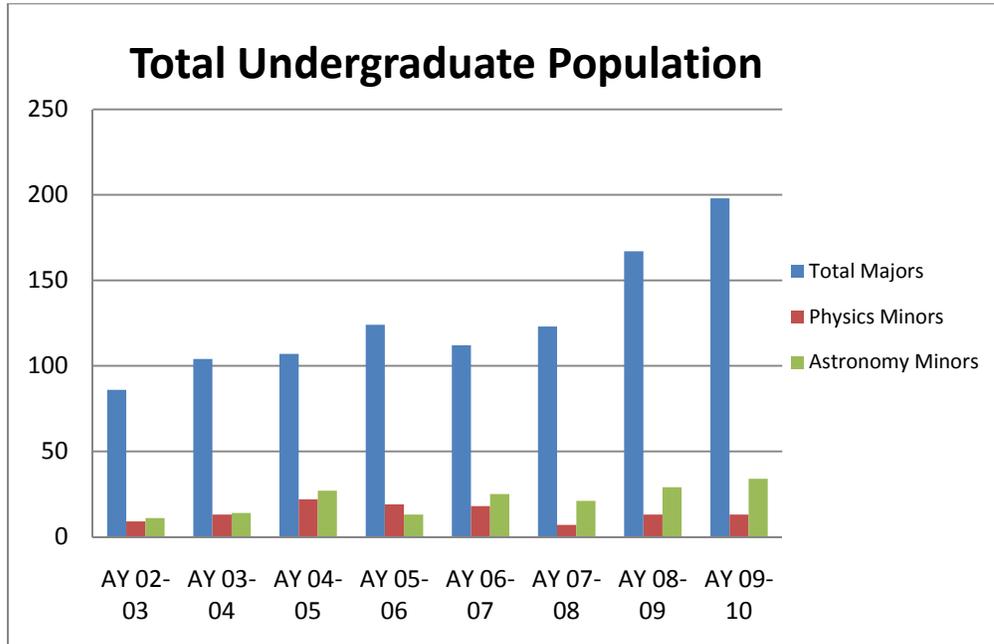
### Seats in PHYS 2205-06 and 2305-06, by year



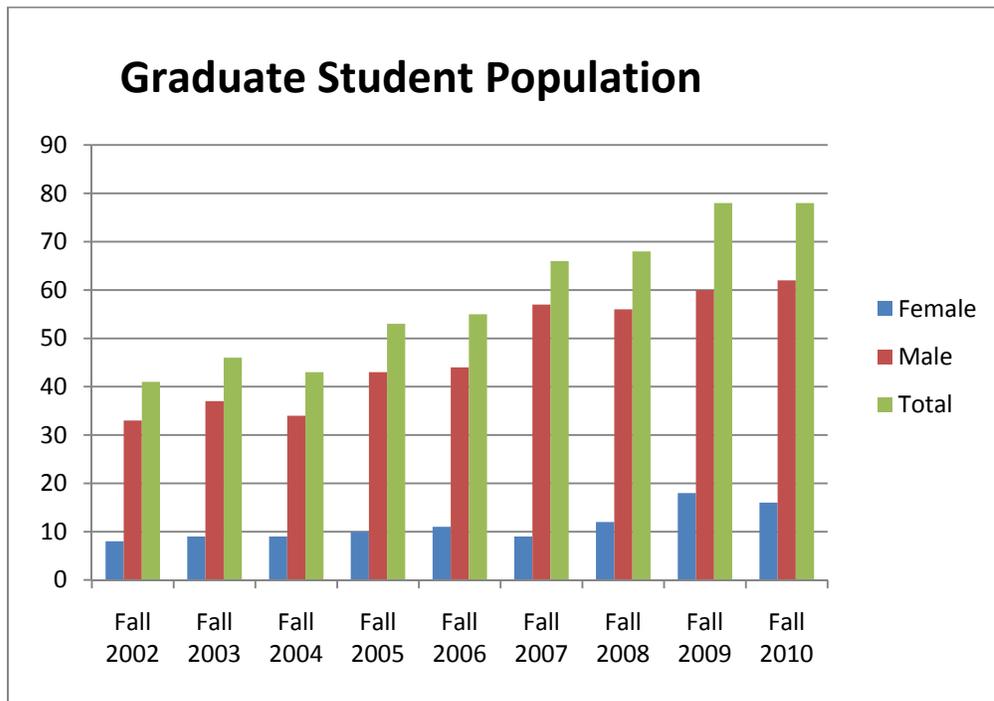
### Enrollments in Introductory Astronomy and Contemporary Physics



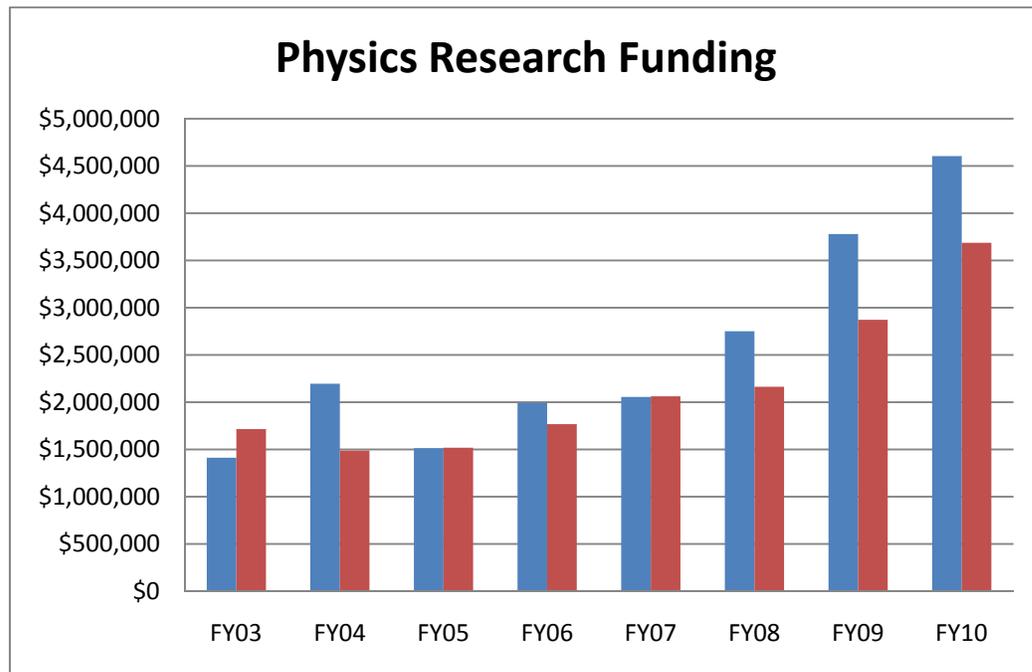
**Physics majors (first and second), physics minors, and astronomy minors (department data):**



**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. Heremans, Khodaparast, Kulkarni, Ritter, and Robinson hold seed grants from ICTAS. Robinson, Schmittmann and Zia were awarded new seed grants, effective FY10.
- Drs. Heflin and Kulkarni are parts of two separate teams which have received seed funding 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. Vito Scarola, Assistant Professor (August 2009)
- Dr. Read Montague, Professor (offer made in May 2010; effective September 1, 2010)
- Mr. Kriton Papavasiliou, Instructor (offer made in May 2010; effective August 10, 2010)
- Mr. Almas Khan, Instructor (offer made in May 2010; effective August 10, 2010)

### **Faculty Promotions and Retirements**

- Dr. Jonathan Link and Dr. Kyungwha Park will be promoted to Associate Professor with tenure, effective August 2010
- Dr. Michel Pleimling will receive tenure, at his current rank of Associate Professor, effective August 2010
- Dr. John Simonetti will be promoted to Professor, effective August 2010
- Dr. Royce Zia retired on December 31, 2009. Drs. Marvin Blecher, Tetsuro Mizutani, and Joseph Slawny will retire effective June 1, 2010. Dr. Alfred “Jimmy” Ritter also plans to retire, most likely effective August 31, 2010
- Dr. Norman Morgan, Senior Research Scientist, is leaving effective June 30, 2010. His position was eliminated, as part of the restructuring of the Electronics Shop.

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

- Fred Mahone, Electronics Technician, is retiring effective June 30, 2010. His position was affected by the restructuring of the Electronics Shop.