Physics Department Self-Study Report for the Academic Program Review

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Abstract

This report contains material for the Academic Program Review of the Physics Department at the University of Arizona. The report mainly covers the years from 2003-2009.

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1 Introduction

1.1 Introduction

The Arizona Board of Regents (ABOR) mandates that each unit undergoes a periodic Academic Program Review (APR). One component of the APR involves a comprehensive self-study by the unit that is summarized as a report, to be provided to the reviewers and the University administration. Based on the self-study report and their site visit, the reviewers are expected to evaluate the unit as well as provide recommendations that may help the Department to better carry out its mission.

The present self-study report of the Physics Department of the University of Arizona was prepared during 2010-11 by the Associate Department Head Kenneth Johns and the Department Head Sumit Mazumdar, with extensive help and input from Physics faculty and staff. The format of the report essentially follows that suggested in the APR manual provided by the Office of the Executive Vice President and Provost, with minor modifications.

The Department's previous APR took place ten years ago in 2000, even as ABOR guidelines mandate reviews every seven years. Twice in the past three years the Department's APR was postponed, in large part due to disruptions in Departmental leadership between 2005 and 2009. In 2007, the Dean of the College of Science, Joaquin Ruiz, recommended a visit to the Department by a "Blue Ribbon Committee" (BRC), consisting of five prominent scientists and the Chair of the then Physics Advisory Board. While the overall charge to the BRC was limited in scope, the purpose of the visit was to an extent the same as an APR, viz., to provide specific guidelines concerning the Department's research and educational missions to the Department members and the University administration. Additional stress during this same period resulted from an unprecedented financial crisis at the University and State levels and implementation of a Transformation Plan by the University "to consolidate and realign programs to adapt to dynamic changes in resources and priorities". Several faculty departures as well as severe staff retrenchment occurred during this period.

In spite of all these, most Department faculty and staff remain optimistic. Many in the Physics faculty are internationally renowned leaders in their fields. Their productivity and visibility remain high. Research by Physics faculty continue to be highlighted in the local and national media. Physics faculty have won recognition in the form of teaching and research awards. Recent hires have all worked out very well. Tenure decisions in the past several years have all been favorable and junior Physics faculty have attracted significant research funding. Several faculty play visible roles in campuswide interdisciplinary research. Newly invigorated outreach efforts aimed towards increasing undergraduate and graduate enrollment and emphasizing women and underrepresented minorities are beginning to take shape.

In spite of financial stresses at the College and University levels, plans to expand the faculty size in Physics are in place. In addition to presenting detailed performance data, the self-study report also offers a strategic plan that is aligned with the University's mission to enhance educational excellence and to increase achievements in research and scholarship. With timely investment, the Department is poised to reach new heights in its mission of academic and research excellence. We look forward to the APR as an opportunity to identify the strengths and weaknesses of the Physics Department and to discuss ways to further enhance the important role the Physics Department plays in achieving University goals.

2 Self Study Summary

2.1 Department Overview

The mission of the Physics Department parallels the mission of UA: to provide a comprehensive, high-quality education that engages students in discovery through research and broad-based scholarship. The goals of the Physics Department are excellence and achievement in education, research, and service. The Physics Department at the University of Arizona (UA) is housed in the College of Science.

A list of faculty in the Physics Department, their rank, and their primary research field is given in Table 1. There are 18 Full, eight Associate, and two Assistant professors in the Department.

There are two lecturers in the Department: Lecturer Shawn Jackson and Senior Lecturer Drew Milsom.

There are academic programs for both undergraduates and graduates. For undergraduates, the Physics Department offers two degrees: a B.S. and a B.A. The B.S. degree is the normal one for students aiming for graduate school or seeking jobs utilizing a Physics background. A Physics minor is offered for non-Physics majors. A B.Sc. in Science Education with a physics concentration can be obtained through the College of Science (COS).

For graduates, the Physics Department offers a Ph.D. There is no official M.S. program; however the degree is often awarded enroute to the Ph.D. A second degree program for graduate students is the Professional Science Masters (PSM) program in Applied and Industrial Physics (AIP). Currently there is one option, Medical Physics. This program is in the process of being renamed to the PSM program in Medical Physics.

The number of undergraduate Physics majors and Ph.D. and PSM students in 2009 is given in Table 2.

2.2 Department Summary

As mentioned above, the goals of the Physics Department are excellence and achievement in education, research, and service. Our view of the Physics Department is that it provides strong and healthy degree programs for both undergraduate and graduate students. It is notable that a

Name	Rank	Research Area
LeRoy, Brian	Assistant Professor	Condensed matter experiment
Sandhu, Arvinder	Assistant Professor	AMO experiment
Cronin, Alexander	Associate Professor	AMO experiment
Fleming, Sean	Associate Professor	Nuclear theory
Jacquod, Philippe	Associate Professor	Condensed matter theory
Manne, Srinivas	Associate Professor	Biophysics experiment
Stafford, Charles	Associate Professor	Condensed matter theory
Su, Shufang	Associate Professor	Particle theory
Varnes, Erich	Associate Professor	Particle experiment
Visscher, Koen	Associate Professor	Biophysics experiment
Barrett, Bruce	Professor	Nuclear theory
Cheu, Elliott	Professor	Particle experiment
Dienes, Keith	Professor	Particle theory
Fang, Li-Zhi	Professor	Astrophysics theory
Hsieh, Ke-Chiang	Professor	Space science experiment
Johns, Kenneth	Professor	Particle experiment
Lebed, Andrei	Professor	Condensed matter theory
Mazumdar, Sumitendra	Professor	Condensed matter theory
Melia, Fulvio	Professor	Astrophysics theory
Meystre, Pierre	Professor	AMO theory
Rafelski, Johann	Professor	Nuclear theory
Rutherfoord, John	Professor	Particle experiment
Sarcevic, Ina	Professor	Particle theory
Shupe, Michael	Professor	Particle experiment
Toussaint, Doug	Professor	Particle theory
van Kolck, Bira	Professor	Nuclear theory
Wing, William	Professor	AMO experiment
Zhang, Shufeng	Professor	Condensed matter theory
Bickel, Bill	Professor Emeritus	AMO experiment
Donahue, Doug	Professor Emeritus	AMS
Garcia, J.D	Professor Emeritus	AMO theory
Huffman, Don	Professor Emeritus	Condensed matter experiment
Just, Kurt	Professor Emeritus	Particle theory
Kessler, John	Professor Emeritus	Biophysics experiment
Kohler, Sigurd	Professor Emeritus	Nuclear theory
McIntyre, Larry	Professor Emeritus	AMS
Scadron, Mike	Professor Emeritus	Particle theory
Thews, Robert	Professor Emeritus	Particle theory

Table 1: List of enture-track, tenured, and emeritus Physics faculty

Students	Number
Undergraduate Physics majors	194
Graduate Ph.D. students	73
Graduate PSM students	6

Table 2: Numbers of undergraduate Physics majors, graduate Ph.D., and PSM students in 2009

majority of physics undergraduates participate in research projects in the Physics Department and elsewhere on campus (beyond the one semester degree requirement). The Physics Department also shoulders the teaching of significant student credit hours for non-majors in disciplines such as Engineering and Life Sciences

In research, our view of the Physics Department is that it is a solid one with much to be proud of. Most faculty maintain strong and visible research programs which are sometimes multidisciplinary. The problems being solved by faculty research are relevant, if not forefront. Some of that research is carried out by faculty who are acknowledged leaders in their fields. Of note, Prof. Keith Dienes is the Program Director for Theoretical High Energy Physics and Cosmology at NSF.

Most of the research in the Department is funded at the individual investigator level through NSF or DOE. While such individual research can be and is outstanding, the resulting grant revenue can be limiting. In the future, the Department hopes to tap into additional sources of funding via broader interdisciplinary collaborations or physics centers. A few faculty members are beginning to lead or join larger collaborative efforts which is encouraging.

In service, two faculty have administrative responsibilities outside the Department. Prof. Elliott Cheu is the Associate Dean of the College of Science and Prof. Pierre Meystre is the Director of the B2 Institute at Biosphere 2. Both lead extensive outreach programs as part of their responsibilities. Beyond this, to date the other outreach activities of the Department are more modest. The new Department Head, Sumit Mazumdar, has made outreach a priority in the Department and named a specific faculty member, Prof. Srin Manne to lead this effort. Our vision is to build on existing outreach efforts already ongoing in the College of Science and we have made noticeable progress in this area.

It is important to note that the State of Arizona has had to reconcile record budget deficits in the last several years. From FY2008 to FY2010, State General Fund appropriations to the UA have been cut by nearly one-quarter, from approximately $431 million to $344 million. Initial projected funds for FY11 are $278 million. Some of these cuts to UA of course flow down to the Physics Department. The foreseeable futures for both the State and the University are ones of continued financial crisis.

The biggest problem facing the Physics Department is its declining number of faculty. The budget ills of the State and University rule out easy fixes. Nevertheless we have developed a sensible strategic plan for moving forward. Our plan takes advantage of the fact that physics is done in a wide variety of departments and institutions on campus. By leveraging existing links and by creating new ones with these groups, we hope to increase our ability to reverse the negative slope in faculty growth. We also have plans to increase the number of Physics majors and Ph.D.'s which aligns with similar growth plans by UA.

In summary, challenging times are ahead for both the Physics Department and the University. Yet we feel optimistic that our existing strengths, realistic vision, and creative ideas will see us through these temporary crisis years.

3 Unit Description

3.1 Unit Mission and Scope

As previously stated, the mission of the Physics Department, aligned with the mission of the University of Arizona (UA), is to provide a comprehensive, high-quality education that engages students in discovery through research and broad-based scholarship. Our goals are excellence and achievement in undergraduate and graduate education, research, and service. The Department carries out leading edge research in many different subfields of physics. The Department engages in local, national and international professional and community service. There are 28 full time faculty in the Department.

- *Education*

  The Physics Department seeks to maintain excellence in education at the undergraduate and graduate levels. At the undergraduate level, we strive to prepare students for superior performance in graduate school or employment in industry or at national labs. At the graduate level, we strive to prepare students for academia in physics or for leading roles in a variety of industries or at national labs.

  At the undergraduate level, the Physics Department offers B.S. and B.A. degrees in Physics though the former is the predominant route pursued by students. The Department used to administer a B.S. degree in Engineering Physics that was offered through the College of Engineering. This degree was discontinued in 2008 by the College of Engineering because of low enrollment. Finally, a Physics Minor is offered for students pursuing other majors but wishing additional concentration in physics.

  At the graduate level, the Physics Department offers a Ph.D. degree in Physics. An M.S. in Physics degree is also offered but there is no official M.S degree program. Rather, the M.S is earned en route to the Ph.D. or by students not continuing to a Ph.D. Additionally, the Physics Department offers a Professional Science Masters (PSM) degree in Applied and Industrial Physics (AIP). Started in 1995, this degree originally targeted students seeking to become high-tech managers in industry or government. It combined core physics courses with specialty courses and off-campus internships. It included courses in business fundamentals. In 2007, this program evolved into one PSM track, medical physics, and it eliminated the business aspects of the program. Thus the existing PSM program now targets students desiring to become medical physicists with an M.S. degree or to continue towards their Ph.D. in this field at another institution. It is in the process of being renamed to the Professional Science Masters program in Medical Physics.

Also associated with the Physics Department is the Science Teacher Preparation Program (STPP). The program is housed in the College of Science with Director Ingrid Novodvorsky's line held by Physics (51%) and Molecular and Cellular Biology (49%). It provides science majors, including those in physics, with the opportunity to take courses and engage in school experiences that will lead to a B.S. degree in Science Education or, with their B.S. degree in science, eligibility for secondary science teacher certification. A B.S. degree in Science Education with a Physics Concentration is available and graduates approximately one student per year.

- *Research*

  The Physics Department strives for excellence in physics research. The research goals of the Physics Department include innovative work on forefront problems in physics and competing for external funding for that research. A small fraction of that research includes interdisciplinary physics with other campus units in the physical sciences.

  Loosely speaking, research in the Physics Department divides into two major groupings which the faculty characterize as the "high-energy physics" (HEP) cluster and the "low-energy physics" (LEP) cluster. Programs in the HEP cluster include theoretical and experimental particle physics, theoretical nuclear physics, and theoretical astrophysics and cosmology. Faculty are involved in search for new fundamental physics at the Large Hadron Collider and for new physics beyond the standard model; theoretical efforts to understand nuclear matter, neutrino physics and dark matter; and the study of the physics of matter and radiation in the extreme conditions encountered near compact astrophysical objects. Programs in the LEP cluster include theoretical and experimental AMO (Atomic, Molecular and Optical) physics, theoretical and experimental condensed matter physics and experimental biophysics. Research interests here include BEC (Bose-Einstein Condensates), atom optics, optomechanics and attosecond light pulses; nanoscience, quantum transport, strongly correlated electrons, superconductivity and spintronics; soft-condensed matter and the single-molecule biological physics of gene expression. There are also a small number of individual and collaborative efforts in applied areas such as photovoltaics and solar energy. Beyond the HEP and LEP clusters, a world class Accelerator Mass Spectrometer (AMS) program is also housed in the Physics Department.

- *Service*

  The Physics Department is engaged in a variety of community and professional service and outreach activities. These occur at the local, national, and international levels. A highlight each year are the Department's Physics Phun Nites (two nights), a community event which entertains nearly three hundred adults and children with a wide array of spellbinding physics demonstrations. At the other end of the spectrum, faculty in the Department have professional committee and editorial responsibilities at the very top of their fields.

3.2 Department Strategic Plan

Because the outlook for the economic conditions of the State and the University are fair at best, the strategic plan for the Department is not overly specific in order to retain flexibility. Our strategic plan was influenced by suggestions made by the previous Academic Program Review as well as those made by the Dean's Blue Ribbon Committee, which visited the Department in 2007 (see Section 4).

The purpose of this plan is to provide a set of guiding priorities which may provide a framework for future decisions. It also contains a few examples of initiatives in progress that align with this plan. The plan was presented to the faculty in Fall 2010 Faculty comments and email were generally supportive of the plan.

The goals of the Physics Department are excellence in research, teaching, and service. The strategic plan for the Department is based on growth in each of these areas. These priorities will allow us to significantly strengthen the Physics Department. Our vision is to create a dynamic department that focuses not only on its own research and educational excellence but also one which is well connected to, and integrated with, other research and educational programs at the University. Below we outline our strategic goals in the areas of research, education, and outreach, not in any particular order of importance.

- *Increasing achievements in research, scholarship and creativity.*

  Continued excellence in research will necessarily require real growth in our faculty size. The strained financial conditions of the State and University during the past five years, coupled with attrition in the Physics Department (see Section 6), have left the number of faculty well below the optimum. Our top priority is to reverse this trend over the next five to seven years. It would be pointless to set a target faculty number in view of the continuing and anticipated financial constraints. An exact number here is less important than achieving a positive slope, in spite of retirements. *We recognize, however, that major overhauls of the program may become necessary in order to attain even this modest growth.*

  The Department plans to pursue new hires in areas that, in general, are also of interest to the College of Optical Sciences and the Departments of Astronomy, Planetary Sciences and Chemistry. Research areas where the interests of Physics faculty overlap with those of faculty in Optical Sciences include different subfields under the broad umbrella of AMO physics. Research collaborations here between the two units have always existed. The Department Heads of Physics, Astronomy, and Planetary Sciences all agree on strengthening the Theoretical Astrophysics Program (TAP), which has lost multiple stellar faculty members to prominent universities in recent years. Physics and Astronomy also share the belief that a strong experimental particle astrophysics program will be a natural growth area for the University of Arizona. The condensed matter physicists, AMO physicists, and biophysicists on the one hand, and physical chemists and biochemists on the other, have very recently (in 2009) created a new Chemical Physics Program that emphasizes interdisciplinary research. Beyond such specific interdepartmental collaborations, there also exist University-wide programs focusing on the environment, sustainability, solar energy, etc. where Physics faculty can potentially play strong roles.

In addition to hires at the interfaces of fields (but within individual Departments) true shared hirings (where the faculty member's responsibilities and commitments are to multiple Departments) will also be of interest. Indeed, this may be one way to generate cluster hires in a broad research area, with "push" from multiple Departments making approvals at the University's administrative level more likely. One overarching goal in all of our above efforts will be to achieve critical mass in specific areas that will allow us to lead or be part of federally funded interdisciplinary research centers.

While these expanded-view hires are critical to our future, it is imperative that this growth does not come at the expense of fields that lie traditionally in physics. Even as one-to-one replacements of recent or future losses due to attrition are not anticipated, targeted hirings in so-called traditional areas will be essential for sustaining excellence in the Department as well as maintaining our visibility in the physics community. While initial investments for experimental hires in traditional physics areas often look prohibitive at first glance, they bear fruit in the long term, as evidenced by the funding support received by our two most recent hires (Profs. Brian LeRoy and Arvinder Sandhu). For any growth to occur it is obvious that the number of new hires must necessarily be greater than the number of retirements.

- *Increasing achievements in graduate education*

  Compared to our peer institutions, our graduate student population is undersized. More importantly, our graduate student population is undersized for our own research needs. At the same time, one of the University's goals is to increase the number of doctoral degrees awarded. We plan to increase the number of graduate students by significantly increasing our recruiting efforts, especially of women and underrepresented minorities. We are pursuing this goal through increased visits to conferences (e.g. SACNAS (Society for Advancement of Chicanos and Native Americans in Science)), through participation in national programs (e.g. APS Minority Bridge Program), and through forging new links with regional institutions including Minority Serving Institutions (MSIs).

  As mentioned above, broadening our research portfolio at field boundaries will also increase opportunities for graduate students. The recently established Chemical Physics program is one example of such an effort. Finally, we will be targeting specific foreign universities for international applicants, as their numbers have fallen somewhat in recent years. Efforts in this direction have already started with a recent visit to multiple research institutes in India by the Department Head.

  A sustainable graduate education program must necessarily be accompanied by a focus on placement of the graduate students, including those who do not want to pursue a traditional academic career. In 2010 we created a new Advisory Board for the Department whose charges include advising the Head on employment opportunities for physicists outside the academic world. Previous advisory boards consisted of academics only. The constitution of the current board is somewhat different from previous boards in the sense that two members (Lacovara and Carsten) are from industry (more industrial members are being sought) and three have extensive administrative experience (Gehrels, Powell, Krane). Two others are Emeritus Professors at UA. In addition to helping us determine career opportunities for physics graduate and undergraduate students, the board will also advise us on increasing overall enrollment of physics majors and increasing minority and female enrollment. The members of the new Advisory Board are given in Appendix B.

- *Increasing achievements in undergraduate education*

  The College of Science budget is based in part on the number of student credit hours, majors, and degrees in the Department. One of the University's goals is to increase the number of Bachelor's degrees awarded. We plan to increase the number of undergraduate physics majors by significantly increasing our recruiting and outreach efforts, especially of women and underrepresented minorities.

  With this in mind, a new Committee for Public Relations, Outreach and Recruitment was therefore created in 2010. The chair of this committee (Prof. Srinivas Manne) will continue to function in that position for at least three years, and was selected based on his strong track record as an award winning classroom teacher and as a successful mentor of undergraduates. Other committee members include yet another award winning teacher (Shawn Jackson), a Hispanic Professor Emeritus with several teaching awards who plays a leadership role on minority education at the national level (Prof. J. D. Garcia), the Director the Science Teacher Preparation Program (Dr. Ingrid Novodvorsky), the Directors of Undergraduate and Graduate Studies (Dr. Drew Milsom and Prof. Koen Visscher), the Department Head (Prof. Sumit Mazumdar) and Associate Head (Prof. Ken Johns), and the Associate Dean of the College of Science (Prof. Elliott Cheu). Cheu is included in order to coordinate our outreach and recruitment efforts with those of the College of Science. We also plan to broaden our appeal by developing one or two high enrollment Natural Science courses for non-majors. The proposed courses would be submitted to satisfy UA General Education requirements.

  Along with these outreach efforts, we will also review the current curriculum to determine how well it addresses the needs of the ”modern, 21st century” student.

  As with graduate education, there will be increased emphasis on student placement of undergraduates. The Department will review its undergraduate curriculum and explore tracks for students with varying career goals. One immediate goal is to establish summer internship programs with local industries. Discussions with the Departmental Advisory Board concerning this have already begun. The Committee on Public Relations is also expected to visit and consult local industries.

- *Increasing achievements in our outreach mission*

  We plan to grow our outreach efforts and better integrate them with the College of Science and University. One goal of this increased outreach is of course increased enrollment of physics majors and increased awareness of the Physics Department in the community.

  We have already taken action towards our goal of increasing outreach. As mentioned, a dedicated Outreach Coordinator and Committee are now in place and at work. Two Physics faculty (Profs. Cheu and Meystre) already direct substantial outreach efforts for the College of Science and Biosphere 2 (B2) Institute. Where possible, we plan to build on and integrate with existing programs. One example is a recently developed physics course “Communicating Physics” that is training junior and senior physics majors in demonstrating and explaining physics experiments to K-12 students. This outreach program aligns closely with service learning activities in existence in the College of Science. More details are given in Section 11.

3.3 Relationship of Goals to the University Strategic Plan

The Physics Department will play a key role in all four areas of the University's five-year strategic plan for 2012-2016 (http://provost.arizona.edu/files/UA_Strategic_Plan_12_15_2010.pdf).

- *Expanding access and enhancing educational excellence*

  One of the main missions of the Physics Department is educational excellence. We will continue to be successful in that mission. One goal of our strategic plan is to increase enrollment in both the undergraduate and graduate programs. In particular, we aim to increase enrollment by focusing especially on underrepresented minorities and women. Our strategic plan gives detailed steps we have taken and intend to take to achieve our goals.

- *Increasing achievements in research, scholarship, and creative expression*

  Another main mission of the Physics Department is excellence in research and scholarship. Again the Physics Department strategic plan provides a roadmap for increasing the strength of the Physics Department by growing at all levels: faculty, graduate, and undergraduate students. It is understood that the model of a standalone Department be further strengthened by a more collaborative model. The University has identified areas critical to Arizona's future. These include Biosciences, Optics, and Space Exploration. As proposed in our strategic plan, a significant fraction of growth in the Physics Department will come in those areas of research on campus which are already excellent and which have broad research overlap with Physics. We also have an individual collaboration with AZRISE (Arizona Research Institute for Solar Energy) that is expected to expand in the future.

- *Expanding community engagement and workforce impact*

  One of the goals of the Department's strategic plan is to increase the number of undergraduate and graduate physics majors. Some fraction of these will remain in Arizona and become technological innovators needed to drive economic development in Arizona. Input from local industry leaders on our new advisory board will help inform the best curriculum for undergraduate and graduate students. The Science Teacher Preparation Program will train the next generation of middle school and high school science teachers in Arizona.

  Our strategic plan also indicated that we will enhance our outreach and community engagement efforts. By joining new or existing outreach efforts in the College of Science we will increase our impact and visibility in the community beyond what exists from our successful Physics Phun Nite and science cafe participation. Our planned service-oriented "Communication Physics" course will positively influence a multitude of K-12 students.

- *Improving productivity and increasing efficiency*

  The Department of Physics will continue to explore tighter integration of physics research and education efforts across campus. Our plan includes and has already led to co-convening courses with Optical Sciences and Astronomy, leading to increased efficiency. Other such efforts (for example, co-convening of courses within the Chemical Physics Program) might ensue in the future.

4 Unit History

4.1 Major Changes Since the Last Academic Program Review (APR)

A number of major changes have occurred since the last APR in 2000. These include multiple disruptions in Departmental leadership, departures of several faculty members (over and above retirements), and intense discussions about potential restructurings at the College and University levels. The latter included many different ideas for merging the Physics Department with other campus units engaged in research in Physical Sciences, such as the departments of Astronomy, Chemistry, Geosciences, Planetary Sciences, and the College of Optical Sciences. The merger discussions were particularly stressful to the Department as they appeared to the Department faculty to be primarily driven by the University leadership down rather than by the Departmental level up. At the same time, there were also reasons to seriously consider forming a loose federation of units within physical sciences. No significant step in this direction has been taken to date, although limited decisions resulting in increased efficiencies in classroom teaching have been taken.

- Disruptions in Leadership

  Prof. Daniel Stein was the Department Head at the time of the last APR in 2000. Stein had provided leadership for almost exactly ten years (1995 - 2005), and had hired nearly all the faculty who were at the level of assistant professor at the time of the last APR or later. When Stein announced his intentions to leave for NYU, a faculty election was held in Fall 2004 but no consensus candidate emerged. Subsequently, Prof. J. D. Garcia was appointed Interim Head by the Dean of the College of Science, Prof. Joaquin Ruiz, and a search committee was formed to pick the next Head. Following another round of elections, Dean Ruiz appointed Pierre Meystre, Prof. of Optical Sciences, as the Department Head and he started in July 2005. Unfortunately, the entire process had taken a lengthy time, allowing uncertainties about the future of the Physics Department to grow among the faculty and staff.

  Meystre had a well thought out plan for the Department that included hiring eight table top experimentalists over the next five years and was led to believe by the University administration that he would be given the resources to do so. After the first two hires Meystre was denied further positions and resigned in a rather public fashion in 2007. Dean Ruiz appointed Prof. Michael Shupe as an Interim Head. Multiple discussions involving mergers and restructurings and the Dean's "Blue Ribbon Committee" visit in November 2007 occurred during this period. Tensions between the different research groups in the Department intensified as each was truly concerned about their long term future in the Department. The Dean gave approval for a search for a permanent Head that was completed in February 2009, over two years after Meystre's resignation. Several faculty departures occurred during this somewhat chaotic period.

In February 2009, following another election, Sumit Mazumdar was appointed by Dean Ruiz as the Department Head. Mazumdar selected Prof. Ken Johns to be Associate Department Head, and appointed Profs. Drew Milsom and Koen Visscher as Directors of Undergraduate and Graduate Studies, respectively. Mazumdar's primary goals since his appointment have been to bring the departmental faculty together, to establish and reestablish connections with other units in the campus, and to reduce the anxiety among the classified staff, whose number has been reduced by $\sim 30\%$ from layoffs due to budget cuts. There are signs that Mazumdar has been modestly successful in these endeavors. Staff and student anxieties appear to have subsided (but may reappear with additional budget cuts). Discussions of mergers have also subsided, even as interactions with other units have increased. Mazumdar has had collaborations with various faculty members in Chemistry, Mathematics and Optical Sciences in the past, and subsequent to his appointment as Department Head has spent considerable effort in re-invigorating relationships with the leaderships of Astronomy and Planetary Sciences. These efforts should lead to greater intra-campus support for Physics. New efforts to reinvigorate a Theoretical Astrophysics Program, for instance, has begun.

- Faculty Departures

  Nine retirements, five departures, and two deaths occurred since the last APR, while thirteen tenure-track or tenured faculty members were hired. Prof. Dan Stein's departure has already been mentioned. Prof. Raymond Goldstein departed for Cambridge University, England soon after Stein's departure for NYU, although these two events were unrelated. This was a serious blow to the Department's decade-long effort to build up a biophysics program, as well as to the Department's links with the Applied Mathematics program. Lecturer Adriana Pesci, Goldstein's wife, accompanied him to Cambridge. Soon after this, then Assistant Prof. Zachariah Chacko departed for the University of Maryland, which had been building up its High Energy Physics effort. The two youngest astrophysicists, Profs. Dimitrios Psaltis and Feryal Özel moved to the Astronomy Department in 2008, cutting their connections to the Physics Department. These departures have taken their toll on faculty morale, and there is apprehension about the longterm survival of the theoretical high energy and the astrophysics programs. Individual members of both groups are currently on leave at other institutions.

- Restructurings and Mergers

  As mentioned above, there was a period of great uncertainty just before and during the University's transformation plan. In fairness, the Provost did challenge all Departments on campus to conceive of restructurings that might lead to increased research prominence and substantial monetary savings. One example of such a reorganization is the School of Mind, Brain and Behavior that brings together three academic departments and two graduate interdisciplinary programs to create an entity that is on the national forefront of neuroscience and cognitive research and education. Several other transformations did indeed occur.

  One motivation for the transformation plan was likely the enormous financial crisis at the State and University levels, along with changes in the University leadership. In the case of the School of Physical Sciences, certainly many ideas were floated and discussed by potential member Departments of the school. For a variety of reasons none of these ideas grew into a substantial proposal. In our view, the Physics Department was wary of a significant consolidation because of the differences in strengths, real and perceived, between the Department and the other units within Physical Sciences. Additionally, different Departments had very different ideas about the nature and scope of the consolidation, if any. The Physics Department was in general open to these ideas and constructively discussed them both within the Department and with other departments on campus.

One last point draws attention to the significant budget cuts suffered by the Department for the last five years in a row. Each of these resulted in layoffs of classified staff as well as creating considerable anxiety. There are reasons to believe that student morale was also affected. At this point in time, there is still considerable uncertainty whether additional cuts must be faced in the coming years.

4.2 Recommendations from the last APR and Blue Ribbon Commission (BRC)

We deviate from the usual norm of self-study reports in this subsection because of the somewhat unusual recent history of the Physics Department. The previous APR took place ten years back in 2000, even as ABOR rules specify that such reviews take place every seven years. During this interim period, the Department was also visited by a Dean's "Blue Ribbon Committee" (BRC) consisting of five prominent scientists and scientific administrators and the Chair of the then Physics Advisory Board. The BRC visited the Physics Department and the UA on November 15-16, 2007. At that time, the Department was led by Interim Head Prof. Michael Shupe. Their charge, though limited in scope compared to the APR's, overlapped with some of the APR's.

Not surprisingly, the recommendations to the Department and to the University in these overlapping areas by the two committees were nearly identical. Below we first list those recommendations of the previous APR that are non-overlapping with the ones made by the BRC, and the unit's responses to these. This is followed by the remaining APR recommendations, the BRC's recommendations and the unit's responses to these. It thus follows that the APR recommendations are given below in increasing order of importance, with the most significant ones coming last.

APR Recommendations involving the Department's educational mission and the unit's responses:

- *"The quality of the large first year service courses could be enhanced by considering ways to make the laboratory work more like the process of science. A clearer, as well as increased, budgetary arrangement for the laboratory coordinators is needed. Greater involvement by the faculty in some of the undergraduate laboratory classes would be desirable."*

  There has been continuous and considerable reform in these directions. To begin with, all laboratory manuals were rewritten in 2002 by Prof. J. D. Garcia (now emeritus) and then again in 2005 by graduate student James Little. More recently, the Department has begun the process of modifying the introductory physics laboratories even more substantively. Ph.D. student Tim Chambers, who is pursuing his degree in Physics Education, has rewritten the laboratory manuals associated with our calculus-based introductory mechanics course. These manuals involve both ”guided experiments” and ”experiment design”, and require more critical thinking than the previous laboratories. Chambers is currently analyzing the results of research conducted on the benefits of these new laboratories.

The Physics Department now has lab fees associated with our laboratory courses. These fees are $50 per student per semester for the introductory courses and $150 per student per semester for the advanced courses. These fees have allowed us to replace aging equipment so the laboratories can run more smoothly. Additionally, we have purchased new equipment and designed modern experiments around the new equipment.

In general, senior faculty do teach the advanced laboratory courses. Our current small size and our overall teaching mission however do not allow senior faculty to be involved in teaching the introductory labs. Dr. Ingrid Novodvorsky , whose interest lies in Teacher Preparation, supervises the Ph.D. student (Chambers) who has modified our calculus-based mechanics laboratories. Additionally, several faculty have helped develop new experiments using our newly purchased equipment.

- *“To aid in recruiting high quality graduate students, an annual recruiting workshop should be implemented.”*

  A recruiting weekend for prospective domestic students was begun in 2002, led by Profs. Michael Shupe and Keith Dienes, and is being continued by the current Director of Graduate Studies Prof. Koen Visscher. Additional effort is being made currently to attract female and underrepresented minorities (see Section 10) . Subsequent to the creation of the Chemical Physics program in 2010, a half dozen Physics faculty participated in the recruiting workshop of the Chemistry Department. Department Head Mazumdar is in the process of establishing ties with top universities in India for recruitment of graduate students. This has already begun to pay off in that the Department received a significantly larger number of applicants from India for admission to the Ph.D. program in 2011. Five offers to these applicants have been made.

- *“Frank discussions concerning issues surrounding the new program in educating high school physics teachers need to take place with the entire faculty of the Physics Department.”*

  Prof. Ingrid Novodvorsky, who leads the Science Teacher Preparation Program, transitioned to a continuing status faculty position (equivalent of tenure) with 51% in Physics and 49% in Molecular and Cellular Biology. The Science Teacher Preparation Program continues to be housed in Physics.

- *“Conflicts concerning minimum enrollment for classes and the 6-month rule for written/oral comprehensive examinations need to be resolved.”*

  Both have been achieved. The current Departmental policies regarding minimal enrollments in undergraduate as well as graduate courses are aligned with those of the University. For co-convened courses, with both undergraduate and graduate students enrolled, a well-defined policy - viz., each graduate student counting as two undergraduates - has been adopted. The written comprehensive exam is now offered every six months and the oral exam must be taken within six months of passing the written exam. Additionally the format of the oral comprehensive exam has been modified to a research-oriented one.

APR Recommendations involving the Department's research aspirations - non-overlapping with recommendations made by the BRC:

- *"The excellence that has been achieved in soft condensed matter/biological physics should be expanded by adding two or three new faculty, of which the majority should be experimentalists."*

  There was little institutional support in the form of startup expenditure for this. Prof. Raymond Goldstein was the principal driving force behind the effort in this direction at the time, supported by then Assistant Profs. Koen Visscher and Srinivas Manne. The then Department Head Prof. Daniel Stein also had significant research interest in biological physics. No new hires were made for several years subsequent to the APR, and to some extent as a consequence Goldstein departed for Cambridge University in 2006. Stein had departed for NYU the previous year. During the second year of Prof. Pierre Meystre's tenure as Head the Department conducted a search for a biophysicist. The search committee led by Visscher successfully identified an excellent faculty candidate with overlaps in research interest with existing local faculty and with keen interest in coming to Arizona. Unusually long delay in procuring the startup in this case created an unsettling failure in the ability of the Department to attract this person to the Department. This left a single biophysicist (Visscher) within the Department. However there are joint faculty from the Department of Chemistry and Biochemistry and the Department of Molecular and Cellular Biology whose research interests include biophysics and there does exists a University wide Biophysical Physics program (analogous to the Chemical Physics program). Consequently, the BRC's recommendation to the Department was to accept that the Departmental biophysics program lacks critical mass for expansion during these lean years. There is no ongoing effort to expand here currently.

- *"University space plans should consider locating the Physics Department buildings closer to those of Astronomy, Planetary Sciences, Optical Sciences, etc. to greatly facilitate the new emphasis on interdisciplinary work."*

  Since the previous APR Optical Sciences was "promoted" to a "College" from a "Center", and expanded its total space by nearly 100% by adding a new west wing to the original building. The Department Heads of Physics, Astronomy and Planetary Sciences continue to be interested in having a common building to be shared by the three units.

APR Recommendations involving the Department's research aspirations - overlapping with recommendations made by the BRC:

What follows is the main thrust of the previous APR recommendations.

- *Given a continuation of the retirement rate experienced over the past five years, it is imperative that the Department vigorously continues its program of hiring new faculty.*

Startup funding, particularly for experimentalists, must be available at a level competitive with other universities. The strategy must be to build upon existing strength and to develop two to three subfields of physics to the point where they have national and international visibility. During the hiring process, care should be taken not to over-emphasize theory. Developing a carefully drawn strategic plan that can lead to a campus-wide strategic plan for Physics will provide benefits both departmentally and university-wide. Future opportunities in hiring theorists vs retirement should take into account, first, the need to maintain balance between theory and experiment, second, the need to broaden the theory effort, and third, opportunities to fill niches that complement the strengths of the university in other areas

Detailed response to the above are given following our discussion of the BRC's recommendations below. Here we give a preliminary response only. What stands out from the above recommendations are: (a) the urgency for the University to support Physics, (b) the emphasis on focusing on a few areas, preferably on campus-wide efforts, and (c) the need to focus on experimental research. It is the perception of the faculty that the Department did not receive the support to hire the experimentalists that are needed. A single experimental hire, that of Alex Cronin (currently a tenured Associate Professor), was made by Department Head Daniel Stein following the APR. At least one search failed because the Department's startup was not competitive. Interestingly, Cronin's research area (atomic physics) overlapped those of several faculty members in the College of Optical Sciences who were hired during the same era, reinforcing perhaps the need to hire in areas where there is campus-wide support. Cronin has more recently branched out into solar energy and plays a leadership role in the campus in this area. During this same period eight new theorists were hired (two each in astro-, high energy, nuclear, and condensed matter physics). All except the hires in condensed matter were at the level of Assistant Professor, with the condensed matter hires at the level of Associate Prof.. Whether so many theory hires, in contradiction to the APR recommendations, were beneficial overall remains a point of debate among the faculty. On the one hand, the new hires, with their excellent performance added significantly to the Department's visibility and reputation. Furthermore, given the many retirements and departures, the faculty size today would have been impossibly smaller had these hires not been made. On the other hand, though, these hires were used to avoid the very crisis (drastic reduction in overall number) that might have forced the University's hands to provide the support for experimental hires.

During the brief tenure of Pierre Meystre as Department Head two new experimental hires (Assistant Profs. Brian LeRoy and Arvinder Sandhu) were made. Meystre's moratorium against hiring theorists until eight new experimentalists had been hired had broad (though not universally enthusiastic) Departmental support. Current policy in the Department continues this strategy.

Summary of the Recommendations of the Dean's Blue Ribbon Committee and the Unit's Responses to the previous APR and BRC.

The BRC's mission was more narrowly focused than the APR's. Their charge was to provide the University as well as the Department with a "set of suggestions ... for the actions necessary to ensure the long-term health and enhanced excellence of the University of Arizona's efforts in physics.". Based on materials received by the BRC before and during their visit, and interviews and meetings with Department faculty, Heads of units closely affiliated with Physics (Departments of Astronomy and Planetary Sciences and the College of Optical Sciences) and University administrators, the BRC produced a report with concrete recommendations. While the bulk of these recommendations were addressed to the Department faculty, some of the most important ones were also intended for the University administration. Chief among the latter were the recommendations that the Department needed to be "supported and invigorated", and that "*waiting five - or even two - years to design and begin to implement a solution to the problems facing Physics would certainly put the Department itself at grave risk.*" (our italics). The BRC also noted that "there will be five more retirements in the near future; the plans for replacing these individuals must be developed now." We have already mentioned above that the BRC recommended against expansion in biophysics.

The BRC's recommendation to the Physics faculty was to develop a *"strategic plan that is realistic in scope, synergistic with strengths in other physical sciences units at the UA, and aimed at developing focused excellence in exciting areas of experimental physics."* (our italics). Specifically, the BRC suggested that the Department create two research "pillars of excellence", that would be interdisciplinary in their scopes, and would be strongly linked with efforts in other physical sciences units. One of these pillars of excellence would involve an experimental astroparticle physics initiative that would take advantage of the existing expertise in Astronomy and Planetary Sciences. A cluster hire of up to three new experimental faculty members was envisaged. A second pillar of excellence would involve a "low energy" physics initiative, with two hires in condensed matter ("as soon as possible") and one in atomic, molecular and optical physics. Possible collaborations with the College of Optical Sciences, Chemistry, Materials Science and Engineering and Electrical Engineering were to be considered in these hires. Hires at the interface of condensed matter and atomic, molecular and optical physics were particularly encouraged. The BRC saw the Department's target size to be 34 faculty members after these hires.

What stands out about the BRC report is its strong overlap with the APR recommendations from 2000. This should convince both the University administration and the Department faculty of the relevance of the recommendations common to both reports.

The Physics faculty welcomed the BRC's recommendations, even though they were limited in scope relative to the Department's original strategic plan. None of the BRC's suggestions, have however, been implemented so far. To begin with, a permanent Department Head was appointed only in February 2009, more than one year after the BRC report became available in January 2008. The interim Head was not given opportunity to implement any of the BRC's suggestions. By the time the permanent Department Head Mazumdar started his tenure, the state of Arizona and the University were already in the middle of an unprecedented financial crisis that continues to date (the new Head started his tenure with a 7% midyear budget cut, which was followed by yet another 2% budget cut that led to staff layoffs.) Cluster hires of up to three experimental faculty (as recommended by the BRC) would be very difficult to get support for in the present financial climate.

Partially in response to the above recommendations, and also as a response to the current fiscal condition, the Department established strong connections with other physical sciences units who are motivated to build new interdisciplinary efforts. In the 2009-2010 academic year, TRIF Photonics had agreed to pay half of the startup costs of a hire in Physics in any area of photonics. Although this hire did not materialize in the end (because of a “two-body” problem that could not be solved in a timely manner), the Department has received support from the College of Science to hire an experimental physicist in the current 2010-2011 academic year. The unit Heads of Physics and Astronomy, as well as individual faculty members from the two departments are in agreement that the University needs a vigorous buildup in the area of particle astrophysics. As this report is being written, efforts to reinvigorate a theoretical astrophysics program (TAP), with active collaborations between the unit Heads of Physics, Astronomy and Planetary Sciences, have begun. The unit Heads recently recommended to the Dean of the College of Science a faculty member from the Department of Planetary Sciences for the position of chairperson of the TAP.

To summarize, the Department is on the right track in pursuing collaborative efforts with other physical sciences units within the University. What remains a fact though is that experimental hires in Physics generally need large startup funds, and the Department will need strong and continued support from the College and the University to reach the target faculty size envisioned by the previous APR committee, the BRC, and the Department Faculty. One-to-one replacements of retiring faculty, albeit in new emerging areas, will be essential for maintaining a vigorous and flourishing program. Indeed, given the current and impending attrition, the Department desperately needs the opportunity and support to hire two experimentalists per year for the next three years. A single search per year is simply not going to prevent the continuous hemorrhaging that the Department has experienced over the past five years. In the absence of vigorous intervention the decline in faculty size will continue, especially with the impending retirements. Even as we write this, however, we also recognize that the economic and financial climates have changed dramatically; the sustainability of the model of development that we have had and that we are proposing are being called into question. Flexibility, and the willingness to form intra-University alliances will be the keys to success in the future.

5 Academic Quality

5.1 External Rankings

One measure of quality can be found from various external rankings.

For the undergraduate physics program we know of no available external ranking other than for UA as a whole. Two national rankings of the Physics Department doctoral program exist. One is from U.S. News and World Report and the other is from the recent NRC (National Research Council) publication, “A Data-Based Assessment of Research-Doctorate Programs in the United States”.

The 2011 U.S. News and World Report ranking of graduate physics programs finds the University of Arizona program ranked 36th out of 145, tied with Michigan State University, University of Florida, and University of North Carolina. Universities ranked directly above University of Arizona (tied for 30th) include Brown University, Carnegie Mellon University, Duke University, Georgia Institute of Technology, and University of California at Irvine. Schools ranked directly below the University of Arizona (tied for 40th) include Boston University, Indiana University, New York University, Purdue University, Texas A&M University, University of California at Santa Cruz, University of Virginia, and Washington University in St. Louis. The U.S. News and World Report rankings are "based solely on the ratings of academic experts". The rank of the UA Physics Department has been at this level (between 30th and 40th) for the last several years and perhaps longer.

As given by U.S. News and World Report, the top five graduate programs in Physics are California Institute of Technology, Harvard, Massachusetts Institute of Technology, Stanford, and Princeton. While we should always look to the best for program ideas and initiatives, these universities are different from the University of Arizona in many ways (e.g. they are private universities) and there is little to be gained by comparison with them.

Another comparison is the rankings of physics departments at our official ABOR (Arizona Board of Regents) peers: U.C. Davis, U.C.L.A., University of Florida, University of Illinois, University of Iowa, University of Maryland, Michigan State University, University of Minnesota, University of North Carolina, Ohio State University, Pennsylvania State University, University of Texas, Texas A&M University, University of Washington, and the University of Wisconsin. We are ranked in the bottom third of this group according to U.S. News and World. Again, these rankings are "based solely on the ratings of academic experts".

The National Research Council (NRC) last published their study of doctoral programs in the physical sciences in 1995 (using data collected in 1993). At that time, the Physics Department doctoral program in Physics was ranked 45th. The new (2010) publication from the NRC uses data collected during 2005-2006 from 212 universities and provides a range of rankings rather than a single number. Actually two ranges are given in the publication. One is an S-ranking (for survey-based), which uses a faculty survey on the relative importance of various measures to develop ranges of rankings. The other is an R-ranking (for regression-based) , which uses a smaller faculty survey on program rankings to obtain weights for program variables so as to closely reproduce those rankings. In the associated spreadsheets accompanying the NRC publication, one finds the S-ranking range (5th to 95th percentile) for the UA Physics Department to be 58-113 and the R-ranking range to be 51-99. Compared to our ABOR peers given above we are second from the bottom. The top two schools from our peers are the University of Illinois (S-ranking 3-14 and R-ranking 13-60) and the University of Texas (S-ranking 4-17 and R-ranking 25-80).

What can one conclude from these rankings? The UA Physics Department is not a top 20 program by most measures. This is unsurprising given the Department's size and resources. However by most measures, the Physics program will be found in the second tier of programs below the top ones. Certainly there are numerous pockets of research and teaching excellence in the Department as well as outstanding faculty who are at or near the top of their fields (see Section 6). One of the Department's long term goals is to continue to improve its research and educational excellence as outlined in the strategic plan.

5.2 Internal Rankings

As a member of the College of Science (COS), the quality or efficiency of the Department is measured using three variables, state expenditures (State), indirect cost recovery (ICR) from research grants returned to the COS, and student credit hours (SCH). These three variables and the total grant revenue for the Department are given in Table 3. We only have the COS ICR data for FY2008.

	FY03	FY04	FY05	FY06	FY07	FY08	FY09
Total Grant Revenue (M$)	3.8	3.7	4.5	3.9	3.6	3.8	4.2
COS ICR (M$)						0.25	
SCH (khours)	14.6	14.0	12.9	13.0	13.8	13.9	14.5
State Expenditures (M$)	4.6	5.0	5.5	5.5	5.6	5.5	
Faculty	28	29	32	28	29	29	26

Table 3: Measures used by the College of Science to assess quality and efficiency

The COS uses an r value to rank UA COS Departments in efficiency. The r value is defined as $r = (ICR\% + SCH\%)/State\%$. The % means the absolute numbers are divided by the total sums in the College of Science. The ratio r used by the COS in FY09 is 1.74. A histogram of the ratios for all Departments in the COS is given in Figure 1. The histogram shows that Physics Department is in the lower half of Departments according to this ratio. One of the goals of the Physics Department is to increase this ratio by increasing ICR return as mentioned above and, to a lesser extent, increasing SCH.

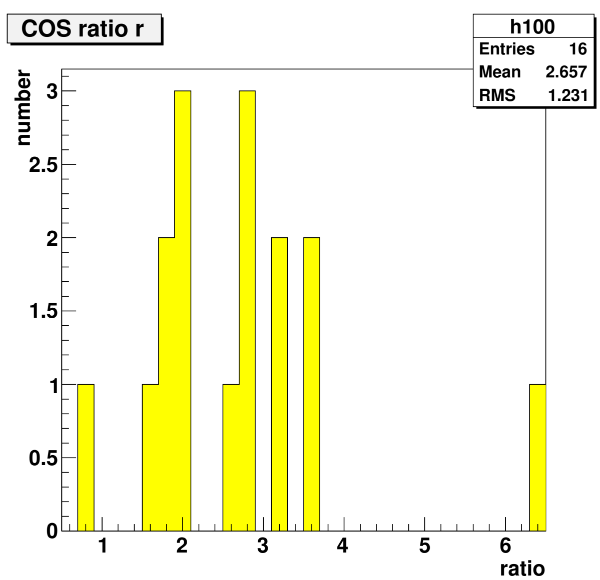

Figure 1: Ratio r used for COS quality for the departments in the COS

The total grant revenue divided by the number of instructional faculty and head in 2008 and 2009 is \$132k and \$161k respectively. A small minority of faculty were without funding at that time. If we count only funded faculty in the denominator, then the average funding per faculty is \$190k and \$200k respectively. This is healthy funding for an individual investigator award in many subfields of physics. (Note that some of the unfunded faculty at that time were junior faculty who are now (2011) currently funded.) Nevertheless, to substantially boost the Department's total grant revenue we must look beyond individual investigator awards to larger science centers or focused collaborations for additional revenue.

Another measure of the Department's quality can be found in the research awards garnered by faculty. Several faculty have received NSF Presidential Young Investigator or CAREER awards or DOE Outstanding Junior Investigator awards (Table 4). These are among the most meritorious awards for young faculty. Likewise several faculty have been named Sloan Fellows or received Research Innovation Awards from Research Corporation. Prof. Andrei Lebed received the Lenin Komsomol prize, which is a major USSR government prize for young scientists.

Name	Award
Sean Fleming	DOE Outstanding Junior Investigator Award (2005)
Kenneth Johns	NSF Presidential Young Investigator Award (1991)
Brian LeRoy	NSF CAREER Award (2010)
Srin Manne	NSF CAREER Award (2001)
Fulvio Melia	NSF Presidential Young Investigator Award (1988)
Arvinder Sandhu	NSF CAREER Award (2010)
Bira van Kolck	DOE Outstanding Junior Investigator Award (2001)

Table 4: List of young faculty research awards from NSF or DOE

Locally, a number faculty have been recognized by the UA for their research accomplishments. These are listed in Table 5

Name	Award
Sumit Mazumdar	UA Henry and Phyllis Koffler Research and Scholarship Prize
Fulvio Melia	COS Galileo Circle Fellow
Pierre Meystre	UA Regent's Professor

Table 5: List of Physics faculty research awards from UA

A Regent's Professor is the highest faculty rank possible and is reserved for professors with exceptional achievements. A Galileo Circle Fellow is the one of the highest honors possible given by the College of Science.

A few faculty have received international and national awards as well. A list is given in Table 6.

Name	Award
Bruce Barrett	Humboldt Research Award
Charles Stafford	Swiss Physical Society Prize
Fulvio Melia	Australia Sir Thomas Lyle Fellow and Miegunyah Fellow
Pierre Meystre	R.W. Wood Prize from OSA and Humboldt Research Award
Fang Li-Zhi	First Award of the Gravity Research Foundation

Table 6: List of Physics faculty international and national awards

6 Faculty

6.1 Faculty Research

For convenience, the list of faculty, their rank, and their primary research field are reproduced in Table 7.

The faculty in the Physics Department are actively engaged in a wide range of leading edge research areas. Many faculty are acknowledged leaders of their fields. An extremely brief summary of the current research areas follows. Some faculty work in several research areas and some research is interdisciplinary involving other fields besides physics.

Theoretical Astrophysics and Cosmology (Profs. Fang and Melia)

The theoretical astrophysics group studies a broad range of phenomena, from the high-energy environments in compact objects, such as neutron stars and black holes, to the formation of galaxies and large-scale structure, to the nature of cosmic expansion and the particle astrophysics of these environments, including the early Universe. The faculty and students in the group have played a leading role in developing a theoretical understanding of supermassive black holes, especially the object at the center of our galaxy. They are also currently studying a variety of non-equilibrium, non-linear problems in cosmology, such as the dynamics of cosmic baryon fluid and dark matter.

The quality of this work has been recognized by numerous awards, most notably over half a dozen prestigious graduate fellowships from NSF and NASA. Of special note is the Trumpler award, given once per year for the most significant Ph.D. thesis in astrophysics in the United States. Astrophysics faculty have themselves been recognized with distinguished national and international awards, and sit on several influential editorial boards, including as editor-in-chief of an important European journal. Prof. Fang was recently named an APS Fellow. The theoretical astrophysics effort in the Department is closely tied to the Theoretical Astrophysics Program (TAP) at the University of Arizona (UA), which brings together astrophysicists from Astronomy, Planetary Sciences, and Physics for intellectual and academic interactions. This program is routinely ranked in the top three to five such units in the country. Prof. Melia is a prolific general science writer and has received many awards including “Best Astronomy Book Worldwide” from Astronomy magazine.

Name	Rank	Research Area
LeRoy, Brian	Assistant Professor	Condensed matter experiment
Sandhu, Arvinder	Assistant Professor	AMO experiment
Cronin, Alexander	Associate Professor	AMO experiment
Fleming, Sean	Associate Professor	Nuclear theory
Jacquod, Philippe	Associate Professor	Condensed matter theory
Manne, Srinivas	Associate Professor	Biophysics experiment
Stafford, Charles	Associate Professor	Condensed matter theory
Su, Shufang	Associate Professor	Particle theory
Varnes, Erich	Associate Professor	Particle experiment
Visscher, Koen	Associate Professor	Biophysics experiment
Barrett, Bruce	Professor	Nuclear theory
Cheu, Elliott	Professor	Particle experiment
Dienes, Keith	Professor	Particle theory
Fang, Li-Zhi	Professor	Astrophysics theory
Hsieh, Ke-Chiang	Professor	Space science experiment
Johns, Kenneth	Professor	Particle experiment
Lebed, Andrei	Professor	Condensed matter theory
Mazumdar, Sumitendra	Professor	Condensed matter theory
Melia, Fulvio	Professor	Astrophysics theory
Meystre, Pierre	Professor	AMO theory
Rafelski, Johann	Professor	Nuclear theory
Rutherfoord, John	Professor	Particle experiment
Sarcevic, Ina	Professor	Particle theory
Shupe, Michael	Professor	Particle experiment
Toussaint, Doug	Professor	Particle theory
van Kolck, Bira	Professor	Nuclear theory
Wing, William	Professor	AMO experiment
Zhang, Shufeng	Professor	Condensed matter theory

Table 7: List of tenure-track and tenured Physics faculty

Experimental Atomic, Molecular, and Optical (AMO) Physics (Profs. Cronin and Sandhu)

Faculty in experimental AMO physics are pushing the boundaries of attosecond science and matter wave interferometry. Ultrafast lasers are an extraordinary tool for measurement, manipulation and control of dynamical processes in atoms, molecules and ions. The Department's laser group has expertise in generation and application of attosecond duration light bursts in the extreme-ultraviolet regime. These attosecond sources are being utilized to probe electron dynamics on their natural time scale, paving the way for fine control of light-matter interaction in atoms, molecules and nanomaterials. A second significant direction in AMO physics is atom optics. Here, faculty have pioneered techniques that exploit atomic and molecular wave interferometry to advance atomic physics. Precision measurements of physical constants and exploration of fundamental quantum mechanics form some of the main directions of research. Both theoretical and experimental AMO efforts in the Physics Department have extensive cross-connections with related efforts in Optical Sciences and the Chemistry Departments, resulting in a very prominent and highly-ranked AMO program in the country. Recently Prof. Sandhu received an NSF CAREER grant for investigation of attosecond and femtosecond dynamics in atoms and molecules.

Theoretical Atomic, Molecular, and Optical (AMO) Physics (Prof. Meystre)

The theoretical AMO group is working in three main areas: cavity quantum electrodynamics (QED), quantum degenerate ultracold atomic and molecular systems, and cavity optomechanics. Cavity QED studies the interaction between light confined in optical resonators with cavity atoms or other particles. While this is a mature field, the concepts it developed are now playing an increasing role in other areas such as circuit QED, cavity optomechanics, quantum information science, and quantum metrology in general. Research on quantum degenerate systems includes work on atom optics and nonlinear atom optics of bosons and fermions, the generation of nonclassical states of matter-wave fields, as well as photon-assisted ultracold molecular physics. Topics of particular current interest include the detection and control of ultracold atoms and molecules, with particular emphasis on polar molecules.

A new field of research is cavity optoelectronics which studies the coupling of coherent optical fields to micromechanical devices. Rapid progress has been achieved with both conventional optomechanical systems, where an optical cavity is coupled to a mechanical resonator, as well as microwave-domain optomechanical systems, where a transmission line microwave resonator is coupled to a mechanical resonator. Equally exciting is recent research investigating optomechanical effects in systems of ultracold atoms. Research on these systems may lead to important applications in quantum metrology, including the ultra-sensitive detection of forces and fields, and quantum information science. As mentioned above, both theoretical and experimental AMO programs in the Department maintain fruitful connections with the College of Optical Sciences.

Of special note, Prof. Meystre is the current Director of the B2 Institute, which is part of the Biosphere 2 Center managed by College of Science. This work is further described in the Section 11 and Section 12. Meystre is also a Humboldt Award winner and a UA Regents Professor that is the highest faculty rank possible and reserved for those faculty with extraordinary achievements.

Experimental Biophysics (Profs. Visscher)

Biological physics explains living processes through the application of physical principles. Core-faculty research in the Department focuses on single-molecule studies of gene-expression, from transcription to translation by ribosomes. A variety of experimental techniques including single-molecule fluorescence microscopy and optical tweezers are employed to gauge the role of mechanical tension in such processes. The Biological Physics Program provides an active forum for discussion and exchange of ideas with biological physics-inspired researchers in other departments (e.g. Chemistry and Biochemistry, Molecular and Cellular Biology, Aerospace Engineering, and Mechanical Engineering). Prof. Visscher was one of the founders of the Biological Physics Program at UA.

Experimental Condensed Matter Physics (Profs. LeRoy and Manne)

The program in experimental condensed matter physics studies the fundamental electronic properties of low dimensional systems including graphene (2D) and carbon nanotubes (1D). Both materials are candidates to replace or augment silicon in future semiconductor technologies. Using scanning probe microscopy, faculty directly visualize, probe, and control the electronic properties of these materials with nanometer scale resolution. An example of this is searching for ways to enable new functionality through the selective application of strain and electric fields. Faculty are also developing techniques to image electron wavefunctions inside quantum dots. Prof. LeRoy has received an NSF CAREER Award to study electron transport in carbon nanotubes. He has also recently received two major grants from NSF-EECS and the Army Research Office.

Theoretical Condensed Matter Physics (Profs. Jacquod, Lebed, Mazumdar, Stafford, and Zhang)

Theoretical condensed matter research in the physics department covers two broad fronts involving (a) electronic structure and novel broken symmetry states in low dimensional materials and (b) mesoscopic physics, electronic and spin transport. Low dimensional materials being studied theoretically by department members include novel organic semiconductors, with applications to organic photovoltaics, and unconventional organic and high temperature superconductors. Strong contributions have been made towards understanding the novel semiconducting phases that are proximate to superconductivity in the organics. Both magnetic field-induced effects and effects due to strong Coulomb correlations have been emphasized. Faculty also research transport properties including studies of mesoscopic proximity effect, decoherence in dynamical systems and spintronics, quantum transport in nanoscale conductors including molecular tunnel junctions, and magnetic and spin transport properties of nanomagnets. Members of the group have pioneered the development and application of non-equilibrium many-body concepts to molecular transport junctions and the application of phenomenological theories for understanding and predicting spin phenomena at the nanoscale to emerging devices such as magnetic random access memory and hard disk drives.

Two members of the group are APS Fellows and one has been a Divisional Associate Editor of Physical Review Letters.

Theoretical Nuclear Physics (Profs. Barrett, Fleming, Rafelski, Sarcevic, and Van Kolck)

The nuclear theory group carries out internationally recognized research in nuclear physics using quantum chromodynamics (QCD). They invented Soft Collinear Effective Theory to describe high-energy behavior of quarks and gluons. They developed Nuclear Effective Field Theories to deduce from QCD the force among nucleons. Other faculty have formulated the innovative No-Core Shell Model to predict the properties of nuclei from fundamental nucleon interactions and for the study of equilibrium and non-equilibrium properties of nuclear matter. Also they developed tools and new approaches for describing the formation and dynamics of matter in the hadronization of quark-gluon plasma and used them to understand and predict results for heavy ion collisions at RHIC and the LHC.

The members of the theoretical nuclear physics group have received numerous awards including two DOE Outstanding Junior Investigator Awards and a Humboldt Senior Scientist Award. Several members of the group are APS Fellows.

Experimental Particle Physics (Profs. Cheu, Johns, Rutherfoord, Shupe, and Varnes)

The primary foci of this group are the ATLAS experiment at the CERN LHC (Large Hadron Collider) and the D0 experiment at the Fermilab Tevatron. Topics in both Standard Model and "Beyond the Standard Model" physics are being pursued by the group, including QCD physics, top quark physics including top quark pair resonance searches, supersymmetry searches, and searches for quark substructure. The D0 experiment has amassed an impressive data set and one faculty continues to mine this by measuring the helicity fractions of the W bosons produced in top quark decay, thereby testing the predictions from the Standard Model. There is also a nascent experimental astrophysics program centered on the LSST (Large Synoptic Survey Telescope) that will allow detailed exploration of dark energy and dark matter.

Highlights from this group include primary responsibility for the design and construction of major detector systems for the D0 (Level 1 Muon and Level 1 Calorimeter-Track Match triggers) and ATLAS (Forward Calorimeter) experiments. This group was among the first to publish top quark physics results in Run II of D0 and just recently submitted for publication one of the first physics papers from ATLAS that placed limits on quark compositeness. Funding for the group from DOE and other sources is consistently over $1M / year.

Theoretical Particle Physics (Profs. Dienes, Sarcevic, Su, and Toussaint)

Members of the particle physics theory group have spearheaded a number of major developments in the field. They have done pioneering work in ultrahigh energy neutrino interactions and are involved in computational studies of the strong interaction which are among the most challenging and sophisticated supercomputer calculations in all of science. They are leaders in efforts to develop and analyze "Beyond the Standard Model" theories, including supersymmetry, grand unification, string theories, and theories with extra spacetime dimensions. The group has done important work relevant to current and future particle accelerators. They are exploring the connections between particle physics and astrophysics, such as probing dark matter using neutrinos from the galactic center. Members of the theoretical nuclear physics and astrophysics faculty are probing the rich physics at the boundaries of those fields and particle physics as well.

One member of the group (Dienes) is currently the Director of the Particle Theory program at NSF. Several members of the group are APS Fellows and one has been a Humboldt Fellow.

Accelerator Mass Spectrometer Lab (Prof. Jull (Geosciences))

One of the unique instruments in the Physics Department is the NSF-Arizona Accelerator Mass Spectrometry (AMS) Laboratory, operated as an NSF Facility since 1981. The present director is Prof. Timothy Jull of Geosciences. Two machines have been used in this facility: a 2.5MV General Ionex 4130 AMS (1981) and a 3MV National Electrostatics Pelletron AMS (2000). The laboratory has focused on three needs: 1) to facilitate radiocarbon research for the greater scientific community, 2) to broaden analytical capabilities to measure additional radionuclides and 3) to conduct independent research projects aimed at improving and expanding AMS applications in nature. The lab has a very high throughput, analyzing over 5000 radiocarbon samples per year. Yet at the same time it maintains the highest quality measurements, in excellent agreement with consensus values from nearly 100 radiocarbon laboratories in the world. The AMS Lab is able to make ^{13}C, ^{10}Be, ^{26}Al, and ^{129}I measurements.

The AMS Lab also maintains its own active research program that encompasses a wide range of topics from archeology, geology, oceanography, lake studies, cosmic-ray studies and extraterrestrial samples (lunar samples and meteorites). The radiocarbon dating work has included a number of high-profile studies such as those on the Shroud of Turin and Dead Sea Scrolls. The lab has also assisted many museums in dating objects from their collections. A recent example is the dating of New Guinean objects in the de Young Museum (San Francisco) collection.

Physics Science Teacher Preparation (Dr. Novodvorsky)

The College of Science Teacher Preparation Program trains the next generation of middle school and high school science teachers. In addition to providing pedagogical coursework, the program places science majors with experienced mentor teachers in area schools, giving them access to quality professional interaction and a well-supervised opportunity to experiment with new ideas. Because the teaching coursework focuses on science, program students experience a unique blend of science and instructional technique.

The program has been awarded two NSF Robert Noyce Scholarships, which provides funding for students to complete the program in exchange for agreeing to teach in high-needs schools upon graduation. The program has prepared a total of 104 science teachers, 62% of whom are still teaching. Of those, 12 are high-school physics teachers. Program graduates who are teaching have also gone on to earn masters degrees and assume leadership roles in their schools.

Program faculty, who currently reside in three different departments in the College of Science, conduct research on the beliefs and dispositions of preservice science teachers. That research has resulted in three articles in peer-reviewed journals. Faculty members are also involved in science education research in their respective departments. In the Physics Department, Dr. Novodvorsky is working with a graduate student who is researching the effectiveness of reforms to the introductory physics laboratory curriculum.

6.2 Faculty Participation in the Academic Profession

Many faculty participate in and influence the academic profession through roles in professional associations, scientific review panels, and advisory groups. Roughly 40% of the faculty have been editors or associate editors of physics journals including Physical Review Letters, Physical Review A, Physical Review D, Astrophysical Journal, Progress in Particle and Nuclear Physics, European Journal of Optics:Quantum Optics, Laser Physics Letters, IEEE Magnetics Letters, Advances in Condensed Matter, International Journal of Modern Physics A, and Modern Physics Letters A.

Roughly 30% of the faculty have held leadership positions in APS Divisions or international professional associations including the APS Division of Particles and Fields Executive Committee, Chair of Four Corners Section of the APS, Chair of the APS Division of Atomic, Molecular, and Optical Physics, General Councilor of the APS, chair of APS Group on Few-Body Systems and Multiparticle Dynamics, Topical Group on Magnetism and its Application Executive Committee, Chair of Board for the International Centre for Relativistic Astrophysics Net, and Chair of the Teacher Preparation Committee for AAPT. Prof. Keith Dienes is currently the Program Director for the Theoretical Elementary Particle Physics and Cosmology Division at NSF.

Faculty have been equally active in organizing or serving in an advisory capacity for international conferences. Roughly 60% of the faculty have served as a conference chair and a similar fraction have served on conference advisory committees.

Many faculty have served on review or advisory committees for NSF, DOE, or the NRC. Examples include membership (past and present) on the Fermilab Physics Advisory Committee, the review committees for the Veritas and CMS experiments, the Nuclear Science Advisory Committee, the Science Committee for the USQCD collaboration, the allocation committee for NSF Supercomputer centers, the organizing committee for NAS/Humboldt Foundation meetings, the NRC committees on the Future of AMO Science and the AMO 2010 Decadal Survey, and the NRC Board on Physics and Astronomy among others.

6.3 Faculty Teaching

The typical teaching load for faculty in the Physics Department is one course per semester. This is similar to that for Physics faculty at peer universities. Some faculty with additional administrative responsibilities (Head, Associate Head, and the Directors of Graduate and Undergraduate Studies) have reduced teaching responsibilities. A few faculty in the Department with less productive research programs have increased teaching responsibilities.

It is the ethic in the Physics Department that all faculty take their teaching responsibilities very seriously and continually strive for excellence. It is difficult to compare the quality of teaching by faculty and lecturers with other units in the College of Science and especially with other units in the University as a whole because of the different nature of courses. For example, it is documented that student evaluations of courses in different disciplines (e.g. Biology, Physics, English) will on average be rated differently.

Nevertheless, within the Department student course evaluations provide one measure of teaching quality. In Appendix C we show the summary Teacher-Course Evaluations (TCE) for all Physics Department courses for Fall 2009 and Spring 2010. Names of instructors have been removed. 100 or 200 level lab courses are taught by graduate Teaching Assistants. The TCE questions are developed by the Office of Institutional Research and Planning Support (OIRPS). The summaries shown give the results of the "overall" questions asked on the forms. The ratings run from 5 (outstanding) to 1 (unacceptable). The numbers in the parentheses show ratings from a comparison group. The comparison group uses courses with the same subject prefix (PHYS in this case) and same level that are of comparable size.

The main conclusion from these reports is that the teaching in the Physics Department is effective and highly rated by the students. Most instructors received ratings of 4 (superior) and above. Very few instructors received ratings of less than 3.5 (3 is "good").

Another measure of teaching quality can be found in a list of teaching awards. Some of the teaching awards in the College of Science and University garnered by faculty are given in Table 8. Other faculty in the Department have been finalists for these and other awards as well.

Name	Award	Year
Elliott Cheu	COS Innovation in Teaching Award	2000
Alex Cronin	UA Henry and Phyllis Koffler Teaching Prize	2009
Alex Cronin	COS Early Career Teaching Award	2007
Keith Dienes	COS Distinguished Early-Career Teaching Award	2004
K.C. Hsieh	UA El Paso Energy Foundation Faculty Achievement Award	1999
K.C. Hsieh	COS Distinguished Career Award for Teaching	2004
Fulvio Melia	COS Distinguished Teaching Award	1998
Shawn Jackson	COS Distinguished Early-Career Teaching Award	2010
Srin Manne	COS Distinguished Teaching Award	2000

Table 8: List of Physics faculty teaching awards

Faculty are also responsible for academic advising of undergraduate and graduate students. There are nine advisors assigned to undergraduate majors and five advisors assigned to graduate students. Normally advisors are selected from faculty who have had significant interactions with undergraduates or graduates either from teaching core courses or through research. The Director of Undergraduate Studies (DUS) and the Director of Graduate Studies (DGS) serve as master advisors in the sense that they are experts in the policies and rules of these programs. Thus if a faculty advisor is uncertain about a particular policy the DUS or DGS can be contacted for clarification.

Details on faculty outreach can be found in the Section 11 of the Self-Study Report.

6.4 Faculty Views on the Strategic Plan

The strategic plan for the Department detailed in Section 4 was submitted to all faculty for feedback and comments in November 2010. The elements of the strategic plan were also discussed in a faculty meeting during the same month. Comments received from the faculty were folded back into the strategic plan.

We had planned an explicit poll on whether the faculty agreed with the strategic plan or not. Since the comments received by email and at the faculty meeting were mostly positive, we did not proceed with the poll. More importantly, it is felt that possibly a "plan B" for the Department will need to be developed in the near future because of expected large budget cuts to the UA imposed by the State in FY2011 and FY2012. At this time (early 2011) the size of cuts are still unknown.

6.5 Faculty Recruitment

In the last ten years, thirteen faculty and four instructors were hired in the Physics Department (Table 9). Additionally, Professor Meystre joined the Department as Department Head in 2006. During this same period, nine faculty retired, five faculty and two instructors resigned to accept positions at other universities or departments, one instructor was terminated because of budget cuts, and two faculty passed away (Table 10). Thus in the last ten years there has been a net loss of two faculty and a net gain of one instructor.

In the last five years, five faculty were hired. During this period, four faculty retired, five faculty resigned, and one passed away. Thus in the last five years there has been a net loss of five faculty, nearly 20% of the Department. This is the negative slope in faculty size that we have referred to.

Name	Arrival Year	Program
van Kolck, Bira	2000	Theoretical Nuclear Physics
Varnes, Erich	2002	Experimental Particle Physics
Cronin, Alex	2002	Experimental AMO
Su, Shufang	2003	Theoretical Particle Physics
Psaltis, Dimitrios	2003	Theoretical Astrophysics
Lebed, Andrei	2004	Theoretical Condensed Matter
Zackaria, Chacko	2004	Theoretical Particle Physics
Jacquod, Philippe	2005	Theoretical Condensed Matter
Fleming Sean	2005	Theoretical Nuclear Physics
Ozel, Feryal	2005	Theoretical Astrophysics
LeRoy, Brian	2006	Experimental Condensed Matter
Sandhu, Arvinder	2006	Experimental AMO
Zhang, Shufeng	2008	Theoretical Condensed Matter

Table 9: Physics faculty hires

Name	Departure Year	Reason
Bickel, William	2002	Retired
Chambers, Robert	2001	Retired
Donahue, Doug	2007	Retired
Garcia, J.D.	2006	Retired
Huffman, Donald	2000	Retired
Kessler,John	2000	Retired
Kohler, Sigurd	2002	Retired
McIntyre, Larry	2003	Retired
Scadron, Mike	2007	Retired
Chacko, Zackeria	2008	Resigned (Maryland)
Goldstein, Ray	2009	Resigned (Cambridge)
Ozel, Feryal	2009	Resigned (UA Astronomy)
Psaltis, Dimitrios	2009	Resigned (UA Astronomy)
Stein, Dan	2005	Resigned (NYU)
McCullen, John	2005	Deceased
Patrascioiu, Adrian	2002	Deceased

Table 10: Physics faculty departures

In the last ten years, the Physics Department achieved excellent results in tenure and promotion reviews. These results are listed in Table 11.

Name	Year	Promotion to
Cheu, Elliott	2002, 2008	Associate, Full
Cronin, Alex	2008	Associate
Dienes, Keith	2003, 2009	Associate, Full
Fleming, Sean	2010	Associate
Jacquod,Philippe	2009	Associate
Lebed, Andrei	2010	Full
Manne, Srin	2004	Associate
Stafford, Charles	2004	Associate
Su, Shufang	2009	Associate
van Kolck, Bira	2003, 2009	Associate, Full
Varnes, Erich	2008	Associate
Visscher, Koen	2004	Associate

Table 11: Faculty tenure decisions and promotions

6.6 Faculty Compensation

The average academic year compensation for different faculty ranks is given in Table 12. All data including that for the University of Arizona was taken from the National Academic Physics Salary Survey 2009-2010 carried out by Florida State University. Data from those institutions defined as peer institutions by the Arizona Board of Regents were averaged to form the peer institution data. These universities were University of California at Davis, University of California at Los Angeles, University of Florida, University of Illinois, University of Iowa, and Michigan State University.

University	Assistant	Associate	Full
Arizona	71675	77097	106295
Peers	76321	83739	125803

Table 12: Academic year compensation comparison with peer institutions

Compared to peer departments, faculty compensation for assistant, associate, and full professors is 94%, 92%, and 84% of the peer average. In fact, if one excludes faculty who also carry administrative roles in the department (such as the Department Head, Associate Dean of the College of Science, and Director of Biosphere 2), the average compensation for full professors drops to $101,000. In this case, the average compensation for full professors is only 80% of the peer department average.

In summary, the academic year compensation for assistant and associate professors is below average of peer physics departments while that for full professors is significantly below average. The low salaries for full professors result in salary compression that may limit the salaries for assistant and associate professors. As the University of Arizona aspires to be one of the top public universities in the United States the low full professor salaries along with the resulting compression may limit the ability of the Physics Department to compete with our peers in attracting outstanding hires to the Department.

6.7 Biographical Sketches

Short biographical sketches of the faculty are given in Appendix A. Other information such as total grant funding for the Department and committee assignments can be found elsewhere in Table 3 and Appendix D.

7 Unit Administration

7.1 Unit Organization

The Physics Department organization is shown in Figure 2. The Department is led in all administrative and academic matters by the Department Head (currently Prof. Sumit Mazumdar). The Head is also responsible for ensuring compliance with University, College, and Departmental policies. The Head represents the Physics Department to academic and other communities. The Head is supported by an Associate Head (currently Prof. Kenneth Johns) in matters of the

Head's choosing. A Director of Undergraduate Studies (DUS, currently Dr. Drew Milsom) and Director of Graduate Studies (DGS, currently Prof. Koen Visscher) also support the Head. These latter positions are responsible for managing the academic affairs of the undergraduate and graduate degree programs in the Department.

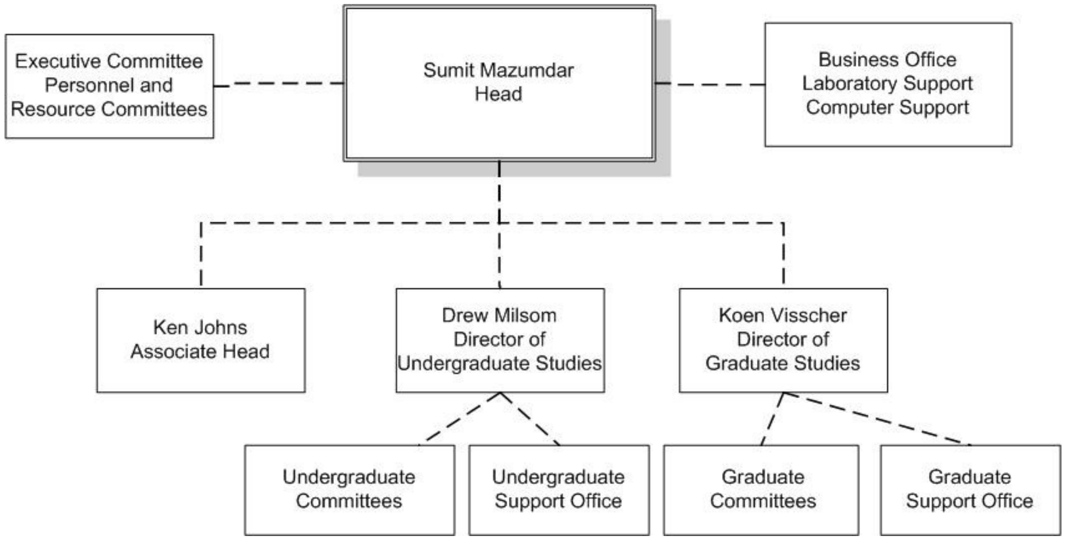

Figure 2: Organization chart of the Physics Department

Faculty are actively involved in the affairs of the Department in several ways. First, an Executive Committee chosen by the Head, but representative of the different groups in the Department, advise the Head on a variety of matters. Examples are potential reorganizations within the University, budgets, and changes in personnel. Typically they meet with the Head two or three times per semester.

Second, numerous standing committees composed of faculty advise the Head on personnel and resource issues as well as support the academic programs in the Department. The list of committees and faculty assignments is given in Appendix D. The committees can be grouped into four areas: undergraduate program, graduate program, personnel and resources, and other. The committee work is spread more or less equally among the faculty members in the Department. In general, the faculty take their committee assignments seriously and put forth a dedicated effort.

Undergraduate committees include Lab Courses and Reform, Curriculum, Arts and Science Advisors, Science Education Advisor, and Undergraduate Recruitment. Graduate committees include Admissions, Examinations, Curriculum, Graduate Advisors, Professional Science Masters, and Graduate Recruitment. Personnel and Resource committees include CAPE (Committee on Annual Performance Evaluation), Promotion and Tenure, and Space. Other committees include Awards and Prizes for faculty and students, Colloquium, Computing, Outreach, and Gender Equity and Diversity. Additional committees are formed as needed. For example a committee to study the CAPE procedures is presently a working committee.

Finally, faculty are involved in the affairs of the Department through regular faculty meetings. The Head makes frequent use of email to keep the faculty up-to-date on departmental news and decisions. The Head is readily accessible to the faculty through email or face-to-face meetings.

7.2 Unit Staff

A list of the professional staff in the Physics Department is given in Table 13. Just over two (2.15) of the professional staff are State-supported. One FTE supports the AMS (Accelerator Mass Spectrometer) program and one supports the Science Teacher Preparation Program (STPP) in the College of Science. The senior lecturer and lecturer are primarily supported by a combination of ICR (Indirect Cost Return) and Temp Teaching funds. The latter is year-to-year funding from the Provost to support the teaching mission of the Department.

Within the Physics Department other professional staff exist who are not supported by State or ICR funds. These additional personnel are generally funded by external research grants. The total number of these non-State-supported professional staff is 12: two with the STPP, seven with the AMS program, and three with the Experimental Particle Physics (EPP) program.

Name	Title	Program	Funding
Beck, Warren	Research Scientist	AMS	State
Jackson, Shawn	Lecturer	Teaching	ICR, Temp Teaching
Milsom, Drew	Senior Lecturer	Teaching	State (15%), ICR, Temp Teaching
Novodvorsky, Ingrid	Director STPP	STPP	State
Biddulph, Dana	Assistant Research Scientist	AMS	Other
Burr, George	Senior Research Scientist	AMS	Other
Cheng, Li	Assistant Resarch Scientist	AMS	Other
Hewitt, Lori	Staff Scientist	AMS	Other
Hodgins, Gregory	Assistant Research Scientist	AMS	Other
Lange, Todd	Staff Scientist	AMS	Other
Leonard, Alexander	Associate Staff Scientist	AMS	Other
Lampl, Walter	Assistant Research Scientist	EPP	Other
Loch, Peter	Associate Research Scientist	EPP	Other
MacPherson, Hunter	Adjunct Instructor	STPP	Other
Quintenz, Barbara	Adjunct Instructor	STPP	Other
Savine, Alexandre	Research Engineer	EPP	Other

Table 13: List of professional staff

A list of the classified staff in the Physics Department is given in Table 15. In total, six of these are fully State-supported and another four are State-supported at the 80% level or greater. Lisa Shapouri (Graduate Program Coordinator) and Mathew Jones (Senior Systems Administrator) are 0.5 FTE (Full Time Equivalent).

Within the Physics Department other classified staff exist who are not supported by State or ICR funds. These additional personnel are generally funded by startup packages or external research grants. The total number of these non-State-supported classified staff is eight: six support the AMS program and two support the EPP program.

There are a total of 11 postdocs in the Department (Table 14). The number is believed to be approximately constant during the period of the self-study report. Postdocs obviously contribute to the research mission of the Department but they also contribute to its educational mission through interactions with graduate and, in some cases, undergraduate students engaged in related research.

Name	Program
Abate, Sabina	Experimental Astrophysics
Aryanpour, Karan	Theoretical Condensed Matter
Kim, Jongjeong	Theoretical Particle Physics
Li, Qi	Theoretical Condensed Matter
Rentala, Vikram	Theoretical Particle Physics
Stano, Peter	Theoretical Condensed Matter
Taliotis, Anastasios	Theoretical Particle and Nuclear Physics
Yang, Chieh Jen	Theoretical Nuclear Physics
Das, Amitabha	Experimental Particle Physics
Goldbaum, Daniel	Theoretical AMO
Kaushik, Venkat	Experimental Particle Physics
Mal, Prolay	Experimental Particle Physics
Rotureau, Jimmy	Theoretical Nuclear Physics

Table 14: List of postdoctoral research associates

Budget cuts to the Physics Department in the last several years have resulted in reductions to the professional and classified staff. In the last three years, the Physics Department has lost the personnel given in Table 16. These reductions are directly or indirectly attributable to budget cuts to the Physics Department imposed by the College of Science (and University). The amount of the Physics Department's ICR also played some role in the reductions.

The reduced numbers of professional and classified staff limit possibilities for staff reconfiguration. In some cases the staff is asked to take on additional responsibilities. Recently one member of the Business Office, Soraya Torabi, was assigned additional duties as part-time administrative secretary to the Head. The Principal Systems Administrator, Michael Eklund, carries out a number of extra duties such as Building Manager and Space Committee Member. As is commonplace across the University, at all levels people are simply asked to do more.

Likely the budget for professional and classified staff in the Physics Department will remain flat or even decrease further if the economic conditions of the State and University do not significantly improve. However, should funding for professional or classified staff become available, priorities for the Department would include a full-time administrative secretary for the Head, a half-time outreach coordinator, an additional instructor, and moving the half-time systems administrator to full-time.

Justification for these positions is as follows. The administrative secretary would relieve some of the current scheduling burden from the Head and help generate reports mandated by the University and the Arizona Board of Regents. The administrative secretary would also present a steadfast contact person for the University. With outreach becoming increasingly important to the University as well as the Department, an outreach person, even part-time,would allow the Department to more effectively implement its own ideas as well as increase its participation

Name	Title	Program	Funding
Arnold, Susan	Administrative Secretary	Academic support office	State
Blurton, Michelle	Administrative Secretary	Academic support office	State, ICR
Cox, Sherie	Senior Accountant	Business office	State, ICR
Eklund, Michael	Principal Systems Administrator	Computer support	State
Haar, Roger	Laboratory Manager	Instructional support	State
Hoffman, Larry	Senior Laboratory Coordinator	Instructional support	State, ICR
Jones, Mathew	Senior Systems Administrator	Computer support	ICR
Shapouri, Lisa	Program Coordinator	Graduate program	ICR
Steinberg, Joel	Electrical Engineer	Experimental Particle Physics	State
Tompkins, Dan	Electrical Engineer	Experimental Particle Physics	State
Torabi, Soraya	Associate Accountant	Business office	State, ICR
Wood, Bonnie	Assistant Accountant	Business office	State, ICR
Ziegler, Patricia	Business Manager	Business office	State
Cruz, Richard	Research Specialist	AMS	Other
DeMartino, Mitzi	Administrative Associate	AMS	Other
King, Stephanie	Research Technician	AMS	Other
Lee, Marcus	Research Technician	AMS	Other
Watson, Rebecca	Research Technician	AMS	Other
Miller, Claudia	Secretary	EPP	Other
Walker, Robert	Engineering Aide	EPP	Other

Table 15: List of classified staff

Name	Title	Support
Baker, Scott	Systems administrator	Computer support
Goisman, Phil	Systems administrator	Computer support
Lawrence, Jon	Instructor	Teaching
Ramirez, Eva	Administrative Secretary	Academic support office
Sherwood, Dotty	Administrative Associate	Head's office
Stremick, Jerene	Public Relations/Outreach Coordinator	Outreach office
Valine, Bill	Laboratory Coordinator	Instructional support
Woerner, Karen	Senior Office Specialist	Main office

Table 16: Professional and classified staff who have left and not been completely replaced

in a variety of College of Science programs. An additional instructor would increase teaching assignment flexibility and perhaps allow the Department to develop new and innovative courses for both graduate and undergraduate students. Increasing one of the system administrator's position from half-time to full-time would give the systems support group a needed breath.

8 Unit Resources

8.1 Unit Resources

Support services exist in the Department for teaching, research, and administration. To a much lesser extent, support services exist for outreach.

A number of Departmental personnel support the teaching mission of the Department. These include two instructors, a Laboratory Manager and a Laboratory Coordinator, an Academic Support Office (ASO) staff of two, and a Graduate Program Coordinator (0.5 FTE).

The two instructors are especially important given the current size of the Physics Department. Their teaching load is approximately three courses per semester. The teaching quality of the instructors is outstanding. One of the lecturers recently won the Distinguished Early-Career Teaching Award from the College of Science. The ability of both lecturers to teach nearly any undergraduate course as well as select graduate ones provides useful flexibility in making faculty teaching assignments. Given the current size of the Department, their significant course load permits specialty Physics courses to be offered at both the undergraduate and graduate level as well as keeping the course load for tenured and tenure-track faculty at one course per semester. The two instructors are primarily supported by Temp Teaching and Department Indirect Cost Recovery (ICR) funds, with only a small fraction of their salary from the State.

The ASO staff and Graduate Program Coordinator are important resources for undergraduate and graduate students respectively. The ASO staff help students with all aspects of course registration and degrees. They also help direct students to faculty academic advisors and tutors. The Graduate Program Coordinator assists the Director of Graduate Studies (DGS). The coordinator plays an important role in graduate admissions process by organizing and checking student applications as well as answering a variety of questions concerning the administrative aspects of the graduate program. The coordinator organizes select recruiting events such as the Department's Recruitment Weekend for domestic students who have been offered admission. The coordinator also plays a similar role to the undergraduate ASO for graduate students.

The Laboratory Manager has among his many responsibilities TA (Teaching Assistant) assignments. He provides weekly training on upcoming labs for the TA's as well. He is also responsible for purchasing and maintaining undergraduate laboratory equipment and the physical setup of student labs each week. He is assisted in lab setup by the Laboratory Coordinator. The Laboratory Coordinator is also responsible for maintaining and delivering all necessary physics demonstrations for courses. He ensures necessary instructional equipment is available for all physics classrooms.

The undergraduate labs are taught by graduate student TA's. Funding for these TA's comes from a "Temp Teaching" fund provided by the University through the College of Science. The level of the Temp Teaching fund for TA's is adequate in that each semester, to a good approximation, all TA lab teaching and course grading needs are covered.

Finally, the two Systems Administrators are responsible for maintaining the undergraduate computing lab that supplies 20 machines running Windows for use by undergraduates in their courses. Using XWindow software, students can also use these machines to connect to a Linux server for scientific applications. Additionally the Systems Administrators are responsible for the over 425 devices (PC's, printers, etc.) connected to the Physics Department computer network. The majority of these devices are used for research.

The Department's Business Office supports administration and research in financial and personnel matters. The Business Office is responsible for establishing and maintaining accounting services for the Department and research grants. It ensures University policy compliant and efficient operation of a broad spectrum of services including payroll, human resources (hiring and benefits), purchasing, travel reimbursement, and financial reporting.

The Business Office also educates members of the Department in changes to University business policies and procedures. In the absence of a dedicated administrative assistant, the Business Office provides assistance for committee assignments including colloquium series, outreach, public relations, awards and prizes, and recruitment. It assists in research grant submission through the Sponsored Project Services at the University. It assists in research grant management through generation and monitoring of financial reports. The Department Business Office is managed by the Business Manager and is supported by Senior, Associate, and Assistant accountants.

As mentioned above, there is no dedicated administrative assistant for the Head. Currently the Associate Accountant in the Business Office is assigned additional duties as part-time administrative secretary to the Head.

One casualty of budget cuts to the Department was elimination of a position dedicated to public relations and outreach. The loss meant these functions are now undertaken by the faculty with mixed success. An informal public relations committee exists. A formal Outreach Committee was recently formed with Prof. Srin Manne designated as the Department's outreach coordinator. Nevertheless, an additional staff person (0.5 FTE) dedicated to public relation and outreach activities is highly desirable. Our emerging outreach program would greatly benefit from such an additional staff person.

9 Undergraduate Program

9.1 Overview

The 2010 CIP (Classification of Instructional Programs) code for this program is 400801.

In undergraduate teaching, the Physics Department has two main goals. The first is excellence in degree offerings for Physics majors. The second is excellence in Physics core course offerings for non-majors including engineering.

The Physics Department offers two undergraduate physics degrees: a B.S. and a B.A. The B.S. degree is the one most frequently awarded. This degree prepares students for a scientific career in industry, academia, or government. The B.S. degree program is the one recommended to students preparing for graduate school. The B.A. degree is intended for students wishing to apply a rigorous physics degree to other fields such as medicine, business or law. A Physics Minor is also offered for non-Physics majors.

A B.Sc. in Science Education with a physics concentration can also be obtained through the College of Science (COS). This degree prepares physics and science teachers for middle and high schools. Finally, a small number of general physics courses are offered that can be used by non-science students to partially fulfill their Natural Science requirements. One example is Phys 202 (Energy, Society, and the Environment). We hope to increase by one or two such Tier 1 or Tier 2 Natural Science courses offered by the Department.

Enrollment data for undergraduate majors is given in Table 17. The B.S. in Engineering Physics was discontinued in June 2009 because of low productivity (enrollment). This degree was offered through the College of Engineering but administered by the Physics Department. The average number of B.S. Physics majors per year is 158. The average classification distribution for freshman, second year, third year, and fourth year and beyond students is approximately 38, 24, 35, and 61. Our (the Department's) experience is that the number of first year majors is roughly twice this number. Uncertainties in the reported numbers may arise because some incoming freshman who intend to double major with Physics only report a single major (e.g. Astronomy or Math).

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
B.S. Physics majors	155	164	154	141	149	150	194
B.A. Physics majors	7	4	9	7	4	5	3
B.S. Eng. Physics majors	38	36	52	36	44	35	17

Table 17: Enrolled Physics majors

Completed major data is given in Table 18. Note that majors completed is not exactly equal to degrees awarded though they are similar. The average number of completed B.S. majors per year is 27.

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
B.S. Physics majors	29	39	21	32	19	25	17
B.A. Physics majors	2	1	5	3	1	1	1
B.S. Eng. Physics majors	4	4	4	4	2	5	6

Table 18: Completed Physics majors

According to AIP (American Institute of Physics) statistics, in numbers, the University of Arizona ranked 14th among Ph.D. granting departments averaging 20 or more bachelor's degrees per year from 2005-2007 [2]. Also according to AIP statistics, the University of Arizona is one of the 19 largest producers of physics bachelors earned by Hispanic Americans from 2004-2008 [4].

The data show a slight decrease in B.S. completed majors in the last three years. One of the Physics Department's strategic goals is to increase the number of physics majors and completed majors. The Department is particularly interested in increasing the number of Hispanic American and women physics majors.

9.2 Courses for Non-Majors

The Physics Department makes significant contributions in teaching physics to non-majors. Two sets of introductory courses, PHYS 102/103 and PHYS 141/142/241 are taught in addition to the PHYS 161/162/261/263 introductory series for physics majors and honors students. PHYS 102/103 is a non-calculus based sequence taken by students with a variety of majors from the College of Agriculture and Life Sciences, College of Architecture and Landscape Architecture, and the College of Science (Ecology and Evolutionary Biology and Psychology majors). PHYS 141/142/241 is a calculus based sequence primarily for science majors from the College of Science and engineering majors from the College of Engineering.

These courses are taught by the instructional faculty in the Department except for PHYS 102. Thus these courses are taught by some of the same outstanding professors that teach courses for physics majors. PHYS 102 is taught by qualified graduate students under the close supervision of a faculty member. They use identical lecture materials prepared by the faculty member. The faculty member prepares all the homework assignments and exams.

The quality of these courses is assessed using the same methods as for other courses in the Physics Department. Student evaluations, grades, and faculty surveys provide some of the data for assessment. Additionally, PHYS 102/103 is monitored periodically using student surveys targeted for this course. One example is a survey that is still being analyzed that compares student satisfaction for multiple Teaching Assistant (TA) lecturers versus one faculty lecturer. The results seem to favor the one faculty lecturer model however the students preferred the smaller class size in the TA model.

The Associate Dean from the College of Engineering periodically meets with the Associate Dean from the College of Science and a faculty member from the Physics Department to discuss improvements or perceived problems with the PHYS 141 series. Recently, for example, such a meeting concluded that engineering students would benefit from additional outside class tutoring in PHYS 141. The Physics Department had hoped to implement additional tutoring for engineering majors beginning in Spring 2011 with support from the College of Engineering and the College of Science. However lack of funding did not allow this to happen and we are continuing to search for alternative solutions. The Director of Undergraduate Studies has initiated similar meetings with departments requiring the PHYS 102 series.

During the APR period, two courses, PHYS 201 and PHYS 202, were offered to satisfy the Tier 2 Natural Science General Education requirement. PHYS 201 is entitled "How Things Work: Physics through Everyday Tools and Devices". PHYS 202 is entitled "Energy, Society, and the Environment". Going forward, PHYS 201 will likely not be taught and PHYS 202 is being renamed as ASTR 202. The Department has plans to develop a new Tier 2 Natural Science course called the "Physics of Cooking".

9.3 Undergraduate Major Program

The requirements for B.S. degree can be found in Appendix E. There is no accrediting body which prescribes the curriculum. However web searches show that the B.S. curriculum offered by the Department follows that of nearly all physics departments from Research I Universities. That curriculum includes four semesters of introductory physics (mechanics, electromagnetism, thermodynamics, optics, and modern physics), six semesters of intermediate level ("junior level") physics including two semesters of quantum mechanics, and six semesters of more field specific courses such as solid state physics and nuclear/particle physics. Additionally a final research project is required that can fulfilled through Phys 483 (advanced lab), Phys 492 (directed research), or Phys 498 (senior capstone).

The requirements for B.A. degree can be found in Appendix F. The B.A. degree is pursued by a small number of students who intend to work in fields outside physics such as law or medicine. The main difference between the degrees is the B.A. has a reduced number of required core courses and no research requirement.

As mentioned, the B.S. curriculum is very similar in scope to that found at most Research I Universities. While the introductory and intermediate level courses are primarily "classical", the faculty are aware of the need to include as many recent ideas and advances as are feasible. The more field specific courses usually include recent developments in the field through lectures or student presentations. The decreasing number of physics faculty has led to limits on the number and frequency of specialized courses that can be offered.

The faculty in the Department have the nearly universal opinion that a research experience is the most active learning strategy for physics. It develops critical analytical skills. It often provides an opportunity to learn practical skills such as programming. It frequently reinforces material learned in the classroom.

The Physics Department stresses independent research as an integral part of an undergraduate Physics major's education. Students are also required to take a graded, one-semester course of independent research (PHYS 483/492/498). Undergraduate research opportunities are advertised on the Department web page as well as on a University web site ur.arizona.edu. Recently the Associate Head supplied two of the junior level physics instructors with prepared slides in order for them to give their classes a short presentation on the nuts and bolts of finding research positions in the Department and on campus. Each May the Department holds an Undergraduate Research Symposium where students can showcase their research. The Symposium includes a banquet lunch and an award for best research presentation. Faculty comments on the student presentations are used as part of assessment measures.

Many undergraduates engage in independent research (beyond the course requirement). A 2010 College of Science exit survey of graduating Physics majors showed that, of the 13 respondents, 77% reported working on an independent research project, either directly in the Department or elsewhere with other physics research groups on campus. The average number of semesters the students participated in research was approximately 3.5 and 40% did independent research over the summer. A 2011 survey of Physics majors showed close to 50% of the 24 junior and senior respondants were currently doing research (outside of the PHYS 483/492/498 requirement).

As concerns instructional technology, nearly 100% of the faculty use D2L (Desire to Learn) for some aspects of their course. The degree of use varies from instructor to instructor but in general D2L is used to post lecture notes, homework assignments and solutions, and grades. A small minority of faculty have experimented with response devices ("clickers") with varied results.

Currently there are no online courses for required or elective courses. In part, these take extensive time to properly develop and in part, there are system issues that must be addressed. That said, the Physics Department is closely following the development of online courses in the College of Science and will monitor their popularity and effectiveness.

9.4 Undergraduate Students

The data on the quality of students selecting Physics as a major, graduation rates, and time to degree compared with other fields are given in Appendix J. The following tables average these data over the last seven years (2003-2009).

In Table 19, the average SAT scores for incoming freshman Physics majors, College of Science majors, and all University of Arizona students is shown. This shows that freshman students attracted to the Physics Department are of higher quality (based on SAT score) than those attracted to majors in the College of Science or all majors at the University of Arizona.

Physics Freshman Count	Ave. SAT	College of Science Freshman Count	Ave. SAT	University of Arizona Freshman Count	Ave. SAT
84.7	1288.1	1225.4	1170.1	7678.7	1108.7

Table 19: Seven year average of freshman counts and average SAT scores in Physics, the College of Science, and the University of Arizona

Table 20 shows the average fraction of Honors College students in the Physics Department, the College of Science, and throughout the University of Arizona. Students accepted into the Honors College are among the very best scholars at the University and must have at least a 3.5 GPA after taking 12 or more units. The large fraction of Physics majors who are in the Honors program compared to majors in the College of Science and at the University of Arizona attest to the high quality of Physics majors in the Department.

Physics Honors fraction	College of Science Honors fraction	University of Arizona Honors fraction
0.34	0.24	0.14

Table 20: Seven year average of the fraction of majors in the Honors program in the Physics Department, the College of Science, and the University of Arizona

In Table 21 it is seen that the time to graduation for Physics majors from 2003-2009 is slightly longer than but comparable to that for all students in the College of Science and to all students at the University of Arizona. Data from the last three years show a time to graduation (4.46 years) that is statistically equal to that for students in the College of Science (4.55 years) and the University of Arizona (4.52 years). One side note is that the number of Physics graduates in the table is artificially low since the data query did not include double majors or transfer students.

Physics Graduates	Years to Degree	College of Science Graduates	Years to Degree	UA Graduates	Years to Degree
11.2	4.86	268.2	4.63	3050.2	4.60

Table 21: Six year average of number of graduates and average years to degree for students in Physics, the College of Science, and the University of Arizona

Table 22 shows the six year average graduation GPA for Physics majors as well as for all students in the College of Science and at the University of Arizona. The GPA for completed Physics majors is the same as for completed majors in the College of Science and the University of Arizona. This shows grades given by the Physics Department are similar to those in other Departments at the University.

Physics Completed Majors	GPA	College of Science Completed Majors	GPA	University of Arizona Completed Majors	GPA
29.7	3.28	535.7	3.28	5093.2	3.17

Table 22: Six year average GPA of completed Physics majors, majors in the College of Science, and all majors at the University of Arizona.

The Physics Department strives to create a welcoming environment for all Physics majors. This, coupled with ample research opportunities and high quality teaching, all serve to help retain undergraduate students.

A welcoming environment is provided in a number of ways. Though free space is very limited in the PAS building, an undergraduate lounge was created on the ground floor where majors can study or socialize. Additionally, there is a computer room with approximately 20 PC's running Windows for students to use. Using XWindow software, students can also use these machines to connect to a Linux server for scientific applications. A dedicated Academic Support Office exists to help students with bureaucratic matters related to class registration and degrees. During most working hours, a graduate student is available in the "consultation room" where students, both majors and non-majors, can seek help with any physics course being offered. At least once a year the Head or Associate Head and Director of Undergraduate Studies holds an open town hall meeting for the majors where any complaints or concerns can be raised. Each fall, the Directors of Undergraduate and Graduate studies hold a meeting for undergraduates to discuss the details of and answer questions about applying to graduate school. One of our emeritus faculty, Prof. Garcia, offers several meetings to help students prepare for the Physics GRE. All these substantial efforts send a message to our undergraduate majors that they are highly valued and this in turn helps retention. We plan that each semester one colloquiuum speaker will be from industry or a national lab and discuss career opportunities as part of his/her talk.

While the Department provides a supportive environment for existing Physics majors, its efforts to attract new majors are just beginning. As mentioned in the strategic plan, one of the goals of the Physics Department is to increase the number of Physics majors. The new created Committee on Public Relations, Outreach, and Recruitment is considering effective and efficient ways to recruit more majors. One plan is to ask the instructors for the introductory physics courses for non-majors to give a pre-prepared talk explaining the variety of career opportunities that can be pursued with a Physics degree. Also the Director of Undergraduate Studies and an additional Physics faculty represent the Department at University "Meet Your Major Fair" held at the start of each Fall semester.

There are nine faculty advisors for Physics majors. Thus there are approximately 20 students assigned per faculty advisor. The faculty advisors in general have extensive experience teaching at the undergraduate level. The Director of Undergraduate Studies serves as the "Lead Advisor" in the sense that he is extremely knowledgeable about University and Department policies and rules as well as common problems that occur and their solution. Thus he is a valuable resource for the faculty advisors.

The effectiveness of the advising has not been well measured to date. One problem is that it is not mandatory for most students to meet with their advisor. In addition to e-emailing students encouraging them to meet with their advisor we are investigating various scenarios to help bring more students and their advisors together. Note that all students on Academic Probation are required to meet with their advisor in order to develop a reasonable course plan for increasing their overall GPA.

One needed area of improvement is tracking of alumni. To date, the best information comes from a survey created by the Associate Head but there is only one year of data. An exit survey from the College of Science exists but it is not mandatory for Physics majors to participate. A survey was submitted to Physics graduate alumni through the Arizona Foundation. While we received 64 responses, only 10% were from graduates in the last six years. And these most recent responses would be the most relevant. One of our goals is to work with the College of Science and University in order to improve tracking of our graduated Physics majors.

In the Associate Head survey, there were 18 respondents from the May 2010 graduating majors. 10/18 (55%) of the students indicated they were continuing to graduate school. The list of graduate schools includes the University of Arizona (Professional Science Masters program), Arizona State University, Caltech, University of California at Davis, Colorado State University, University of Colorado, Harvard, University of Minnesota, Northern Illinois University, and the

University of Washington. While we have no recorded data from previous years, our experience tells us this is typical. That is, every year a few of our best students matriculate to a Top 10 graduate program in Physics, most continue to a graduate program at one of our peer institutions, and a few continue to graduate school at somewhat lesser quality schools. The remaining 8/18 (45%) students pursued jobs. Not all respondents gave details of their jobs. Among the job positions accepted were work at a National Lab, air force pilot, physics engineer, accelerator operator, and a research position at Steward Observatory. At least one of the students in this category indicated they would eventually like to attend graduate school.

The exit survey from the College of Science had fewer respondents but did contain more information on how the students viewed their educational experience. Two of the questions are used here.

Students were asked about their overall undergraduate experience compared to their expectations. Possible answers were Exceeded, Met All, Met Some, Met Few, or Did Not Meet. The corresponding fraction of student responses were 15%, 23%, 46%, 8%, 8%. Comments on expectations included:

"I would have liked to have more elective options." "I came to the U of A to study Astronomy, but what I was taught was Astrophysics, not Astronomy." "More field courses would have been helpful. "There was a lack of major's courses that I felt needed to be addressed for coming years"

Students were asked if they were trained to solve problems. Possible answers were Strongly Agree, Agree, Neither, Disagree, and Strongly Disagree. The corresponding fractions of student responses were 31%, 54%, 15%, 0%, 0%.

Finally, from the Arizona Foundation survey, and using only alumni that had graduated in the last six years, come the following comments. Note however this is only four out of an estimated 180 graduating Physics or Engineering Physics majors.

These are answers to the question "Please comment on the Quality and Effectiveness of the UA Physics Degree Program".

"Sometimes in class faculty forgets that we are learning that stuff for the first time and so the assume we know things that actually we will learn in another class. This creates holes in the process of understanding and at that level students do not even know that these holes exist. I think it would be great to have a review session with graduate students or maybe a time once or twice a week were graduate students would explain one complete topic and some of its connections to other areas in physics. For example the Hamiltonian: what is it, what is it used for and what other ways there are to solve that same problem, how is it used in mechanics and what does it mean in quantum, etc."

"The UA Physics program prepared me very well for the Biomedical Physics graduate program I am currently in. I believe my basic physics background was as good or better than the majority of the students in my graduate program."

"Every year there are teachers who consistently receive bad reviews from students, yet every year they are allowed to teach again with no improvement. For UA physics program to be effective, this must change."

"I believe a math methods course should be mandatory" (An editorial note is that it is mandatory.)

9.5 Assessment

Assessment of the undergraduate physics program is documented on the University of Arizona assessment website. The link is http://assessment.arizona.edu/sci/PhysicsUndergrad. The Department received an "Achievement in Assessment" award for 2009-2010.

The expected outcomes and assessment activities and findings are documented on this page. The expected student outcomes are:

- Physics majors should have significant knowledge of the theories that form the basis of classical mechanics, electromagnetism, quantum mechanics, optics, and thermodynamics. Additionally, they should have some knowledge of more specialized topics such as solid state physics, nuclear physics, particle physics, and/or biophysics.
- Physics majors should be able to design and conduct experiments in order to investigate physical phenomena. They should be able to document, analyze, and critically interpret the results of these experiments.
- Physics majors should be able to use mathematical or computational skills in order to investigate physical phenomena. They should be able to document, analyze, and critically interpret the results of their work.
- Physics majors should be able to communicate their results through clear written reports and oral presentations.
- Physics majors should be prepared to enter quality graduate degree programs in physics or to assume challenging technical positions in a variety of industries.

Assessment in the Physics Department is carried out by the Assessment Coordinator, who is assigned by the Department Head. The current Assessment Coordinator is the Associate Head, Prof. Ken Johns. Faculty and students participate indirectly through surveys, grades, course evaluations, etc. The Director of Undergraduate Studies (DUS) utilizes the information gathered in developing plans for the undergraduate program. The DUS also uses extensive contact with faculty and students in formulating changes to the program. While these contacts provide less formalized assessment, they are an excellent source of detailed assessment nonetheless.

The effort to assess both the undergraduate and graduate programs was recently increased in the Physics Department, in part driven by increased emphasis by the University. Assessment is an ongoing process and it is used in the Department to develop program plans. A variety of data is used to assess the undergraduate program. Institutional and departmental data are used to provide an overview of and to monitor the undergraduate program. The knowledge of core disciplines in physics can be evaluated using GRE subject scores. Note that none of the Department courses teaches directly to the GRE. Department, College of Science, and University surveys are used to get student feedback. A recent Physics major survey showed we need to increase promotion and advertising of research opportunities in the Department. Course grades, student evaluations, and faculty surveys are also used in program assessment. Assessment data is often difficult and time-consuming to collect. Hopefully the recently implemented PeopleSoft Campus Solutions from Oracle will allow more detailed data to be collected more easily in the future.

A specific example of how assessment data is used was a poll given to PHYS 102 and 103 students that sought feedback about how the class was taught. PHYS 102 used Teaching Assistants in order to reduce the class size. PHYS 103 used one professor with a much larger class size. The results of the poll are being studies by the Undergraduate Curriculum Committee in order to increase the effectiveness of both courses. Another example grew from the results of a semester-end poll to faculty that included a question on computational physics in courses. A result is that computational physics components were added to several of the junior level physics course curricula.

9.6 Plans

The Physics Department has already initiated discussions with the College of Engineering in regards to the physics sequence taken by most engineering students. One result of these discussions were plans to provide significantly more tutoring for Physics 141 students. In the same spirit, we plan to initiate discussions with colleges/majors whose students take Physics 102/103 (our algebra-based physics courses). We want to determine if they have any concerns about the content of the course and/or its current structure.

The Director of Undergraduate Studies plans to continue discussions with the curriculum director in the Math Department. These discussions will primarily focus on whether the Math Department can make any changes in their introductory curriculum that would be beneficial to us as well as to keep current on the Math curriculum. For example, the DUS recently learned that MATH 129 expanded their coverage of complex numbers. This may have implications to what is taught in PHYS 204 (Math Techniques). Another example is Physics was asked if it mattered what examples of integration were taught. Previously they were using work as an example but wanted to try out other examples as well.

The undergraduate Physics curriculum is currently targeted towards students who will be attending graduate school in physics. The curriculum committee will be reviewing the undergraduate curriculum and exploring the idea of providing degree tracks for students with varying career goals. We expect that such options in the curriculum will help attract more students and potentially assist in retention as well. Possible tracks include: chemical physics, environmental physics, biological physics, etc. All of these would obviously involve interaction with other departments and the University (since ABOR requirements must be considered).

We are hopeful that the new Physics Advisory Board will also help enhance the undergraduate education for Physics majors. The new board includes local industry leaders as well as an ex-Vice President of Research at UA. One of its goals is provide training and guidance to Physics majors not choosing a path to graduate school. At least one of the Departmental colloquia each semester will focus on careers of physics majors outside of academics. Along these same lines, the Department also plans to improve its tracking of Physics baccalaureates. In addition to information provided by the College of Science in exit polls, we hope to encourage students to respond to the Department's exit polls as well.

We have begun to consider offering a new general education course. While this is not set in stone yet, our preference is to offer a course on the physics and chemistry of cooking. An informal poll showed this topic would hold great interest for non-science majors.

10 Graduate Program

10.1 Overview

The 2010 CIP (Classification of Instructional Programs) code for this program is 400801.

There are two graduate degree programs offered by the Physics Department. The first is the Ph.D. program. The second is Professional Science Masters (PSM) program in Medical Physics. There is no official M.S. in Physics program, however the degree is often awarded to Ph.D. students who have passed the written comprehensive exam.

The requirements for a Ph.D. in Physics are given in Appendix G. The current coursework required for the Ph.D. student is 12 courses in physics (broadly defined) and four courses in the minor field (which is usually physics as well). The four courses in the minor field are required to be taken from four of eight subfields of physics, thus providing breadth to the degree. Students must pass a comprehensive written exam and an oral exam in order to advance to Ph.D. candidacy. In the oral exam, the student is expected to defend their proposed Ph.D. research as well as answer general physics questions related to their research topic. Finally, a completed Ph.D. dissertation must be successfully defended by the student during an oral presentation (i.e. a thesis defense). Students successfully completing the Ph.D. program should be prepared to follow a career path towards achieving quality positions in academia or assuming leading technical roles in the private sector or government.

The PSM program in Medical Physics was established in 2007. It grew out of earlier PSM program in Applied and Industrial Physics. Recently we requested a name change for this program to Professional Science Masters in Medical Physics. The PSM in Medical Physics is a joint program between the Departments of Physics and Radiation Oncology. The program is currently working towards CAMPEP (Commission on Accreditation of Medical Physics Educational Programs) accreditation. Students who successfully complete this degree should be well prepared for the Part 1 Examination in Radiologic Physics administered by the American Board of Radiology and will be ready to enter a medical physics residency program.

The PSM requirements are given in Appendix H and students must take 36 units of courses selected from Physics, Radiation Oncology, Optical Science, and Biomedical Engineering. Courses in Human Anatomy and Physiology are also suggested. A summer internship in Medical Physics is an additional requirement.

Specialty graduate programs in Biological Physics and Theoretical Astrophysics exist. There are no specific course requirements associated with these programs however they both provide faculty support and research opportunities that cut across normal departmental boundaries.

In 2009, a Chemical Physics Program was added as a new specialty program. This is an interdisciplinary track that enables students to pursue cutting edge research at the boundaries of Physics and Chemistry. Such boundaries exist in such diverse fields such as Nanoscience and Biological Physics. The program recognizes the high impact such an interdisciplinary and collaborative program can bring to solving modern research problems. This flexible program allows students to take core courses from both the Physics and Chemistry departments.

Table 23 shows the number of Ph.D. students per year and the number of first year Ph.D. students per year.

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Enrolled Ph.D. students	69	76	75	69	65	69	73
First year Ph.D. students	11	14	13	13	10	13	12

Table 23: Enrolled and first year Ph.D. students

Averaged over the last six years, the number of instructional (tenured and tenure-track minus administrators) faculty is approximately 27. The number of Ph.D. students is approximately 70 giving a ratio of Ph.D. students to faculty of 2.6. This number is artificially high however. The number of "post comprehensive exam" students is approximately 50 and 18 of these have joint appointment or outside department advisors. Thus the ratio of Ph.D. students who have passed the comprehensive exams to instructional faculty is 32/27 = 1.2. It is desired that this number be somewhat higher. In general, we feel the number of enrolled Ph.D. students is below optimal.

The six year completion rates are taken from the National Research Council Survey (see Appendix J). The completion data uses five entering cohorts of Always Full-Time Students in the Academic Years 1996-2000. The six year completion rates for all students who graduated in academic years 2003-2005 is 26% (12/47). The completion rate for females is nearly the same, 25% (3/12). The median time to degree was 5.25 years. Likely the completion rate in Physics has increased given the tightening of minimum GRE Physics score needed for admission to the graduate program. This has increased the success fraction of students passing the comprehensive written and oral exams.

Recent and planned changes in the graduate program are designed to improve the completion rate and time to Ph.D. The requirement to pass a preliminary written exam to be taken upon entering the program and covering undergraduate physics material was eliminated in 2010. The focus of the oral exam was changed from a comprehensive exam on graduate physics material to a defense of proposed Ph.D. research coupled with general physics questions related to the proposed research. Finally, it is planned to reduce the the Physics Minor requirements from 12 units to 9 units with 3 units replaced by mandatory colloquium attendance. Improved tracking of research work through oral rather than written progress reports is also planned.

Two national rankings of the Physics Department doctoral program exist and have been discussed in Section 5. One is from U.S. News and World Report and the other is from the recent NRC (National Research Council) publication, “A Data-Based Assessment of Research-Doctorate Programs in the United States”.

Repeating some earlier text for convenience, the 2010 U.S. News and World Report ranking of graduate physics programs finds the University of Arizona program ranked 36th, tied with Michigan State University and the University of Florida, and University of North Carolina. The rank of the UA Physics Department has been at this level (between 30th and 40th) for the last several years and perhaps longer.

The National Research Council (NRC) recently published a new study of doctoral programs in the physical sciences. This new (2010) publication from the NRC uses data collected during 2005-2006 and present a range of rankings rather than a single number. Actually two ranges are given in the publication. One is an S-ranking (for survey-based), which uses a faculty survey on the relative importance of various measures to develop ranges of rankings. The other is an R-ranking (for regression-based) , which uses a smaller faculty survey on program rankings to obtain weights for program variables so as to closely reproduce those rankings. In the associated spreadsheets accompanying the NRC publication, one finds the S-ranking range (5th to 95th percentile) for the Physics Department to be 58-113 and the R-ranking range to be 51-99.

10.2 Curriculum and Courses

The core Physics courses offered by the Department are similar to those offered by the top graduate programs as well as by peer programs. Specialty courses in subfields of physics are offered for the primary subfields of research carried out in the Department. These subfields include AMO (Atomic, Molecular, and Optics), Particle Physics, Nuclear Physics, Condensed Matter Physics, Astrophysics, and Biophysics. Student interest often drives the frequency of these courses since the minimum enrollment for a graduate course is five students. The present faculty size also limits the number of specialty courses that can be offered each semester. In general the specialty courses offer a breadth that is consistent with the active research areas in the Department. Programs such as the Chemical Physics program allow students to take courses in both the Physics and Chemistry department. We plan to construct other broad interdisciplinary tracks in the future.

There are several active learning strategies used in the Ph.D. degree program. The first is the strong recommendation that students take two semesters of PHYS 599 during their first two years of study. PHYS 599 is an independent study course intended to be supervised research with individual faculty or a research group. The course allows students to become immersed in research fields in which they are interested or wish to try out. The specific independent study activities varies from professor to professor or group to group but most involve active learning experiences such as laboratory work, computer simulation, or mathematical calculation.

A second strategy is that the comprehensive oral exam towards Ph.D. now requires an oral defense of a proposed Ph.D. project in addition to answering general physics questions related to this research topic. In order to successfully pass the oral exam, the student must necessarily become actively involved in research relatively early. This requirement helps shorten the time to degree since some research topic needs to be identified by the end of second year of study.

Of course the thesis research itself is an active learning experience.

A large fraction of faculty use D2L (Desire2Learn) course management system to post lectures, problem sets and solutions, and other relevant material. Other forms of instructional technology such as clickers or podcasting are not used in graduate physics courses. Online courses are not available for required or elective courses.

There is adequate but tight space for graduate students to carry out their studies. Cubicle space for TA (Teaching Assistant) graduate students is provided in several rooms throughout the PAS building. RA (Research Assistant) graduate students typically have shared offices in space provided by their research advisor or group. Unoccupied office space is nearly non-existent in the Department. The head of the Graduate Student Council (GSC) in the Physics Department notes that the space for graduate students could be improved although the situation is not desperate.

Graduate students have adequate computing and supplies to carry out their studies. A large fraction of graduate students have personal laptops. Most RA's have access to additional computing within their research group. Resources such as printers or copiers are readily available to the graduate students. The undergraduate computer lab is also available to graduate students who need access to Windows machines.

As concerns travel money for conferences and workshops, travel for many RA's is supported through the research grants of their advisors. Additionally, travel grants for students attending or presenting research at academic or professional conferences is available through the GPSC (Graduate and Professional Student Council). Within the department, the C.Y. Fan "FanFare" Award is a memoriam award that supports conference travel for two graduate students per year. Also, travel to the APS Four Corners Meeting (regional APS meeting) is usually subsidized by the Department.

All admitted Ph.D. graduate students are guaranteed financial support, including health insurance. In general, all Ph.D. students are compensated as Teaching Assistants (TA's) or Research Assistants (RA's). The compensation for students is dependent on whether or not they have passed the comprehensive written and oral exams. The "pre-comprehensive" compensation is approximately 15.0k$ and the "post-compensation" is approximately 16.6k$. These are academic year salaries. Both RA's and TA's are typically hired at 0.5 FTE, which amounts to 20 hours/week. Students may earn an additional 4/9 times their academic year compensation by working as 1.0 FTE RA's during the summer. All Ph.D. student RA's and TA's hired at the 0.5 FTE have their Out-of-State tuition waived. In addition, 100% of registration fees are remitted. The miscellaneous student fees that the student is responsible for is approximately $300.00/semester. Health insurance is covered as a benefit of their assistantship and they receive a 10% discount at the Bookstore. The low cost of living in Tucson makes the graduate student stipend a livable one.

A snapshot of the RA/TA mix shows 35 TA's (25 of which are "pre-comprehensive"), 20 RA's (18 are "post-comprehensive"), and 6 RA/TA mixtures. Additionally, 11 students are supported from sources outside the Department, four are supported through other fellowships, and two are self-supported.

As mentioned above, the six year completion rates from the National Research Council Survey for all students who graduated in academic years 2003-2005 is 26% and the median time to degree was 5.25 years. This data was not included in the last Physics Department APR so no comparison can be made. However as mentioned above, several changes were recently made to the graduate curriculum that are designed to improve the six year completion rate and time to degree.

10.3 Graduate Students

The Physics Department uses several different means to recruit graduate students. The foundation for recruitment must come from the high quality, cutting edge, and visible research programs pursued by the faculty. A Physics Department web site is maintained and frequently updated with national and local news items related to faculty research and awards.

Additionally, faculty indirectly recruit through their colloquia and seminars at universities as well as through research ties with other universities. Finally, up-to-date brochures describing the graduate program and areas of research excellence are sent to targeted undergraduate schools around the country.

A very effective recruiting weekend is held for all domestic students who are admitted to the graduate program. Airfare and lodging expenses are paid by the Department. Students intensively interact both professionally and socially with faculty and graduate students. Short talks describing Department research are given to the students along with lab tours. Additionally, the Director of Graduate Studies and senior graduate students give talks on academic expectations as well as practical matters of being an Arizona physics graduate student. There are also several social events for all faculty and graduate students during the weekend. The recruiting weekend is successful in the sense that a large fraction (30/44 in the last years) of those students who visit the Department during that weekend ultimately matriculate to Arizona.

The data on women in the graduate Ph.D. physics program is given in Table 24. The total number of Ph.D. students each year is approximately 70.

The data show that on average 18.4% of the enrolled Ph.D. students are women. Assuming that all these students continue to earn their Ph.D. in physics, then this average fraction is

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Number	13	14	15	14	13	12	10
Percent	18.8	18.4	20.0	20.3	20.0	17.4	13.7

Table 24: Women in the graduate Ph.D. program

approximately the national average in 2007. The national average data on the percent of physics Ph.D.'s earned by women was approximately flat or perhaps slightly increasing by a percent or two between 2002 and 2007 [3]. While the Fall 09 data shows a decrease in the fraction of women enrolled in the Ph.D. program we believe this to be a statistical fluctuation rather than a trend. The fraction of women in the matriculating 2010 Ph.D. student class is 23%.

The Physics Department is acutely aware of the proportionally small fraction of women graduate students. We acknowledge that physics is one of the last areas in the sciences where there is significant under-representation of women and minorities relative to their proportion of the population. We understand that the loss of the participation of women in physics occurs increasingly at the undergraduate, graduate, and faculty levels.

The Department's awareness of the low fraction of Ph.D. students who are women extends to the Admissions and Recruitment Committee. Great care is taken to ensure that all qualified women are admitted by taking a broad look at their applications. Additionally, during the recruitment weekend described above, efforts are made to make the women applicants feel as welcomed as possible. The two women faculty members in Physics meet with the applicants in an informal setting. Also, last year, one of the women faculty members of the Department gave the Department Colloquium that all students invited to the weekend attended. Finally, we take advantage of the Graduate Diversity Fellowships available from the Graduate College if possible. These are $10k fellowships for incoming domestic graduate students and are intended to increase the number and quality of diverse graduate students admitted to Arizona.

The data on underrepresented minorities (URM's) in the graduate physics program is given in Table 25. The total number of Ph.D. students each year is approximately 70. The fraction of URM's is obviously very low and similar to that found in most Physics Departments across the country. Currently only 30-35 Ph.D.'s are awarded to (US) URM's each year, which is about 5% of the total Ph.D.'s awarded [1], [5]. While the fraction of URM's enrolled in the Ph.D. program is decreasing, we do not consider this a trend given the small absolute number. On the other hand, the small absolute number is a concern and the Physics Department is taking steps in order to increase the enrollment and degree completion of URM Physics Ph.D.'s.

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Number	5	5	6	2	2	2	2
Percent	7.2	6.6	8.0	2.9	3.1	2.9	2.7

Table 25: Underrepresented minorities in the graduate Ph.D. program

The Physics Department is actively pursuing participation in the APS (American Physical Society) Minority Bridge Program (MBP) as a constructive step to address this issue. The specific details of the APS MBP program are still being developed however the idea is to establish bridge programs between Doctorate Granting Institutions (DGI's) and Minority Serving Institutions (MSI's) in order to increase the number of URM's obtaining Physics Ph.D.'s. The Physics Department working proposal is given in Appendix I. We participated in all APS MBP meetings. Two faculty from UA and two faculty from UTEP have given or will give colloquia and seminars at UTEP and UA. The visiting faculty also take time to talk to and interact with undergraduate and graduate students. The UA and UTEP Physics Departments have secured funding for three UTEP students to participate in the UA Summer Research Institute (SRI) sponsored by the UA Graduate College. The SRI provides both research experiences as well as workshops that focus on important issues such as GRE, grad school applications,and leadership. Possible research collaborations in the future are also being explored which would further strengthen the ties between the two schools. We hope to build similar collaborations with Northern Arizona University and New Mexico State University at Las Cruces.

Our proposal seeks to build on the success the University of Arizona has had in general in attracting URM's as graduate students. Seventeen per cent of all enrolled graduate students at Arizona come from URM backgrounds and Arizona ranks in the top five universities nationally in the number of Hispanic and Native Americans who obtain Ph.D.'s. We have been in contact with some of the experts in this area at the University for advice and input. One result is that Director of Graduate Studies participated in the national SACNAS (Society for Advancement of Chicanos/Latinos and Native Americans in Science) conference in Fall 2010 in order to recruit potential graduate students and to establish new contacts with faculty at other universities. This will likely become an annual trip for the DGS and perhaps an accompanying graduate student.

10.4 Assessment

Assessment of the graduate physics program is documented on the University of Arizona assessment website. The link is http://assessment.arizona.edu/sci/PhysicsGrad. The Department received an "Achievement in Assessment" award for 2009-2010.

The expected outcomes and assessment activities and findings are documented on this page. The expected student outcomes are:

- Physics Ph.D.'s should have deep knowledge of the theories that form the basis of classical mechanics, electromagnetism, quantum mechanics, and statistical mechanics. Additionally, they should have extensive knowledge of one or more specialized fields such as condensed matter physics, AMO physics, biophysics, astrophysics, nuclear physics or particle physics.
- Physics Ph.D.'s in experimental subfields should be able to design and conduct original experiments in order to investigate physical phenomena. They should be able to analyze data and publish these results in scientific journals.
- Physics Ph.D's in theoretical subfields should be able to construct original theories in order to explain or predict physical phenomena. They should be able to describe and publish their work in scientific journals.

- Physics Ph.D.'s should be prepared to follow a career path towards quality positions in academia or assume leading technical roles in a variety of industries.

Assessment in the Physics Department is led by the Assessment Coordinator, who is assigned by the Department Head. Currently this responsibility is assigned to the Associate Head. Faculty and students participate indirectly through surveys, grades, course evaluations, etc. The Director of Graduate Studies (DGS) utilizes the information gathered in developing a strategic plan for the graduate program. The DGS also uses extensive contact with faculty and students in developing desired changes in the program.

As previously mentioned, the effort to assess both the undergraduate and graduate programs was recently increased in the Physics Department, in part driven by increased emphasis by the University. Assessment is an ongoing process and it is used in the Department to develop program plans. A variety of data are used to assess the graduate program. Institutional and departmental data are used to provide an overview of and monitor the graduate program. As an example we closely monitor the number of women graduate students in the program. Knowledge of core disciplines in physics is evaluated using the comprehensive written and oral exam results. Recently an undergraduate/graduate elective course on classical and quantum relativity was added to the curriculum in part based on results from the comprehensive written exam. Course grades, student evaluations, and faculty surveys are also used in program assessment. As mentioned, the DGS uses extensive contact with the faculty, which provides an excellent source of informal assessment. Assessment data is often difficult and time-consuming to collect. Hopefully the recently implemented PeopleSoft Campus Solutions from Oracle will allow data to be collected more easily in the future.

Two sets of data which need to be greatly improved are the placement tracking of Ph.D.'s from the program and statistics on graduate student publications and conference presentations. We intend to work with the College of Science and the University of Arizona Foundation in order to better document the career paths of physics doctorate and master's students. While there are several exit surveys students in the Department, College of Science, and University, they are not uniformly completed by the students. Improved communication with both graduate and undergraduate alumni may be useful in securing external fund-raising for the Department. A proposal exists to request graduate student publication and conference presentation information as part of the yearly CAPE (Committee on Annual Performance Evaluation) documentation.

Probably the biggest outcome of the assessment process thus far was to implement changes designed to shorten the time to obtain a Ph.D. These changes were already discussed and include adding an option to make the oral exam

10.5 Plans

One major change recently implemented was to modify the oral comprehensive exam format to one that focuses on an oral defense of future thesis research work. General physics questions are still asked but in general they are related to the research plans presented by the student. It is expected that the new format will direct students towards research earlier than was previously the case.

One planned change to the graduate curriculum is to reduce the Physics Minor requirements from 12 units to 9 units. The three units will be replaced with mandatory colloquium attendance for first and second year students. The idea is to replace one course with colloquium attendance, possibly with homework. The benefits are increased exposure to current research in a variety of fields as well as increased interaction with faculty before and after the colloquium.

Another planned change will improve the tracking of student progress towards the Ph.D. Starting in 2011, graduate students will be required to make a short presentation discussing their research progress to their dissertation committee. The committee will respond with a short report including recommendations if and/or how the students should continue in the program. This new format will replace the yearly one-page written report submitted by students. We expect that closer and more frequent interactions with the committee will create a more active and mentoring research/learning environment for the student. We also hope that the improved tracking will help reduce the average time to graduation.

Not all Ph.D. graduates continue in academia. Recognizing this fact, we are exploring implementing summer-internships for graduate students at local companies. This is expected to improve the job perspective for students interested in non-academic careers. This is a multi-year effort as generating a network of participating companies is expected to be a time-consuming process. The newly formed Advisory Board for the Department should help us here.

Finally, as already mentioned in this section, we will increase our recruiting efforts for underrepresented minorities and women. A good start has already been made by participating in the APS MBP program and by establishing ties with UTEP. The previous subsection offers more detail. We intend to talk with additional minority serving institutions in Arizona and New Mexico. We also plan to take concrete steps towards improving the number of women in the graduate program.

11 Academic Outreach

11.1 Outreach

The Department faculty are involved in a wide range of outreach activities, primarily local. As stated in our strategic plan, one of the goals is to grow our outreach efforts and better integrate them with the College of Science and University. To achieve this goal, the Head has already appointed a dedicated Outreach Coordinator and Committee. Already a few new ideas have been generated and implemented.

Probably the biggest community outreach event sponsored by the Department is Physics Phun Nite. This event is open to the public and held once or twice per year. Physics Phun Nite involves faculty, staff, and students presenting a wide range of exciting and entertaining physics demonstrations. Examples are bed of nails and burning bubbles demonstrations. Physics Phun Nite is held in the largest classroom in the Physics building and nearly all of the 375 seats are filled. Physics Phun Nite provides an excellent opportunity for the Department to connect to the public.

Another significant outreach event sponsored by the Department is the public Blitzer Award talk. The Leon and Pauline Blitzer Award honors excellence in the teaching of physics and related sciences. It is given once a year to a member of the Astronomy, Atmospheric Sciences, Planetary Sciences, or Physics Departments. The award winner gives a public lecture related to his/her research and this is usually well attended.

In the last two years, the Physics Department also held two high profile public lectures related to the Large Hadron Collider (LHC): one at the turn-on of the LHC and the other coinciding with the premiere of the film “Angels and Demons” which featured CERN. Profs. Cheu and Varnes who are particle experimentalists working at CERN gave the talks that were attended by well over 500 people and were enthusiastically received. The Department plans other such talks on significant occasions or breakthroughs in fields with active researchers in the Department

In addition to these large public talks, several faculty have given talks at one of the “Science Cafes” sponsored by the College of Science. The “Science Cafes” provide an opportunity to learn new science and connect with UA faculty in an informal setting.

The Physics Department also continues its successful Summer Bridge Research Experiences for Undergraduate (REU) program that is supported by NSF. This program targets local community college students, primarily from Pima Community College in Tucson, who plan to transfer to the Physics Department or other science or engineering department for a B.S. degree at UA. The REU program provides summer research opportunities with many different research groups on campus doing physics.

Several faculty including the Head are involved in the Tucson Area Physics Teachers Organization (TAPT). The TAPT meets monthly and provides support and a social network for local physics teachers. It also provides an opportunity to exchange technical and administrative information. TAPT is coordinated by Prof. Garcia and the Department hosts a breakfast once a year. Several faculty have given informal research talks at the meeting.

Two of the faculty are involved in substantial outreach efforts as part of their administrative positions. These faculty are Prof. Elliott Cheu, Associate Dean of the College of Science, and Prof. Pierre Meystre, Director of the B2 Institute at Biosphere 2. The B2 Institute is a division of Biosphere 2 that addresses “scientific Grand Challenges whose solutions require the combined expertise of a broad range of scientific fields and diverse interdisciplinary talents”.

As Director of the B2 Institute, Prof. Meystre is actively involved in planning significant outreach activities including public lectures and teacher training. There is also artist-in-residence and journalist-in-residence programs that help build bridges to the public through these media. Examples of B2 Institute outreach include the Arizona Center for STEM Teachers (ACST), a program connecting the Tara Oceans oceanographic expedition with local middle and high school classrooms, and an Experts Bureau that provides a pool of experts to create programs and present lectures. The ACST program has significant local funding and its goal is to expand the quality and retention of science, technology, engineering, and math teachers in Arizona. It aims to engage more than 300 teachers within three years.

As Associate Dean of the College of Science, one of Prof. Cheu's responsibilities is outreach between the College of Science and the public. In fact, the Physics Department aims to join some of these outreach programs in order to increase its outreach efficiency and impact. The College of Science has outstanding public facilities including Flandrau Planetarium, Biosphere 2, and the Mount Lemmon Sky Center. Professor Cheu oversees and develops a wide range of outreach activities for schools and the community. The activities include a large number of field trip possibilities, classroom visits, science materials and resources, and professional development opportunities. Some of the Physics faculty have participated in the latter through the Science Cafe program. One exciting program among many is Project Soar which enrolls UA students to become engaged in service learning program. This potential outreach army serves hundreds of middle school students by providing meaningful mentoring to these students.

Nearly all of the experimental physics faculty and the AMS group give lab tours to any group that requests them. Most of the tours are for high school seniors contemplating coming to UA but a few have also been given to younger students interested in physics. The number of tours is high, approximately 10 or more per lab per year, especially for the AMS lab.

Several faculty (Profs. Cronin, Manne, Visscher) and the AMS lab have had high school students work in their labs. Visscher was also interviewed a number of times about biological physics by high school students for a class project.

Prof. Cronin is very active in outreach. A public health graduate student working with Prof. Cronin is collaborating with three different middle schools to disseminate curriculum relevant to solar energy that also satisfied the Arizona state educational standards for the relevant grades. She has an impressive portfolio of curriculum lesson plans, educational hardware kits, contact information, and projects in progress with Tucson area middle and high school teachers. Cronin himself has guided several high school students in their science fair projects.

Prof. Falco who is a joint appointmentee, is also very active in outreach. He developed a hands-on workshop to teach fundamental principles of optics to K-12 students. It was taught twice on campus in summer outreach programs, once in a summer program at the Tucson Museum of Art, and twice overseas to K-12 science teachers in Saudi Arabia and in the U.A.E.

As mentioned, outreach has renewed emphasis under the direction of the new Head. Recently the new Outreach Coordinator Prof. Srin Manne oversaw the development of a series of one-minute vignettes on "Football Physics". They are professionally recorded and shown on the UA stadium Jumbotron during home games. The vignettes concern basic physics as it relates to football and star Department member Ingrid Novodvorsky and her students. Several more vignettes are in the works, and the Department is currently gauging interest in filming a similar series for other divisions of UA Athletics.

Not only do we hope for increased community engagement but also (eventual) increased student enrollment in the undergraduate program. With this in mind, Manne and his committee has developed a new course for K-12 outreach. The course is entitled "Communicating Physics" and trains junior and senior physics majors in demonstrating and explaining physics experiments to K-12 students. This course was advertised throughout the Physics and Math Departments and has attracted a critical mass of six students. Currently an independent study course, it will undergo formal approval during Spring 2011. Students in this course will be trained in age-appropriate pedagogical techniques in a 8-hour workshop at the beginning of the semester. Thereafter they will spend 2-3 hours per week engaged in K-12 outreach under appropriate supervision.

Permanent space has been reserved at Flandrau Planetarium for lab activities and demonstrations, alongside a similar effort by the Ecology and Evolutionary Biology Department. The "Communicating Physics" outreach stations will thus be an integral aspect of the College of Science's proposal to convert the Flandrau Science Center into a centralized outreach location, encompassing astronomy, biology, physics, and other disciplines. This beachhead will greatly extend the outreach of the Department well beyond the individual faculty visits to K-12 classrooms.

Finally, the Department plans to host a yearly open house, perhaps during National Physics Day (should these reoccur). The open house would consist of lab tours and a poster area highlighting departmental research. An engaging speaker would deliver a public talk associated with the open house.

12 Collaboration

12.1 Collaboration with Other Units

The Physics Department maintains dynamic collaborations with other units on campus including the departments of Applied Math, Biochemistry, Chemistry, Planetary Sciences, Math, and the College of Optical Sciences. Most of these connections are at the individual investigator level. As mentioned in the Department's strategic plan, we aim to broaden and strengthen these links to the other research groups by calculated hirings and increased effort. The current Department Head, Prof. Sumit Mazumdar, meets regularly with the Heads of Astronomy, Planetary Sciences, and Chemistry in order to explore coherence in hiring, potential interdisciplinary proposals, and education. The Head plans to set up a similar relationship with Electrical Engineering.

12.2 Collaborations in Research

Joint appointments are one way to foster collaboration with other departments on campus. The Physics Department has offered courtesy joint appointments to faculty across the campus whose research interests overlap with physics. There are currently 18 such joint faculty members, whose primary appointments are in Astronomy, Chemistry, Electrical Engineering, Geosciences, Planetary Sciences, Mathematics, and Optical Sciences.

As Director of the B2 Institute, which is part of Biosphere 2, Prof. Meystre collaborates closely with a broad range of departments and units within the College of Science and the University. The strategic vision of the B2 Institute is that of an organization of researchers who work together across multiple disciplines to identify the most important scientific questions, design experiments to answer those questions, and synthesize data from a variety of disciplines to extract the implications of experimental results for society and decision makers. This highly interdisciplinary research involves connections to the departments of Atmospheric Sciences, Biology, Chemistry, Hydrology, Geology, and Physics among many others.

Several members of the Department (Profs. Barrett, Melia, and van Kolck) are affiliate members of the Program in Applied Mathematics. Prof. Visscher serves on the Steering Committee for the program. This is a highly regarded interdisciplinary program that tackles a broad range of problems at the interface of mathematical, physical, life, and engineering sciences.

Astrophysics, nuclear and particle theorists as well as particle experimentalists in the Department have a variety of connections to Astronomy and Planetary Sciences. Many of these connections are through membership in the TAP (Theoretical Astrophysics Program). The TAP program is a top-ranked interdisciplinary program involving Astronomy, Planetary Sciences, Physics, and Applied Math. The program administers a weekly colloquium, graduate student research prize, a postdoctoral fellowship, and a visitor program. Physics faculty who are members of the TAP include Profs. Fang, Melia, Rafelski, and Sarcevic. Melia and Sarcevic have many connections through formal research collaborations or frequent discussions. Melia and Sarcevic also supervise graduate and undergraduate students from Astronomy and LPL. Sarcevic is a member of the Steering Committee of TAP. Recently Sarcevic submitted a pre-proposal for an NSF Physics Frontier Center, called the ”Arizona Center for Dark Matter Physics”, involving 21 faculty members from four Departments.

Also in 2009, particle experimentalists Profs. Cheu and Johns joined the LSST (Large Synoptic Survey Telescope) collaboration. The LSST collaboration already had substantial involvement from the Astronomy Department and NOAO (National Optical Astronomy Observatory), which is located on the UA campus. As a result, additional ties were established between Physics and researchers in these units. Finally, Prof. Hsieh has had extensive collaborations with faculty in LPL, in particular with Prof. Jokipii.

Prof. Visscher (experimental biophysics) holds joint appointments in Physics, Molecular and Cellular Biology (MCB), and the College of Optical Sciences. He maintains or has had research collaborations with faculty in Optical Sciences, Chemistry and Biochemistry, and Applied Mathematics. As one of the founders of the Biological Physics Program, Visscher has frequent interactions with faculty in the Life Sciences (MCB, Biochemistry, and the Medical School) during biweekly meetings.

Several collaborations exist with the Chemistry Department (Profs. LeRoy, Mazumdar, Sandhu, and Stafford). LeRoy works frequently with the Keck Center for Nanoscale Structure and Dynamics. This is a facility located in the Chemistry Department and run jointly by Chemistry and Physics. Sandhu and faculty in Chemistry and Optical Sciences together established a research center for Ultrafast Spectroscopy and Imaging at UA. Mazumdar has held several umbrella grants with faculty in Chemistry and Optical Sciences in the past and has served on Ph.D. committees of both departments.

AMO (Atomic, Molecular, and Optical) theorists and experimentalists as well as condensed matter theorists have substantial collaborations with the College of Optical Sciences. Profs. Cronin, Jacquod, Mazumdar, Meystre and Sandhu hold joint appointments in the College of Optical Sciences. Meystre works closely with many colleagues in Optical Sciences, especially Prof. Wright. Mazumdar interacts with the groups of Profs. Peyghambarian, Norwood and Binder in Optical Sciences. Sandhu has submitted a joint grant proposal with faculty in Chemistry and Optical Sciences aimed at studying the interplay between the electronic and nuclear degrees of freedoms. Prof. Stafford recently served as thesis advisor for a student in Optical Sciences.

One of the Physics faculty, Prof. Cronin, is actively involved with AZRISE (Arizona Research Institute for Solar Energy) which includes numerous faculty interested in basic solar energy research, systems, and policy. Cronin's activities, which involve five other faculty at UA, center on a large solar test yard at TEP (Tucson Electric Power) where he and his collaborators evaluate 25 different grid-tied PV (Photovoltaic) systems. TEP plans to use the yard to guide large-scale investments.

Finally, the AMS (Accelerator Mass Spectrometer) facility has significant participation from Geosciences. Prof. Jull of Geosciences is the current Director of AMS. The research carried out by the AMS lab includes a wide range of interdisciplinary topics including geology, paleoclimatoloy, and archeology.

12.3 Collaborations in Education

The Department is an active participant in the Integrated Science Major. Prof. Koen Visscher developed an interdisciplinary laboratory module entitled "Biological motion across the varying length scales" for the course MCB/PHYS 303, "Explorations in Integrated Science". The Physics Department has committed to teaching this course for 1/3 of its offerings.

An Accelerated M.S. Program (AMP) in Atmospheric Science is offered exclusively to UA Physics majors. The program goal is to give students who wish to pursue a career in atmospheric sciences opportunities to take graduate courses and engage in graduate level research in atmospheric sciences.

There are also several existing collaborations in the graduate program. A Biological Physics Program (BPP) has existed for some time. The BPP is a collaboration between the Departments of Physics, Chemistry and Biochemistry, and Molecular Biophysics and includes lab rotation and research opportunities in all these departments. The Theoretical Astrophysics Program (TAP) was formed to encourage closer interactions between the faculty in the Astronomy, Physics, Planetary Science, and Applied Math Departments working on astrophysics problems.

While there is no course track associated with this program, TAP does provide a biweekly colloquium series, a visitor program, a graduate student prize for research, and the opportunity for graduate students to apply for funds for travel or publication.

As mentioned several times in the Self-Study Report, a Chemical Physics Program (CPP) was created in 2009 in order to satisfy the considerable attention paid to the interface of these two fields. Seven Physics faculty, Profs. Cronin, LeRoy, Manne, Mazumdar, Sandhu, Stafford and Visscher are members of the Program. In 2010 the CPP applied to the NSF for a REU site.

Finally the PSM (Professional Science Masters) program in medical physics is a joint program between the Physics and Radiation Oncology Departments. Students complete course work in both departments and are well prepared for ABR (American Board of Radiology) Certification or to enter a residency program in medical physics.

13 Diversity

13.1 Overview

One of the goals of the Department's strategic plan is to increase the number of women and underrepresented minorities at all levels in the Department. The Physics Department has taken many steps in order to create a welcoming and supporting climate inclusive of diversity. Many of these steps were implemented by the current Head and Associate Head in response to recommendations from the 2008 Title IX Compliance Review Report from NASA. The Physics Department takes seriously the ideals of providing equal educational opportunities and preventing discrimination.

13.2 Faculty and Staff

The gender composition of the faculty and staff in the Physics Department is given in Table 26. All professional and classified staff are included regardless of their funding source (i.e. both State and research funded).

Title	Fraction of Women
Faculty	0.07
Professional staff (all)	0.19
Classified staff (all)	0.60

Table 26: Fraction of women in the faculty, professional staff, and classified staff

The Department is acutely aware of the need to increase the number of women and underrepresented minorities at all levels in the Physics Department: faculty, postdoc, graduate, and undergraduate. As stated in our strategic plan, we envision growth in the Department especially for these groups.

Of these levels, increasing the number of women on the Physics faculty is the most difficult. This is true nationwide as only 9.5% of Physics faculty of all ranks at major research universities are women. Still, we must strive to improve.

The pool from which women faculty are drawn (postdocs, national labs, other universities, industry) is small. Hiring of any new faculty is a very competitive and costly process. Especially for women and underrepresented minorities, the economic law of supply and demand applies. An an example, during our 2009 faculty search, one of the five finalists was a women. She wowed the Department and certainly would have been our first choice except that her startup requirements were four times what the College of Science was able to offer. In this particular case, the University simply could not afford the startup costs.

Nevertheless, we will continue to make increasing the number of women faculty a priority. We strongly encourage all search committees for new hires to attend a talk given by the ADVANCE group on campus to educate themselves on the best hiring practices, ways to deepen the hiring pool, and possible unintentional biases in the hiring process. The ADVANCE program in campus is managed by the Center for Research, Equity and Opportunity (CREO) and "seeks to actively advance the research and scientific reputation of the University of Arizona by promoting faculty diversity and the equitable treatment of faculty".

13.3 Undergraduate and Graduate Students

The gender composition of undergraduate and graduate students in the Physics Department is given in Table 27. The percentage of physics bachelor's earned by women nationally was ap-

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Undergraduate	0.28	0.26	0.27	0.21	0.21	0.19	0.22
Graduate	0.21	0.19	0.19	0.18	0.18	0.17	0.14

Table 27: Fraction of women among undergraduate and graduate students

proximately 21% in 2007. The percentage of Ph.D.'s earned by women nationally was approximately 18% is 2006. While these numbers surely need to be improved, the Physics Department enrollments of women at the undergraduate and graduate levels are close to national averages. The dip in women enrollment in Fall 2009 is believed to be a statistical fluctuation (of small numbers) downward.

The efforts to attract and retain women graduate students was described in Section 10. The Admissions Committee is acutely aware of our need to increase qualified women graduate students and takes a broad view of applicants during the admissions process. All domestic students offered admissions are invited to a weekend where they can experience the Department faculty, staff, and graduate students. Extra efforts are made for women applicants by showcasing the research programs of women faculty at the colloquium and through informal chats with the women faculty.

Additionally, we aim to recruit and retain women undergraduate and graduate students by maintaining a welcoming climate in the Department and these efforts are described below.

The fraction of undergraduate and graduate students from underrepresented minorities in the Physics Department is given in Table 28.

	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Undergraduate	0.14	0.16	0.16	0.14	0.20	0.20	0.23
Ph.D.	0.07	0.07	0.08	0.03	0.03	0.03	0.03

Table 28: Fraction of underrepresented minorities in the undergraduate and Ph.D. programs

The average percentage of bachelor and Ph.D. degrees awarded nationally to underrepresented minorities is approximately 10% and 5-6% respectively. Thus in the Physics Department we already have a healthy fraction of URM undergraduates, primarily Hispanic. At the graduate level, we are below the national average and the absolute numbers are small. In the Department's strategic plan we envision growth in the number of URM's for both the undergraduate and graduate programs. We have taken concrete action in order achieve these goals, especially increasing URM Ph.D.students.

As discussed in Section 10, the Physics Department is actively pursuing participation in the APS (American Physical Society) Minority Bridge Program (MBP). In the interim, we are currently building a collaboration with the University of Texas at El Paso (UTEP) in order to provide a pathway for UTEP M.S. students to become UA Ph.D.students. UA and UTEP have secured funding for three UTEP students to participate in the UA Summer Research Institute (SRI) sponsored by the UA Graduate College. The SRI provides both research experiences as well as workshops that focus on important issues such as GRE, grad school applications,and leadership. There has also been a good exchange of UA and UTEP faculty for colloquia and visits that include interactions with undergraduates. Possible research collaborations in the future are also being explored. We hope to build similar collaborations with Northern Arizona University and New Mexico State University at Las Cruces.

Additionally, the Director of Graduate students attended the national SACNAS (Society for Advancement of Chicanos/Latinos and Native Americans in Science) conference in Fall 2010 in order to recruit potential graduate students and to establish new contacts with faculty at other universities. We hope to make this a yearly recruitment trip. Another goal of the Department's new Advisory Board is to advise the Department Head on the means to attract and retain female and minority students.

13.4 Creating a Welcoming Environment

The Physics Department places a high priority on creating a welcoming and supporting environment for all students. The Department received constructive input from an APS Climate for Women Site visit in 2004, an Administrative Review of the Physics Department by the College of Science in 2006, and a Title IX Compliance Review by NASA in 2008. The current Head and Associate Head subsequently implemented a number of steps to help create a welcoming and supporting climate inclusive of diversity. While each of these actions is small by itself, in sum they show the Department is proactive in fostering diversity.

Some of the initiatives for students, faculty, and staff undertaken by the Department include (in no particular order)

- Ensured 100% participation in the "Preventing Sexual Harassement Training", which is mandatory for all UA employees
- Arranged live training by the Office of Institutional Equity (OIE) on discrimination and harassment to all incoming undergraduate and graduate students in the Physics Department
- Posted NASA posters on "Equal Educational Opportunity" and APS posters on "Celebrate Women in Physics" in high traffic areas in the Department.
- Monitored demographic statistical data on admissions, enrollment rates, and other metrics to track trends in this area
- Encouraged the inclusion of questions related to the climate for women and ethnic groups in the Department into a yearly poll for the graduate student population carried out by the Graduate Student Advisory Council
- Created a standing Committee on Diversity to generate ideas for increasing the enrollment of women at the undergraduate and graduate levels
- Held Town Hall meetings for undergraduate and graduate students once or twice each academic year
- Advertised to all students via instructor presentation how to pursue research opportunities available in the Department
- Created surveys for undergraduate and graduate students who did not matriculate to UA to learn their reasons for choosing to matriculate elsewhere
- Maintained contact with the Office of Institutional Equity in order to increase our awareness of other steps to create a welcoming environment for all in the Department
- Utilized the ADVANCE program on campus, which provides funding to invite outstanding women colloquium speakers.

14 Unit Profiles

14.1 Responses to Questions and Comments

Data supplied to the Physics Department from the Office of Academic Affairs can be found in Appendix J. Some of this data has been already analyzed in various sections throughout the Self-Study Report. Additionally, questions and comments were provided by Celeste Pardee from the Office of Academic Affairs to be addressed in the Self-Study Report. Responses to these are found below.

- *"Enrolled Majors: The PHYS - BA/BS enrollment was relatively stable, ranging from 148 to 169, prior to the closure of the EPH Program. However, between Fall 08 and Fall 09, PHYS enrollment rose 27% – with additional freshmen and juniors. Was the increase due to absorbing would-be EPH majors or other factors? At the graduate level, the number of AIP students was 6 or fewer, while enrollment of graduate PHYS students stayed fairly constant (70 - 84). Was the lack of growth in these programs intentional?"*

  The jump in B.S. Physics majors is likely an anomaly. One of the goals of the UA is to increase the undergraduate enrollment by about 1300 students each year. Indeed the number of undergraduate students has already been increasing since 2007. The number of freshman Physics majors does not correlate with this increase except for Fall 09. Perhaps the increase in the number of junior majors was due to the disestablishment of the Engineering Physics program by the College of Engineering as freshman and sophomore students were advised to pursue either Physics or a specific Engineering degree. But we have no tracking data to support this conjecture. Nearly all Ph.D. students are supported by either Teaching Assistantships (TA) or Research Assistantships. The sum of these has remained constant over the last several years thus the number of Ph.D. students has remained approximately constant as well. There is now only one track in Professional Science Master (PSM) program - medical physics. The Medical Physics PSM is currently seeking accreditation. If successful, likely the number of students in this program will increase as students preferentially seek accredited programs.

  As mentioned in the Self-Study Report, one strategic goal is to increase the number of Ph.D. students in the program. Through faculty growth, expansion of interdisciplinary research with other academic units on campus, and increased efforts in securing external fellowships for students, the number of RA's, and hence the number of students that can be supported, can be increased.

- *"Enrolled Minors: Undergraduate PHYS minors peaked at 36 in Fall 06 and then subsided. The PHED (teaching) minor and Engineering Physics (EPH) minors were disestablished in June 2009 for lack of students. To what do you attribute the low interest in the baccalaureate minors? Enrollment in the PHYS doctoral minor was relatively steady, with 13 - 19 students"*

  Physics minors are not actively promoted or tracked by the Department. This is in part because many Astronomy or Math majors pursue a double major with Physics rather than a minor. The Department needs to improve its tracking of the Physics minors. We are a bit confused by the low number of Ph.D. student minors since nearly all Ph.D. Physics students choose Physics as the minor. Hence we would expect a larger number. Perhaps students don't record that this requirement is satisfied until they are close to obtaining their Ph.D.

- *"Completed Majors: The number of completed BA/BS - PHYS majors per year ranged from 18 to 40 during the APR period. The number of PHYS graduate completers fluctuated between 14 and 20 in the past 6 years. There were no obvious trends or anomalies in these data. Two of your current programs don't meet ABOR productivity standards: (1) the PSM - AIP, with only 8 completions in the past 3 years, and (2) the BA - PHYS, with only 3 completions. You'll need to submit Low Productivity Reports justifying the continuation of both programs."*

  We subsequently learned that it was not necessary to submit a Low Productivity Report for the B.A. program as it is exempt from the ABOR threshold because it doesn't require different resources than the B.S.

  We will submit a Low Productivity Report for the Professional Science Masters (PSM) program. We have already submitted a name change request to the Professional Science Masters degree in Medical Physics.

  The PSM program in Medical Physics started in earnest three years ago and has been enrolling about five students per year. The Medical Physics PSM is currently seeking accreditation. If successful, likely the number of students in this program will increase as students preferentially seek accredited programs.

- *"Majors by Gender: Since Fall 03 the percentage of female students declined at the undergraduate and graduate levels. How do you account for the decreasing gender diversity?"*

  This has been discussed in Section 13 of the Self-Study Report. Nationally, the fraction of women in Physics at all levels: undergraduate, graduate, post-doc, and faculty is below 50%. These fractions decrease with the level of advancement. One of the goals of the Department's strategic plan is to increase the number of women and underrepresented minorities at all levels in the Department. The absolute numbers of women undergraduate Physics majors (41) and graduate Ph.D. students (13) are small. Small changes in the numbers obviously give large changes in the fractions.

  At the undergraduate level, the fraction of women Physics majors in the Department is very close to the national average. At the graduate level, the fraction of women Ph.D. students in the Department is slightly below the national average. The Physics Department pays special attention in creating a welcoming environment for all students. Examples are providing a study lounge for undergraduates, holding surveys and town hall meetings, and providing training through the Office of Institutional Equity for incoming undergraduate and graduate students. We are hopeful that outreach activities that are in progress or planned will increase the number of both men and women Physics majors. Similarly extra efforts are made for women graduate applicants who attend the recruiting weekend by showcasing the research programs of women faculty at the colloquium and through informal chats with the women faculty. We utilize support on campus (ADVANCE) in order to bring additional outstanding women physicists as Department colloquium speakers. And as already mentioned, one of the charges of the Department's new Advisory

Board is advise the Head on ways to achieve higher enrollment and retention of women at all levels.

- *"Majors by Ethnicity: Underrepresented ethnic groups (African Americans, Asian Americans, Hispanics, and Native Americans) constituted 14% of undergraduates in Fall 03 and 23% in Fall 09 -a significant improvement in ethnic diversity. However, the reverse occurred at the graduate level, with the percentage of underrepresented minorities falling from 6.3% of majors in Fall 03 to 2.5% in Fall 09. What factors contribute to the lack of ethnic diversity among your graduate students?"*

  This has been discussed in Section 13 of the Self-Study Report. Nationally, the fraction of underrepresented minorities (URM) in Physics at all levels: undergraduate, graduate, post-doc, and faculty are well below their fraction of the population. One of the goals of the Department's strategic plan is to increase the number of women and URM's at all levels in the Department.

  At the undergraduate level, the Department is fortunate to have a healthy fraction of URM Physics majors, primarily Hispanic. At the graduate level, the fraction of URM Ph.D. students is below the national average and the absolute numbers are small. We are making a significant effort to attract URM graduate students through an active collaboration with UTEP (University of Texas at El Paso) and increased recruiting at national conferences such as SACNAS. We are also actively participating in the APS Minority Bridge Program. Both UA and UTEP have provided funding for three UTEP students into the Summer Research Institute (SRI) that is run by the UA Graduate College. There have been exchanges of faculty for colloquia. Also research collaborations between faculty are being investigated. The long term hope is that promising UTEP students from their undergraduate or M.S. program would become Ph.D. graduate students at UA.

- *"Freshman ACT/SAT Scores: The 7-year average composite ACT score for freshman PHYS majors (28.1) far exceeded that for freshmen in the College (25.1) and for the University as a whole (23.6). This is an excellent indicator of the quality of your students."*

  We agree that the high SAT and ACT scores of students who matriculate to UA as Physics majors is an excellent indicator of the quality of these students. Our experience is that many of the high school students who do well on the SAT and ACT are interested in the sciences or engineering in general and physics and math in particular. Attracting more of these students into the Physics program is one of the goals of our outreach program.

- *"Majors in Honors: The 7-year average percentage of Honors students was very high for PHYS majors (34.2%) This is far above the average for the College of Science (23.8%) and the UA in general (13.8%). To what do you attribute the high participation in Honors?"*

  This is simply speculation. As seen above, many of the incoming students are particularly well-qualified as defined by their SAT and ACT scores. These students also tend to be highly motivated and high-achieving ones. Also, both scholarship and research experience are emphasized by the Physics faculty which hopefully inspires students to participate in distinctive programs such as the Honors College.

- *"Enrolled Majors Per Instructional Faculty: The number of undergraduate majors per instructional faculty FTE remained low during the APR period (ranging from 6.5 to 8.2),* *despite the loss of 5.4 state-funded faculty FTE–31.5 (Fall 05) to 26.1 (Fall 09). With fewer graduate majors, the loss of faculty FTE had little effect on the number of graduate students per instructional faculty; that number remained < 3. Any comments on this would be helpful."*

It is important to note that significant SCH (Student Credit Hours) are taught by the Physics Department in addition to those for Physics majors. The introductory physics sequences required for engineering majors and for life science majors are taught by the Physics Department. Thus the teaching load for the Department is larger than that found by just considering Physics majors.

Additionally, one of the priorities for UA is excellence in research. A minimum number of faculty are needed to provide both breadth and depth in research areas. In fact, compared to our peers, the size of the faculty in the Department is average or below average.

At the undergraduate level, it has been already noted that, in numbers, the Department ranked 14th among Ph.D. granting departments averaging 20 or more bachelor's degrees in 2005-2007. That is to say, the size of the undergraduate class will unlikely ever double as evidenced by the B.S. degrees per year granted by Ph.D. granting departments. However the Department does have as a strategic goal an increase in the number of Physics majors.

At the graduate level, the table of enrolled majors shows that the number of graduate majors fell slightly in 2006-2008 thus making the ratio of enrolled graduate majors to faculty constant. In fact one of the goals of our strategic plan is to increase the number of enrolled graduate majors through increased recruiting. Some of these majors could come from other Departments or could be supervised by physicists outside the Department as our interdisciplinary research efforts increase. In 2011, a larger number of admissions offers to potential graduate students have been made compared to preceeding years.

- *"Enrolled Majors Per Completed Major: The number of enrolled majors per completed major is an indicator of retention; the lower the number, the better (< 5 is desirable). The undergraduate number was quite high, with the exception of FY04-05 and FY06-07. The graduate number stayed at a healthy level every year (< 5) but FY09-10. What strategies have been considered, if any, to raise your BS/BA completions?"*

  One the one hand we desire to increase the number undergraduate Physics majors. On the other hand, Physics can be a difficult discipline to some students. As a general rule, students find the junior level Physics courses more challenging than the introductory ones. Unfortunately we lose some students after the junior year if their performance was poor in the junior level classes. We try to provide a healthy academic environment through the "Consultation Room" where students can seek help from Physics Department graduate students and an Undergraduate Physics Lounge that encourages students to work together.

  That said, one of the priorities in undergraduate education is to improve the advising process. An existing problem is that meetings between students and advisors is not mandatory (via a hold on registration e.g.). Instead we must increase our encouragement through email and class announcement for students to meet and talk with their advisors. Additionally, lunchtime "chats" with advisors with free food are also being considered.

  One area in which we hope to improve is student tracking. In theory, the new PeopleSoft software used for student administration at UA will allow us to better investigate at what points students are leaving and to where they migrate. We intend to study this as well as what are the important factors in addition to course performance.

- *"FTE Enrollment: Full-time enrollment in undergraduate courses went up 4% between Fall 08 (420.8) and Fall 09 (439), probably reflecting the increase in BS majors. However, graduate FTE fell 34%, from a high of 59.2 (Fall 08) to 38.8 (Fall 09). What might account for declining FTE enrollment at the graduate level?"*

  Here we can only put forward a conjecture. The number of graduate majors in Fall 08 and Fall 09 were 69 and 73 respectively. Thus we would expect the number of graduate FTE to be similar. One consequence of the decreasing number of faculty in the Physics Department is that some graduate and undergraduate courses, especially specialty courses, are now offered less frequently than previously. This frees up faculty for teaching core courses as well as allowing student demand to build. This may account for some of the FTE drop in Fall 09 even though the number of graduate students was essentially the same in Fall 08 and Fall 09.

- *"State Expenditure Per Completed Major: With an average of 49 completions each year during the APR period, the state expenditure per degree was very high. What factors contribute to the high cost?"*

  For the Physics Department, the state expenditures are primarily faculty and a few staff salaries. Department operations and other staff salaries are funded primarily through ICR. The question then equivalently asks why is the number of faculty per completed major so high. As mentioned above, Physics faculty teach the introductory physics sequence courses for engineering and life science majors in addition to courses for physics majors. Additional faculty are needed for this responsibility. Also, a dynamic Physics Department is a necessary part of any Research I Institution. In order to maintain an active and revenue generating Department, a critical number of Physics faculty is needed. This ensures both some breadth and some depth in a few key research areas. In order to maintain research excellence some minimum number of faculty are needed, probably close in number to that which exists currently. At the same time we intend to increase the number of undergraduate and graduate physics majors.

- *"UA Departments for Comparison: Please select 2 departments in CoS or other UA colleges with which to compare your data on (1) SCH/Faculty, (2) Majors/Completers and (3) State expenditure/Completer"*

  The departments chosen for comparison are EEB (Ecology and Evolutionary Biology) and GEOS (Geosciences). These departments were chosen because they had similar ratio r values to the Physics Department. The data in Table 29 are from 2008.

	Physics	EEB	GEOS
Total Grant Revenue (M$)	3.8	4.5	4.9
COS ICR (M$)	0.25	0.27	0.21
SCH (khours)	13.9	11.0	11.1
State Expenditures (M$)	5.5	4.7	4.6

Table 29: Measures used by the College of Science to assess quality. The data is from 2008.

Taking US News and World Report as a measure of external quality, EEB is ranked 9th (tie with Princeton) (with a total of nine places), GEOS is ranked 7th (with a total of 108 places), and Physics is ranked 36th (tie with Michigan State, University of Florida, and University of North Carolina) (with a total of 145 places). The total grant revenue for Physics is somewhat smaller than for EEB or GEOS.

As a measure of internal quality, the College of Science uses an r ratio. The r value is defined as $r = (ICR\% + SCH\%)/State\%$. The % means the absolute numbers are divided by the total sums in the College of Science. The r values for EEB, GEOS, and Physics are 1.92, 1.72, and 1.74 respectively. In spite of larger differences in (somewhat arbitrary measures of) external quality, the internal quality or efficiency as defined by the College of Science is nearly the same.

Data on enrolled and completed majors are given in Table 30. The numbers are averages from 2003-2009.

The number of undergraduate majors is over three times larger in EEB compared to Physics while the number of undergraduate majors is approximately three times lower in GEOS compared to Physics. Likely this reflects the popularity of these subjects among undergraduates. The number of majors per completed majors appears to be smaller when the total number of majors is smaller. One note is that in Physics the number of majors has remained approximately constant in the last seven years while both EEB and GEOS have seen some increase (though it is difficult to disentangle statistical fluctuations).

The number of graduate majors and completed majors is roughly the same for the three departments. One might have expected Physics to be slightly higher since the size of the graduate class is driven by the number of faculty that can supervise research towards a Ph.D. The faculty size in Physics is larger than EEB or GEOS. We have already stated in the Self-Study Report that we feel the number of graduate students in the Physics Department is below optimal. The number of majors per completed major is also nearly the same for the three departments but slightly higher in Physics. However in the last three years the average ratio of graduate majors per completed majors is 4.6 which may reflect changes in the graduate program designed to increase the success of the students.

	Physics	EEB	GEOS
Undergraduate Majors	203	672	74
Undergraduate Completed Majors	32	91	14
Majors per Completed Majors	6.7	7.4	5.4
Graduate Majors	80	63	79
Graduate Completed Majors	17	14	20
Majors per Completed Majors	5.1	4.6	4.2
Instructional Faculty	29	20	23

Table 30: Majors and completed majors for the three departments. The data is averaged from 2003-2009

The SCH and the SCH per faculty are given in Table 31. Here we use averages only from 2007-2009 because of significantly increasing SCH in EEB and GEOS in these years.

The data show that Physics has larger undergraduate SCH than EEB or GEOS. Likely this is due to the introductory physics sequences for engineering, life science, and other non-physics majors. The SCH per faculty is approximately the same for Physics, EEB, and GEOS. This shows the faculty teaching load is approximately the same for these departments.

	Physics	EEB	GEOS
Undergraduate SCH (hours)	13040	10142	11040
Graduate SCH (hours)	1008	778	1216
Instructional Faculty	27.9	21.9	24.2
Total SCH per Faculty	505	498	510

Table 31: SCH per faculty for the three departments. The data is averaged from 2007-2009

The state expenditures, total completed majors, and the ratio are given in Table 32. The numbers are averages over the last seven years.

The data show that the state expenditures per completed major is approximately the same for Physics and GEOS and that both are higher than that for EEB. Obviously a larger number of completed majors for identical faculty size will result in a lower number. EEB has two-three times the number of completed majors as Physics and GEOS. One of the goals in the Physics Department strategic plan is to increase the number of undergraduate and graduate majors. One problem the Physics Department must always face is the preconceived notion by undergraduates that Physics is a “difficult” major.

	Physics	EEB	GEOS
State expenditures ($M)	5.2	4.1	4.3
Total Completed Majors	49	105	34
Expenditures per Completed Major ($M)	0.11	0.04	0.13

Table 32: State expenditures and completed majors for the three departments. The data is averaged from 2003-2009

15 Special Considerations: Threshold for Defining Low Productive Programs

15.1 Special Consideration for PSM Program in Medical Physics

This section discusses the Professional Science Masters (PSM) program in Medical Physics, which is a low degree production program. Our intent is to continue this program for the reasons given below. The primary reasons for keeping this program are that it (the Medical Physics program) was only recently established (2007), it is in the process of gaining CAMPEP (Commission on Accreditation of Medical Physics Educational Programs) accreditation, and it provides a highly skilled work force for Arizona and the U.S.

The history of the program is as follows. The PSM program in Applied and Industrial Physics (AIP) was started in 1995. The degree originally targeted students seeking to become high-tech managers in industry or government. It combined core physics courses with specialty courses and off-campus internships. It included courses in business fundamentals. There were three tracks: materials physics, photonics, and biophysics. In 2007, the program evolved into one PSM track, medical physics, and it reduced the business aspects of the program in favor of professional clinical training. In 2011, we requested a title change of the program to Professional Science Masters in Medical Physics. We also requested that the other three tracks be discontinued since they were essentially defunct.

The PSM requirements are given in Appendix H and students must take 36 units of courses selected from Physics, Radiation Oncology, Optical Science, and Biomedical Engineering. Courses in Human Anatomy and Physiology are also suggested. A summer internship in Medical Physics is an additional requirement

15.2 Expanded Information

As mentioned, the PSM program in Medical Physics has applied for CAMPEP accreditation. This is important since a CAMPEP initiative requires that beginning in 2012, in order to take the ABR (American Board of Radiology) Part 1 Examination in Radiologic Physics, candidates must be enrolled in or have graduated from a CAMPEP accredited program. Currently there are only 27 accredited medical physics graduate programs in North America and the UA program will be an important addition to this list.

The status of CAMPEP accreditation is that the self-study report is in the final stages of preparation. We believe the site visit will occur after August 2011 after the CAMPEP committee meeting at the AAPM (American Association of Physicists in Medicine) annual meeting in late July. We believe the UA program will be successful since it is viewed by us to be equivalent to or stronger than other programs that have been accredited in the last two years.

Five students have graduated from this program and all have very good placement. Two have entered Ph.D. program in Medical Physics (at M.D.Anderson in Houston and Wayne State University in Detroit). One is in the Medical Physics Residency program at UA. The other two are working in radiation oncology clinics including one in Phoenix.

The PSM program in Medical Physics aligns with the strategic plan of the University. Certainly the program strives for academic excellence, both in education and research. Many of the Medical Physics students participate in research projects in Radiation Oncology and other departments on campus. The educational component is consistent with the high standards set by CAMPEP accreditation. The program also contributes to quality of life and societal impact. Radiologic physics is an important component of radiation therapy for cancer, diagnostic imaging, and nuclear medicine. These procedures are playing an ever increasing role in medicine, especially for an aging population. As an example, a proton therapy facility is planned for the Mayo Clinic in Phoenix that will need significant staffing of medical physicists.

In terms of contributions to other programs in the University, the PSM program provides a career pathway to University of Arizona (UA) B.S. students. The Medical Physics program is an interdisciplinary one given that students take courses from the Departments of Physics, Radiation Oncology, Biomedical Engineering, Optical Sciences, and Management Information Systems.

The Medical Physics program would be unique since there is no CAMPEP accredited graduate program in Arizona. Furthermore, there are very few accredited programs in the Southwest. The nearest two are at the University of New Mexico and San Diego State University.

The Medical Physics program has a target size of four to eight students per year. It is further assumed all of these highly motivated students will complete the degree requirements. The size of the program is set by the possibilities for students to receive clinical training, which is an important part of this program. The program is seeking additional clinical training partners throughout the state. This may lead to an increase in the self-imposed student enrollment cap.

Table 33 shows the number of Medical Physics students enrolled from 2007-2010. One student each from 2009 and 2010 decided not to enroll and they were not included in the count. The year 2008 is an anomaly and occurred primarily because of a lack of recruiting effort that year. The number of students from the other years is consistent with the desired class size. In any event, assuming all students successfully complete the program, the number of degrees awarded would be above the threshold for defining a productive program (nine degrees in three years).

Fall 07	Fall 08	Fall 09	Fall 10
5	1	4	4

Table 33: Number of enrolled Medical Physics students

No one unit devotes all or nearly all of their effort to this program. There are few incremental costs since the courses taken by the PSM students are offered to graduate students in other degree programs already.

The Physics Department has launched an initiative to increase the enrollment of underrepresented minority and women students into the Physics Ph.D. program. This effort grows out of the Department's participation in the APS (American Physical Society) Minority Bridge Program. In particular, the Department is building ties with Minority Serving Institutions (MSI's) such as the University of Texas at El Paso (UTEP). These ties include opportunities for UTEP students to do research at UA through the Graduate College SRI (Summer Research Institute) program or existing REU (Research Experiences for Undergraduates) programs in the Department. The ties also include exchange of colloquium speakers between UA and UTEP as well as exploration of research collaborations between faculty. Similar connections are being sought with other MSI's. It is imagined that some of the applicants resulting from this increased recruiting activity will be attracted to the PSM program in Medical Physics. It is also anticipated that the awarding of CAMPEP accreditation will also improve our recruitment base and the number of applicants.

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Appendices

A Faculty CV's

Curriculum Vitae

BRUCE RICHARD BARRETT

August 27, 2010

EDUCATIONAL BACKGROUND:

B.S., 1961 (Physics, Math) University of Kansas, Lawrence, Kansas
Foreign Exchange Student, 1961-62 (Physics, Math) Swiss Institute of Technology (ETH), Zurich, Switzerland.
M.S., 1964 (Physics) Stanford University, Stanford, California
Ph.D., 1967 (Theoretical Nuclear Physics) Stanford University, Stanford, California
Thesis topic: Giant Resonances in Closed-Shell Nuclei with Realistic Nuclear Forces. Advisor: J. D. Walecka

PROFESSIONAL EXPERIENCE:

1967-68	Junior Research Fellow, Weizmann Institute of Science, Rehovot, Israel
1968-69	Andrew Mellon Postdoctoral Fellow, University of Pittsburgh, Pittsburgh, PA
1969-70	Research Associate of Physics, University of Pittsburgh, Pittsburgh, PA
1970-72	Assistant Professor of Physics, University of Arizona, Tucson, AZ
1972-76	Associate Professor of Physics, University of Arizona, Tucson, AZ
1973	(February-June) Visiting Professor, University of Sydney, Sydney, Australia
1976-77	Sabbatical Leave: Max-Planck-Institute for Nuclear Physics, Heidelberg, FRG
1976-date	Professor of Physics, University of Arizona, Tucson, AZ
1980	Leave of Absence, Fall Semester, KVI, Groningen, The Netherlands
1982	Fall Semester: Institute for Theoretical Physics, U. of California-Santa Barbara
1983-84	Sabbatical Leave: University of Melbourne, Australia; Max-Planck Institute for Nuclear Physics, Heidelberg, FRG; and University of Sussex, Sussex, UK
1985-87	Leave of Absence, Program Director, Theoretical Physics, National Science Foundation, Washington, D.C.
1986-87	Honorary Adjunct Professor of Physics, Drexel University, Philadelphia, PA
1989	(Fall) Visiting Professor, Universities of Tokyo and Kyoto, Japan
1990	(May-August) Visiting Professor, University of Melbourne, Australia
1991	(January-May) Sabbatical Leave: MPI for Nuclear Physics, Heidelberg, Germany
1992	(September-December) Program Co-Organizer, National Institute for Nuclear Theory (INT), University of Washington-Seattle
1997-98	Sabbatical Leave: South Africa, France, Belgium, Germany, Japan, Australia
2000-date	Affiliate Professor, University of Washington-Seattle
2004	(September-December) Program Lead-Organizer, INT, University of Washington
2004-05	Sabbatical Leave: TRIUMF, INT, Spain, Belgium, France, South Africa, Australia
2007	(September-December) Program Lead-Organizer, INT, University of Washington

AWARDS:

Alfred P. Sloan Foundation Fellowship, 1972-76.
Alexander von Humboldt Fellowship to do research in Heidelberg, FRG 1976-77.
F.O.M. Fellowship, The Netherlands, to do research at the KVI, fall 1980.
Alexander von Humboldt Senior U.S. Scientist Award, Heidelberg and Cologne, Nov. 1983-July 1985; GSI-Darmstadt, Germany, July 2007-February 2009.
Honorary Fulbright Fellow, Heidelberg, Germany, November 1983-June 1984.
Japan Society for the Promotion of Science Fellowship, U. of Tokyo, April-June 1998.
Fellow, American Physical Society, 1987; APS Outstanding Referee 2008.
Member of Phi Beta Kappa and the Circle of Omicron Delta Kappa, College Honorary Society, University of Kansas, 1961.
Listed in Who's Who in the World, Who's Who in America, Who's Who in the West, Who's Who in Frontiers of Sci. and Tech., Who's Who in American Education, American Men and Women of Science.

PROFESSIONAL ACTIVITIES:

Associate Chairman, Department of Physics, University of Arizona, 1977-83.

Faculty Senate, University of Arizona, 1979-83, 1987-90, 1991-97; Kitchen Cabinet, 1980-82; University Research Policy Committee, 1991-95 (Chair, 1993). Member: Ad Hoc Academic Budget Advisory Committee, 1992; Technology Transfer Committee, 1996-97,1998-99.

Member: Applied Mathematics Program at the University of Arizona 1977 to date.

Chair, Organizing Committee, October 2003 Annual Division of Nuclear Physics (DNP) meeting of the APS, Tucson, AZ, October 29-November 1, 2003 (600 participants).

Organized the Conference on Effective Interactions and Operators in Nuclei, June 2-6, 1975, and the Workshop on Nuclear Structure Theory, August 1980, both in Tucson, AZ.

Steering Committee, Nuclear Physics Summer School, 1987-date; Chair, 1996-98; Co-PI on grant for the Summer School, 2000-2004 and 2005-2009.

Regional Advisor (Organizing Committee), International Summer School on the N-N Interaction and the Nuclear Many-Body Problem, Changchun, China, July-August 1983.

Lead-Organizer Fall Programs, INT, September-December 1992, 2004 and 2007.

Served on the National Advisory Committee for the INT 2005-08, Chair 2007-08.

Elected to Rare Isotope Accelerator Theory Group (RIATG) Executive Committee 2006-09, Chair 2008-09.

APS Membership Committee, 2007-09.

DNP Committees: Publications Com., 1983-84, 1985-86, Chair, 1984-85; Program Com., 1993-95, 2002-03; Bonner Prize Com., 2006-07.

Elected to Executive Committee, Four Corners Section, APS, October 1998, Member at Large, two year term. Co-organizer 4CS APS meeting, Tucson, Oct. 1-2, 1999; elected Four Corners Section-APS Vice-Chair 2000-01, Chair-elect 2001-02, Chair 2002-03.

Elected Forum on International Physics-APS Vice-Chair 2000, Chair-elect 2001, Chair 2002; member APS Committee on International Scientific Affairs, 2001-2004, elected Chair of CISA for 2003; member APS Task Force on Africa, 2003-2005.

JUSTIPEN Visiting Professor, University of Tokyo, March-April 2007.

Most Cited Research Publications (number of cites in []):

1. S. A. Coon, M. D. Scadron, P. C. McNamee, B. R. Barrett, D. W. E. Blatt, and B. H. J. McKellar, "The Two-Pion-Exchange Three-Nucleon Potential in Nuclear Matter," Nucl. Phys. **A317**, 242 (1979). [398]

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4. B. R. Barrett and M. W. Kirson, "Higher-Order Terms and the Apparent Non-Convergence of the Perturbation Expansion for the Effective Interaction in Finite Nuclei," Nucl. Phys. **A148**, 145 (1970). [143]

5. H. Kamada, B. R. Barrett, *et al.*, "Benchmark Test Calculations for a Four-Nucleon Bound State," Phys. Rev. C **64**, 044001 (2001). [142]

6. B. R. Barrett, R. G. L. Hewitt and R. J. McCarthy, "A Simple and Exact Method for Calculating the Reaction Matrix," Phys. Rev. C **3**, 1137 (1971). [131]

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CURRICULUM VITÆ

Education:

Cornell University, Ithaca, NY
Ph.D. Physics, July 1991

Stanford University, Stanford, CA
B.S. Physics with Honors, June 1986

Ph.D Thesis in Physics:

"Hadronic Cross Section above $\Upsilon(4S)$ and B* Meson Production"
Thesis Advisor: Professor Nariman B. Mistry

Employment:

2009-present: Associate Dean, College of Science, University of Arizona

2008-2009: Interim Associate Dean, College of Science, University of Arizona

2008-present: Professor, University of Arizona

2006-2008: Director of Undergraduate Studies, Dept. of Physics, University of Arizona.

2002-2008: Associate Professor, University of Arizona

1996-2002: Assistant Professor, University of Arizona

1994-1996: Research Scientist, University of Chicago

1991-1994: McCormick Fellow, University of Chicago

1987-1991: Research Assistant, Cornell University

Honors:

Leon Blitzer Excellence in in the Teaching of Physics Award, 2010.

College of Science Distinguised Advising Award, 2008.

College of Science Innovation in Teaching Award, 2000.

Arthur Holly Compton Lecturer, 1993.

Robert R. McCormick Postdoctoral Fellowship, 1991-1994.

Service Activities (2005-present)

Local Outreach

Let's Talk Science Lecturer, Mar. 2009

College of Science Public Lecture, Feb. 2009

LHC public presentation, Sept. 2008.

University Committees

Mosaic Student Systems Advisory Group, 2009-present.

Honors College Advisory Board, 2008-present.

P-20 Education Council of Southern Arizona, 2008-present.

TRIF Workforce Development Subgroup, 2008-present.

Integrated Science Advisory Board, 2008-present.
Assessment Coordinating Council, 2008-present.
University Budget Redesign Task Force, 2008-2009.
Student Affairs Policy Committee, 2006-2008.
College of Science Sabbattical Committee, 2007-2008.

Department Committees

Physics Department Undergraduate Curriculum committee, chair, 2006-2008.
Physics Department Service Course committee, chair, 2006-2008.
Physics Department Executive Committee, 2004-2008.
Chair, Physics Department Graduate Examinations, 2004-2006.
Physics Department Undergraduate Recruitment & Scholarships, 2003-present.
Physics Department CAPE committee, 2002-2003, 2006-2007.
Physics Department Laboratory Equipment committee, 2002-2006.

Professional Activities

NSF Quarknet Review Panel, 2001, 2004.
Reviewer DOE Proposals, 1999-present,
Reviewer NSF Proposals, 1999-present,
Member, American Physical Society, 1986-present.

Selected Publications (out of 261 total)

1. "The Mark III Vertex Chamber." J. Adler *et al.*, *Nuclear Instruments and Methods in Physics Research* **A276,** 42-81 (1989).

2. "Search for Neutrinoless Decays of the Tau Lepton." T. Bowcock *et al.*, *Physical Review* **D41,** 805-814 (1990).

3. * "Measurement of the Inclusive B^* Cross Section above the $\Upsilon(4S)$." D. Akerib *et al.*, *Physical Review Letters* **67,** 1692-1695 (1991).

4. "CPT Tests in the Neutral Kaon System." B. Schwingenheuer *et al.*, *Physical Review Letters* **74,** 4376-4379 (1994).

5. "Observation of Direct CP Violation in $K_{S,L} \to \pi\pi$ Decays", A. Alavi-Harati *et al.*, *Physical Review Letters* **83,** 22-32 (1999).

6. "Measurement of the Decay $K_L \to \pi^0\gamma\gamma$", A. Alavi-Harati *et al.*, *Physical Review Letters* **83,** 917-921 (1999).

7. A. Alavi-Harati *et al.* "Measurements of Direct CP Violation, CPT Symmetry, and Other Parameters in the Neutral Kaon System,", *Physical Review* **D67,** 012005 (2003).

8. V. M. Abazov *et al.*, "Search for $B_s \to \mu^+\mu^-$ at D0," Phys. Rev. D **76**, 092001 (2007) [arXiv:0707.3997 [hep-ex]].

9. E. Abouzaid *et al.*, "Measurement of the Decay $K_L \to \pi^0 e^+ e^- \gamma$," Phys. Rev. D **76**, 052001 (2007) [arXiv:0706.4074 [hep-ex]].

BIOGRAPHICAL SKETCH: **Alexander D. Cronin** updated January 2011

Professional Preparation	Stanford University,	Physics	B.S.	1993
	University of Washington,	Physics	Ph.D.	1999
	Massachusetts Institute of Technology,	Physics	Postdoc.	1999 – 2002

Appointments	University of Arizona, Associate Professor of Physics	2008 – pres.
	University of Arizona, Joint Appt. Professor of Optical Sciences	2004 – pres
	University of Arizona, Assistant Professor of Physics	2002 – 2008

Ten Publications Selected from 6 PRL, 8 PRA, and 14 other peer-reviewed publications.
h-index: 10

1. "Atom Diffraction Reveals the Impact of Atomic Core Electrons on Atom-Surface Potentials," VPA Lonij, CE Klauss, WF Holmgren, and AD Cronin, *Physical Review Letters* **105**, Art. No. 233202 (2010).

2. "Absolute and Ratio Measurements of the Polarizability of Na, K, and Rb with an Atom Interferometer," WF Holmgren, MR Revelle, VPA Lonij, and AD Cronin, *Physical Review* A **81**, Art. No. 053607 (2010).

3. "A Simple Nonlinear Model for the Impacts of Partial Shade on Photovoltaic Systems," N Thakkar, S Pulver, D Cormode, V Lonij, and AD Cronin, *IEEE Photovoltaics Specialists Conference* **35** proceedings Art. No. 572 (2010).

4. "Optics and Interferometry with Atoms and Molecules," AD Cronin, J Schmiedmayer, and DE Pritchard, *Reviews of Modern Physics* **81**, pages 1051-1129 (2009).

5. "Dispersive Atom Interferometry Phase Shifts due to Atom-Surface Interactions," S Lepoutre, H Jelassi, VPA Lonij, G Trenec, M Buchner, J Vigue, and AD Cronin, *Europhysics Letters* **88**, Art. No. 20002 (2009).

6. "An Electron Talbot Interferometer," BJ McMorran, AD Cronin, *New Journal of Physics* **11** Art. No. 033021 (2009).

7. "Electron Interferometry with Nanogratings," AD Cronin and BJ McMorran, *Physical Review* A **74** Art. No. 061602R (2006).

8. "Atom Optics – Atom Interferometry on a Chip," AD Cronin, *Nature Physics* **2**, 661 (2006).

9. "Matter-Wave Decoherence due to a Gas Environment in an Atom Interferometer," H Uys, JD Perreault, and AD Cronin, *Physical Review Letters*, 95, Art No. 150403 (2005).

10. "Observation of Atom Wave Phase Shifts Induced by Van der Waals Atom-Surface Interactions" JD Perreault, TA Savas and AD Cronin, *Physical Review Letters* **95**, Art. No. 133201 (2005).

Awards

Koffler Prize for Teaching, University of Arizona	2009
Distinguished Early Career Teaching Award, UA College of Science	2007
Excellence in Undergraduate Teaching Award, UA Physics Department	2005

Service Activities

AZ Research Institute for Solar Energy Technical Advisory Committee	2009- present
Tucson Electric Power Solar Test Yard Research Coordinator	2008 - present
Director of Undergraduate Studies, University of Arizona Dept. of Physics	2008- 2009
Graduate Student Advisor, UA Department of Physics	2006 - present
Undergraduate Advisor, UA Department of Physics	2004 - present
Referee for 10 different Journals	2004 - present
Reviewer for 7 different funding Agencies	2004- present
I have served on the organizing committee for 5 national conferences	2002- present

Memberships: APS, OSA, IEEE

Advisors

Graduate Thesis Advisor:	Dr. E. Norval Fortson, University of Washington	1994 - 1999
Postdoctoral Advisor:	Dr. David E. Pritchard, MIT	2000 - 2002

Collaborators at the University of Arizona

Dr. Pierre Meystre, Physics
Dr. Warren Beck, Physics
Mr. Nate Allen, Biosphere2
Dr. Bill Conant, Atmospheric Sciences
Dr. Ray Kostuk, Electrical Engineering
Dr. Joe Simmons, Materials Sciences
Dr. Poul Jessen, Optical Sciences
Dr. Brian Anderson, Optical Sciences
Dr. Moe Momayez, Geological Engineering

Other Collaborators

Dr. Jacques Vigue, IRSAMC Toulouse France
Dr. Joerg Schmiedmayer, PI, Vienna, Austria
Dr. Peter Toennies, MPQ Goettingen, Germany
Dr. Tim Savas, MIT
Dr. Sarah Kurtz, NREL
Dr. Dirk Jordan, NREL
Dr. Bruce Doak, Arizona State University
Dr. George Maracas, Arizona State University
Mr. Bill Richarson, SOLON Corporation
Dr. Glenn Rosenberg, Prism Solar Technologies
Mr. Mark Shields, SunPower Corporation
Mr. Chris Lindsey, Tucson Electric Power

Students

In 2010 I supervised research for 4 Ph.D., 2 M.S., and 5 B.S. students.
Graduated students whom I supervised (2004-2009) include: 2 Ph.D., 1 M.S., and 6 B.S. students.

Classes

I have taught 14 regular semester classes, and 50 independent studies at the University of Arizona (2003-2010).

Grants

In 2010 I had grants from NSF, NREL, TEP, SFAZ, UA, Biosphere2, and AZRISE totaling $380,000/yr.

ABRIDGED CV — Prof. Keith R. Dienes

Education

Cornell University	Physics	Ph.D.	5/91
Cornell University	Physics	M.S.	1/89
Princeton University	Physics	A.B. with Honors	6/85

Professional Appointments

NSF	Program Director, HEP Theory	9/09 –
University of Maryland	Visiting Professor	9/09 –
University of Arizona	Full Professor	8/09 –
University of Arizona	Director of Graduate Studies, Physics	8/05 – 7/09
University of Arizona	Associate Professor	8/03 – 8/09
University of Arizona	Assistant Professor	8/99 – 8/03
CERN Theory Division	Postdoctoral Fellow	9/97 – 8/99
IAS, Princeton	Postdoctoral Fellow	8/94 – 8/97
McGill University	Postdoctoral Fellow	8/91 – 8/94
Cornell University	Graduate Research Asst.	8/87 – 8/91

Significant Publications (selected to represent several of my dominant research themes):

1. *Extra spacetime dimensions and brane-world scenarios:* K.R. Dienes, E. Dudas, and T. Gherghetta, *Extra Spacetime Dimensions and Unification*, *Phys. Lett.* **B436**, 55 (1998); *Grand Unification at Intermediate Mass Scales through Extra Dimensions*, *Nucl. Phys.* **B537**, 47 (1999). More recent papers include: K.R. Dienes, *Shape versus Volume: Making Large Flat Extra Dimensions Invisible*, *Phys. Rev. Lett.* **88** (2002) 011601; K.R. Dienes, E. Dudas, and T. Gherghetta, *GUT Precursors and Non-Trivial Fixed Points in Higher-Dimensional Gauge Theories*, *Phys. Rev. Lett.* **91** (2003) 061601; S. Bauman and K.R. Dienes, *New Regulators for Quantum Field Theories with Compactified Extra Dimensions, Parts I and II*, *Phys. Rev.* **D77** (2008) 125005 and 125006. Many other papers on extra dimensions, focusing on axion physics, cosmological phase transitions, radius stabilization, string winding modes, radiative corrections in KK theories, dark matter, *etc.*
2. *New approaches for neutrino masses and mixings:* K.R. Dienes, E. Dudas, and T. Gherghetta, *Light Neutrinos without Heavy Mass Scales: A Higher-Dimensional Seesaw Mechanism*, *Nucl. Phys.* **B557**, 25 (1999); K.R. Dienes and I. Sarcevic, *Neutrino Flavor Oscillations without Flavor Mixing Angles*, *Phys. Lett.* **B500**, 133 (2001); K.R. Dienes and S. Hossenfelder, *A Hybrid Model of Neutrino Masses and Oscillations: Bulk Neutrinos in the Split-Fermion Scenario*, *Phys. Rev.* **D74**, 065013 (2006).
3. *High-scale string phenomenology and string unification:* K.R. Dienes and A.E. Faraggi, *Making Ends Meet: String Unification and Low-Energy Data*, *Phys. Rev. Lett.* **75**, 2646 (1995); *Gauge Coupling Unification in Realistic Free-Fermionic String Models*, *Nucl. Phys.* **B457**, 409 (1995); K.R. Dienes and J. March-Russell, *Realizing Higher-Level Gauge Symmetries in String Theory: New Embeddings for String GUTs*, *Nucl. Phys.* **B479**, 113 (1996). K.R. Dienes, *New Constraints on SO(10) Model-Building from String Theory*, *Nucl. Phys.* **B488**, 141 (1997). Other papers have focused on extra $U(1)$'s, unusual Standard-Model embeddings, *etc.* *Also authored an extensive*

review article: K.R. Dienes, *String Theory and the Path to Unification: A Review of Recent Developments*, *Physics Reports* **287**, 447 (1997).

4. String model-building/string landscape: K.R. Dienes, *Statistics on the Heterotic Landscape: Gauge Groups and Cosmological Constants of Four-Dimensional Heterotic Strings*, *Phys. Rev.* **D73**, 106010 (2006); K.R. Dienes, M. Lennek, D. Sénéchal, and V. Wasnik, *Supersymmetry versus Gauge Symmetry on the Heterotic Landscape*, *Phys. Rev.* **D75** (2007) 126005; *Is SUSY Natural?*, *New J. Phys.* **10** (2008) 085003.
5. *Non-SUSY directions in field theory and string theory:* K.R. Dienes, *Modular Invariance, Finiteness, and Misaligned Supersymmetry: New Constraints on the Numbers of Physical String States*, *Nucl. Phys.* **B429**, 533 (1994); K.R. Dienes, M. Moshe, and R.C. Myers, *String Theory, Misaligned Supersymmetry, and the Supertrace Constraints*, *Phys. Rev. Lett.* **74**, 4767 (1995); J.D. Blum and K.R. Dienes, *Strong/Weak Coupling Duality Relations for Non-Supersymmetric String Theories*, *Nucl. Phys.* **B516**, 83 (1998); K.R. Dienes, *Solving the Hierarchy Problem without Supersymmetry or Extra Dimensions: An Alternative Approach*, *Nucl. Phys.* **B611**, 146 (2001).
6. *New Vacuum Structures for Supersymmetric Field Theories:* K.R. Dienes and B. Thomas, *Building a Nest at Tree Level: Classical Metastability and Non-Trivial Vacuum Structure in Supersymmetric Field Theories*, *Phys. Rev.* **D78** (2008) 106011; *Cascades and Collapses, Great Walls and Forbidden Cities: Infinite Towers of Metastable Vacua in Supersymmetric Field Theories*, *Phys. Rev.* **D79** (2009) 045001 — this paper was featured on the APS website *Physics: Spotlighting Exceptional Research*, `http://physics.aps.org`, February 2009.

Selected Honors and Service/Outreach Activities

- In 9/09, I was appointed as the Program Director for Theoretical High-Energy Physics and Cosmology at the US National Science Foundation. In this position, I am responsible for overseeing all aspects of NSF-sponsored financial support for theoretical high-energy physics and cosmology research across the United States. This includes serving as the voice of theoretical particle physics and cosmology within the National Science Foundation, and in various interagency and academy settings (including HEPAP and AAAC advisory committees). It also includes interacting with the research community regularly on all matters relating to research support, including developing a strategic vision for the future as well as addressing the research and funding challenges that arise from year to year. Finally, I also oversee the "broader impacts" of NSF-sponsored research in my program, including the education and training of young researchers, developing new funding streams, and enhancing the level of public outreach, education, and dissemination of research results across the US. (*Note:* While holding this position, I also continue my research activity with postdocs and graduate students as a Visiting Professor at the nearby University of Maryland.)
- Won University-wide *2008 Outstanding Administrator of the Year* for my work as the Director of Graduate Studies for the Department of Physics; College-wide *Early-Career Teaching Award* (September 2004); University-wide *Graduate Advisor of the Year Award* (2001); Department *Excellence in Graduate Physics Teaching Award* (2002).
- Invited Lecturer at TASI Summer Schools in 1998, 2001, 2006 (topic: string model-building and string phenomenology); TASI Summer School 2002 (topic: extra space-time dimensions and KK theories); SLAC Summer Institute 2005 (topic: GUTs).

- *Research Innovation Award (2000-2005)*: Awarded by Research Corporation, a nationwide foundation for the advancement of science, for "research transcending the ordinary and promising significant discovery".
- July 2004 – October 2008: Elected to serve as **Chair of the Four Corners Section of the American Physical Society** (Arizona, Colorado, New Mexico, Utah). Worked to increase student participation, mentoring, and research opportunities; to develop connections with physics institutions in neighboring regions; and to broaden the ethnic/cultural diversity of the next generation of physicists in the Southwest.
- Served as the **Head Organizer for the SUSY 2003 Conference**, held at the University of Arizona, June 2003. Responsible for all aspects of this six-day conference, which attracted over 200 participants with over 150 plenary and parallel talks. Also served as Head Organizer for the *String Vacuum Project Kickoff Meeting*, April 2008.
- Numerous articles in popular science magazines, several TV and radio interviews (including an appearance as an invited guest on NPR's "Talk of the Nation: Science Friday"). Also served as Co-Organizer of the 2005 Arizona Distinguished Physicist Public Lecture Series, held in conjunction with the Einstein World Year of Physics. Lecturers included Nobel laureates Charles Townes and Frank Wilczek.

Vita for Li-Zhi Fang (Fang Lizhi)

Education:

Diploma, Department of Physics, Peking University, 1956

Positions Held:

1992 – present, Professor of Physics and Astronomy, University of Arizona,
1991 Director's Visitor, Institute for Advanced Study, Princeton
1990 Guest Professor of the Royal Society, Institute of Astronomy, Cambridge University.
June 1989 - June 1990, Hidden in US Embassy in Beijing.
1987-1989, Professor, Head of Theoretical Astrophysics Group, Beijing Astronomical Observatory, Chinese Academy of Sciences, Beijing, China.
1984-1987, Vice-President, University of Science and Technology of China, China.
1978-1987 Professor of Physics, University of Science and Technology of China, China.
1973-1977 Lecturer, University of Science and Technology of China
1967-1972 in Labor Campus of China
1958-1966 Assistance and then Lecturer, University of Science and Technology of China
1956-1958, Junior Research Fellow; Institute of Modern Physics, Chinese Academy of Sciences, Beijing, China.

Awards and Honors (selected):

National Award for Science and Technology, China, 1978
First Award of the International Gravity Research Foundation, 1985
Honorary Life Membership, The New York Academy of Sciences, 1989
Honor Doctors of Universite Libre de Bruxelles, Universita di Roma "La Sapienza", University of Toronto, College of William and Mary in Virginia 1989 - 1994
Nicholson Medal, American Physical Society, 1996
Xu-Guangqi Chair Professor, International Center for Relativistic Astrophysics Network, Rome-Pescara, Italy, 2007

Academies, Societies and Assignments (selected)

Member, Chinese Academy of Sciences 1981-1989
Member of Council, International Center for Theoretical Physics, Trieste, 1984-1989
Chair, Commission C19 on Astrophysics of IUPAP, 1990-1993
Chair, Committee on the International Freedom of Scientists, American Physical Society, 1994
Fellow, American Association for the Advancement of Science, 1995
Chair of Board, International Center for Relativistic Astrophysics Net, Pescara, Italy 2005 - present

Selected Publications:

Stochastic fluctuations and structure formation in the universe, A.Berera and L.Z.Fang, *Phys. Rev. Lett.*, **72**, 458, 1994
An Infrared cutoff revealed by the two years of COBE observations of cosmic temperature fluctuations, Y.P.Jing and L.Z.Fang, *Phys. Rev. Lett.*, **73**, 1882, 1994

Thermally induced density perturbations in the inflation era, A.Berera and L.Z.Fang, *Phys. Rev. Lett.*, **74**, 1912, 1995

Evidence for scale-scale correlations in the cosmic microwave background radiation, J.Pando, D. Valls–Gabaud and L.Z. Fang, *Phys. Rev. Lett.*, **81**, 4568, 1998

Low-redshift cosmic baryon fluid on large scales and She-Levueque's universal scaling, P. He, J.R. Liu, L.L. Feng, C.W. Shu and L.Z. Fang, *Phys. Rev. Lett.*, **96**, 051302, 2006

Vorticity of IGM velocity field on large scales, W. S. Zhu, L. L. Feng and L.Z. Fang, *Astrophys. J.*, **712**, 1, 2010

Sean Fleming

University of Arizona

Physics Department
1118 E. 4th Street, PO Box 210081
Tucson, AZ 85721

Phone: (520)626-4377
Fax: (520)621-4721
Email: fleming@physics.arizona.edu

Education

NORTHWESTERN UNIVERSITY — Evanston, IL

Major Field: Physics

Degree: Ph.D. awarded December 1995.

Thesis adviser: Eric Braaten.

Thesis title: *A Theoretical Study of Inclusive Charmonium Production at the Fermilab Tevatron.*

GEORGETOWN UNIVERSITY — Washington, D.C.

Major Field: Physics

Degree: B.Sc. awarded June 1989.

Employers

UNIVERSITY OF ARIZONA — Tucson, AZ

Associate Professor, Aug. 2005 – Present. Nuclear theory group.

UNIVERSITY OF CALIFORNIA SAN DIEGO — La Jolla, CA

Research Associate, Sept. 2004 – July 2005. High energy theory group.

CARNEGIE MELLON UNIVERSITY — Pittsburgh, PA

Research Associate, Sept. 2000 – Aug. 2004. High energy theory group.

UNIVERSITY OF TORONTO — Toronto, Canada

Research Associate, Sept. 1997 – Aug. 2000. With Michael Luke.

UNIVERSITY OF WISCONSIN — Madison, WI

Research Associate, Sept. 1995 – Jan. 1996 and May 1996 – Aug. 1997. Phenomenology Institute.

Visiting Assistant Professor, Jan. 1996 – May 1996. Phenomenology Institute. Taught modern elementary physics.

Awards

1. *Outstanding Junior Investigator Award.* Awarded by The Office of Nuclear Physics of the Department of Energy.

Graduate Students Supervised

1. Michael Fickinger, Joined group Fall 2006, Research Topics: precision QCD, collider phenomenology.
2. Emanuele Mereghetti, Joined group Winter 2006, Research Topics: nuclear form factors.
3. Delphine Perrodin, Joined group Fall 2007, Research Topics: gravitational radiation from in-spiraling black holes. (Graduated May 2009).

Service & Outreach

1. *Colloquium committee:* Spring 2006 – Spring 2008.
2. *Undergrad Service Courses Committee:* Fall 2006 – Present.
3. *Grad Advisor:* Fall 2007 –Present.
4. *Examinations Committee:* Fall 2008–Present.
5. *Physics Phun Night volunteer:* Fall 2005, Fall 2006, Fall 2007.

Courses & Taught

1. *Mathematical Methods for Physicists:* Spring 2006.
2. *Graudate Quantum Mechanics:* Fall & Spring 2006 – Spring 2009.
3. *Introductory Algebra based Physics:* Fall 2008.
4. *Quantum Field Theory:* Spring 2010.

Selected Articles

1. E. Braaten, S. Fleming, *Color-Octet Fragmentation and the ψ' Surplus at the Tevatron*, Phys. Rev. Lett. **74**, 3327 (1995).
2. S. Fleming, T. Mehen, I.W. Stewart, *NNLO Corrections to Nucleon-Nucleon Scattering and Perturbative Pions*, Nucl. Phys. A677: 313 (2000).
3. C. Bauer, S. Fleming, M. Luke, *Summing Sudakov Logarithms in $B \to X_s\gamma$ in Effective Field Theory*, Phys. Rev. **D63**: 014006 (2001).
4. C. Bauer, S. Fleming, D. Pirjol, I.W. Stewart, *An Effective Theory for Collinear and Soft Gluons: Heavy to Light Decays*, Phys. Rev. **D63**: 114020 (2001).
5. S. Fleming, M. Kusunoki, T. Mehen, U. van Kolck, *Pion interactions in the X(3872)*, Phys. Rev. **D76**: 034006, 2007.
6. Sean Fleming, Andre H. Hoang, Sonny Mantry, Iain W. Stewart, *Jets from massive unstable particles: Top-mass determination*, Phys. Rev. **D77**: 074010, 2008.

Curriculum Vitae

Ke Chiang HSIEH

Birth: Chungking (Chongqing), China, 14 June 1940

Citizenship: U.S.A., 22 February 1977

Education: B. A., Physics, *cum laude*, Wabash College, 1963
Ph. D., Physics, University of Chicago, 1969

Employment:

University of Chicago		Research Associate	1969-1970
University of Arizona		Assistant Professor	1971-1976
		Associate Professor	1977-1993
		Professor	1994-present

Also:

University of Chicago	Visiting Assist. Prof.	1971 summer
Max-Planck Institute for Aeronomy	Visiting Scientist	1978-1980

National Space Program Office, Republic of China in Taiwan

Instrument Scientist, Payload Development Division	1992-1993
Acting Head, Research & Development Division	1993-1994
Project Manager, IPEI on ROCSAT 1	1994

Max-Planck Institute for Extraterrestrial Physics Visiting Scientist
Summers of 1996 & 1997

Professional experience:

Studying cosmic rays under Prof. J. A. Simpson led me to discover ^{3}He-rich solar flares and confirm adiabatic deceleration in solar modulation of cosmic rays, and taught me space-borne particle-detection instrumentation. At UA, I expanded into atomic and molecular physics in the lab with Profs. W. E. Lamb and L. C. McIntyre, and the detection of thermal and energetic neutral atoms in space with Prof. C. Y. Fan and Dr. C. C. Curtis. Two types of neutral-gas analyzers based on our work at UA flew by Comet Halley in 1986 on Soviet Vega 1 & 2 and measured the radial dependence of the gas density in the coma. At my urging in 1992, ENA (energetic neutral atom) capability was added to HSTOF/CELIAS on ESA/NASA SOHO mission and detected ENA of heliospheric origin for the first time. SOHO's ENA observations at 1 AU and Voyagers' ion measurements in the heliosheath led the first empirical estimation of the thickness of the heliosheath. In 1994, I served on NASA's Inner Magnetospheric Imager Science Definition Team and became the original instrument lead of HENA on IMAGE, co-investigator of MIMI on *Cassini* to Saturn, Sweden's ASPERA on ESA's Mars Express and Venus Express. I now lead an international team in a white paper on studying space weathering of exposed bodies such as Mercury, Moon, and asteroids by ENA imaging the sputtering from space-plasma impacts.

After assisting NSPO in Taiwan in its formation and its first satellite project, I started the Student Satellite Project at UA in 1996 to offer students hands-on experience in planning, designing, and making a small, scientific, low Earth-orbit satellite, to be followed by mission operation and data analysis. Students ran the entire project: management and eight technical teams. Twenty professors from seven units served as reviewers and team mentors. Capstones, senior theses and MS theses were generated in several departments. The Guidance, Navigation & Control Team, mentored by Prof. E. Fasse of ECE, won top student-paper award twice at the International Small Satellite Conference. A campus-wide course number, Supervised Research (292, 394 and 494) was proposed and listed. In 2000, I transferred the project to Prof. M. Drake, Director of LPL and the Arizona Space Grant Consortium, for better funding and management. Chris Lewicki, the first Project Manager went on to JPL and was a flight director for the 2003 Mars Lander. The project fizzled for lack of resources and launch opportunities.

In 1999, I began a NATS 201 course, *How Things Work*, including building and testing simple devices, from levers to motor/generator to radio and digital logic. Low demand ended the course in 2006.

In 2007, I started observing oscillating liquid N_2 drops using the high-speed camera in Prof. R. E. Goldstein's lab with help from his post-docs, C. Dombrowsky and L. Cisneros. Prof. Goldstein's direct participation expedited and enhanced this work, using the trap and two-view imaging optics of my design.

Working with scientists, engineers, technicians, and administrators in different fields and countries, and with graduate and undergraduate students at UA enriched my life.

Curriculum Vitae

Ke Chiang HSIEH

PhD Dissertation Director for:

Ping Wai Kwok, "Very High Energy Gamma Rays from the Crab Nebula and Pulsar," (with Trevor Weekes, Smithsonian Institution), 1989.

Hongyao Hu, "Cometary Atmospheres: Gas Dynamic Model and Inferences of Coma Parameters," (with Prof. H. P. Larson, Department of Planetary Science), 1990.

Kun-Long Shih, "Distribution of Hydrogen and Production of Energetic Neutral Hydrogen in the Heliosphere," 1993.

Mark Charles Chantell, "UV Imaging of Extended Air Showers at TeV Energies with the Whipple Observatory's 10-meter Air Cherenkov Telescope," (with Trevor Weekes, Smithsonian Institution), 1995.

Elena Moise, "Acceleration of Pickup Ions in the Heliopshere" (with Prof. T. Zurbuchen, University of Michigan), 2004.

MS Thesis Director for:

Stephanie Ann Loutzenhiser, "Preliminary Stress Analysis of UASat," (with Prof. Weinong Chen, Aerospace & Mechanical Engineering), 1998. [*Pilot for MS in Applied Physics or PSM*]

Jennifer Deaton-Millard, "Heat Transfer Analysis of the University of Arizona Student Satellite UASat," (with Prof. Weinong Chen, AME), 2000. [*PMS*]

Adam Shaw, "First Detection of Energetic Neutral Helium of Heliospheric Origin", 2002. [*MS*]

Honors: Phi Beta Kappa, 1963 Sigma Xi, 1966
Fellow, American Physical Society, 2000

Awards: NASA Group Achievement Award, MIMI/Cassini, 1998
The El Paso Energy Foundation Faculty Achievement Award, 1999
UA Asian-American Faculty, Staff and Student Assoc. Faculty Award, 1999
UA College of Science Distinguished Advising Award, 2000
NASA Group Achievement Award, IMAGE, 2001
UA College of Science Distinguished Career Teaching Award, 2004
European Space Agency Recognition of Outstanding Contribution made to ESA's Venus Express Mission, 2006
The Professor Leon and Pauline Blitzer Award for Excellence in the Teaching of Physics and Related Sciences, 2006

Summary of publications:

Articles in refereed journals	92
Articles in books or monographs	26
Contributed papers	33
Abstracts of talks and posters	73
Invited talks and papers (Lead or sole author: 43; co-author: 6)	49

Four selected publications:

K. C. Hsieh, J. Giacalone, A. Czechowski, M. Hilchenbach, S. Grzedzielski, J. Kóta, "Thickness of the heliosheath, return of the pick-up ions, and Voyager 1's crossing the heliopause" *Astrophys. J. Letters*, **718**, L185-L188 (2010).

K. C. Hsieh, K. L. Shih, J. R. Jokipii, and S. Grzedzielski, "Probing the heliosphere with energetic hydrogen atoms," *Astrophys. J.* **393**, 756-763 (1992).

K. C. Hsieh and C. C. Curtis, "A model for the spatial and energy distributions of energetic neutral atoms produced within the Saturn/Titan plasma system," *Geophys. Res. Lett.* **15**, 772-775 (1988).

K. C. Hsieh and J. A. Simpson, "The relative abundances and energy spectra of ^{3}He and ^{4}He from solar flares," *Astrophys. J. Lett.* **162**, L191-L196 (1970).

PHILIPPE JACQUOD

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Professional Activities

- **Appointments**

since 2009	**Associate Professor of Physics with Tenure**, University of Arizona
2005 - 2008	**Tenure-Track Associate Professor of Physics**, University of Arizona
2003 - 2005	**Assistant Professor of Physics**, University of Geneva

- **Academic Visiting Positions**

Official academic visiting positions of three weeks or more have been listed.

06/2010	**Visitor**, KITPC, Chinese Academy of Sciences, Beijing
08/2009	**Visitor**, INT, University of Washington, Seattle
07/2009	**Visitor**, Aspen Center for Physics
06/2009	**Scientific Visitor**, Basel Center for Quantum Computing
11-12/2008	**Visiting Scientist**, University of Geneva
10-11/2008	**Visiting Professor**, Swiss Institute of Technology (EPFL)
08-09/2008	**Visiting Scientist**, University of Regensburg
06-07/2008	**Scientific Visitor**, University of Basel
07-08/2006	**Visitor**, Aspen Center for Physics
07/2002	**Visitor**, INT, University of Washington, Seattle
06-07/2002	**Visiting Scientist**, University of Geneva
9-10/2001	**Visitor**, ITP, University of California, Santa Barbara
08/2000	**Visitor**, Aspen Center for Physics
05/1999	**Visitor**, MPIPKS, Dresden

- **Postdocs Supervised**

2009 - ...	Dr. P. Stano, University of Arizona
2005 - 2006	Dr. A. Bhullar, University of Arizona
2003 - 2005	Dr. R. Whitney, University of Geneva

- **Graduate Students Supervised**

2009 - ...	J. Meair, PhD. student, University of Arizona
2005 - 2008	J. Weiss, PhD. student, University of Arizona
2003 - 2007	C. Petitjean, PhD. student, University of Geneva
2002 - 2005	M. Goorden, PhD. student, University of Leiden (co-supervision)

- **Master Thesis and Independent Studies Supervised**

2006	J. Xue, PhD. student, University of Arizona
2006 - 2008	M. Kruse, PhD. student, University of Arizona
2006	I. Zimmerman, PhD. student, University of Arizona
2004	C. Chamot, M.S. student, University of Geneva

- **Grants**

These are all individual grants, for which I am or have been the sole Principal Investigator. The indicated year corresponds either to the actual duration of the grant or the would-be starting year.

2011	**Nanoscale Heterostructrures with Novel Electromagnetic and Thermoelectric Properties and Functionalities** US DOE, Material Sciences and Engineering – submitted 4/10, 217'689.00 US $ / 3 years
2010	**Coherence, Noise and Cross-Correlations in Nanosystems** US NSF, DMR division – submitted 10/09, 291'319.00 US $ / 3 years
2010–2013	**Wave Interferences and Nonlinearities in Atomic Physics and Quantum Optics** US NSF, AMO theory division – awarded 210'000.00 US $ / 3 years
2007–2010	**Coherence, Noise and Cross-Correlations in Nanosystems** US NSF, DMR division – awarded 255'000.00 US $ / 3 years
2006	**Transport, Spectroscopy and Coherence in Hybrid Superconducting Microstructures** US NSF, DMR division – declined 489'929.00 US $ / 3 years
2003–2006	**Quantum Signatures of Classical Dynamics in Coherent Electronic Microstructures** Swiss NSF – awarded 980'000.00 US $ (1'200'000.00 sFr) / 4 years
1999–2000	**Quantum Chaos, Interactions and Transport in Disordered Systems** Swiss NSF – awarded 93'000.00 US $ (115'000.00 sFr) / 2 years
1997–1998	**Interactions and Transport in Chaotic and Disordered Systems** Swiss NSF – awarded 55'500.00 US $ (68'000.00 sFr) / 1 year

Selected Recent Publications

Some of my most significant publications since 2001.

1. **Golden Rule Decay versus Lyapunov Decay of the Quantum Loschmidt Echo**,
   Ph. Jacquod, P.G. Silvestrov and C.W.J. Beenakker, *Phys. Rev. E* **64**, *055203(R)/1–4 (2001).*
2. **Semiclassical Time-Evolution of the Reduced Density Matrix and Dynamically Assisted Generation of Entanglement for Bipartite Quantum Systems**,
   Ph. Jacquod, *Phys. Rev. Lett.* **92**, *150403/1–4 (2004).*
3. **Semiclassical Theory of Quantum Chaotic Transport: Phase-Space Splitting, Coherent Backscattering and Weak Localization**,
   Ph. Jacquod and R.S. Whitney, *Phys. Rev. B* **73**, *195115/1–19 (2006).*
4. **Mesoscopic Spin Hall Effect**,
   I. Adagideli, J. Bardarson, and Ph. Jacquod, *Phys. Rev. Lett.* **98**, *196601/1–4 (2007).*
5. **Superconductivity-Induced Macroscopic Resonant Tunneling**,
   M.C. Goorden, Ph. Jacquod, J. Weiss, *Phys. Rev. Lett.*, **100**, *067001/1–4 (2008).*
6. **Controlling the Sign of Magnetoconductance in Andreev Quantum Dots**,
   R.S. Whitney and Ph. Jacquod, *Phys. Rev. Lett.* **103**, *247002/1–4 (2009).*
7. **Decoherence, Entanglement and Irreversibility in Quantum Dynamical Systems with Few Degrees of Freedom**,
   Ph. Jacquod and C. Petitjean, *Adv. Phys.* **58**, *67–196 (2009).*
8. **Spin Accumulation in Diffusive Conductors with Rashba and Dresselhaus Spin-Orbit Interaction**,
   M. Duckheim, D. Loss, M. Scheid, K. Richter, I. Adagideli, and Ph. Jacquod, *Phys. Rev. B.* **81**, *085303/1–7 (2010).*
9. **Scattering Theory of Current-Induced Spin Polarization**,
   Ph. Jacquod, *Nanotechnology* **21**, *274006/1–8 (2010).*
10. **Coherent Thermoelectric Effects in Mesoscopic Andreev Interferometers**,
    Ph. Jacquod and R.S. Whitney, arXiv:0910.2943, to appear in *Europhys. Lett. (2010).*

January 2011

KENNETH A. JOHNS
Physics Professor
Physics Department
University of Arizona
Tucson, AZ 85721
johns@physics.arizona.edu

CURRICULUM VITAE

Education

Ph.D., Physics, Rice University, 1986
"A Study of High Transverse Energy Events in Hadron-Hadron Collisions at $\sqrt{s}$ = 27 GeV Using a QCD Monte Carlo Including Both Initial and Final State Gluon Bremsstrahlung" (Prof. Jay Roberts, Advisor)
M.A., Physics, Rice University, 1983
B.A., Physics, Rice University, 1981

Employment

Associate Physics Department Head, University of Arizona, 2009-present
Professor, University of Arizona, 2000-present
Associate Professor, University of Arizona, 1994 - 2000
Guest Scientist, Fermilab, 1996 - 1998
Assistant Professor, University of Arizona, 1989 - 1994
Research Associate, University of Minnesota, 1986 - 1989
Research Associate, Rice University, 1985 - 1986

Honors and Awards

NSF Presidential Young Investigator, 1991-1996

Synergistic Activities

Head of the Level 1 Calorimeter-Track Trigger Project for the D∅ experiment, 2002 - 2007
Head of the Level 1 Muon Trigger Project for the D∅ experiment, 1995 - 2007
Co-head of the Muon Detector Upgrade Project for the D∅ experiment, 1996 - 1999
Co-convener of the B Physics Group for the D∅ experiment, 1993 - 1996
Co-spokesperson of Fermilab Experiment E-800, 1989 - 1994
Spokesperson of Fermilab Experiment E-821, 1990 - 1994

Current Interests

Top quark production cross section measurements and searches for Beyond the Standard Model physics involving top quarks at ATLAS, development of next generation signal processing and readout for high luminosity collider experiments, front-end electronics development for muon micromegas detectors

Selected Publications

"Measurement of the Top Quark-Pair Production Cross Section with ATLAS in pp Collisions at √s =7 TeV"
ATLAS Collaboration, G.Aad *et al*., submitted to EPJC(2010).

"The ATLAS Experiment at the CERN Large Hadron Collider",
ATLAS Collaboration, G.Aad *et al*., JINST **3**:S08003 (2008).

"Measurement of the Top Quark Mass in the Dilepton Channel"
DØ Collaboration, V.M. Abazov *et al*., Phys. Lett. B **655**, 7 (2007).

"Search for Right-handed W Bosons in Top Quark Decay"
DØ Collaboration, V.M. Abazov *et al*., Phys. Rev. D **72**, 011104 (2005).

"Measurement of the $t\bar{t}$ *Production Cross Section in* $p\bar{p}$ *Collisions at √s =1.96 TeV in Dilepton Final States"*
DØ Collaboration, V.M. Abazov *et al*., Phys. Lett. B **626**, 55 (2005).

"The Level 1 Muon Trigger for Run II of DØ",
DØ Collaboration, J. Steinberg *et al*., IEEE Trans. Nucl. Sci. **44**, 348 (1997).

"Precision Measurement of the Ω^- *Magnetic Moment*",
E-800 Collaboration, N.B. Wallace *et al*., Phys. Rev. Lett. **74**, 3732 (1995).

Collaborators and Other Affiliations

a) Collaborators
I am a member of the ATLAS and DØ collaborations.

b) Graduate Advisor
Jay Roberts, Rice University

c) Postdoctoral Advisors
Ken Heller, Marvin Marshak, University of Minnesota

d) Advisees
Graduate Students: Susan Burke, Kevin Davis, Dave Fein, Bryan Gmyrek, Eric James, Xiaowen Lei (current), Rob McCroskey, Ajay Narayanan, Alex Smith, Jeff Temple, Jason Veatch (current), Dave Vititoe
Postdoctoral Associates: Stefan Anderson, Joan Guida, Venkat Kaushik (current), Leigh Markosky, Freedy Nang, Noah Wallace

Andrei G. Lebed

Department of Physics, *University of Arizona*, Tucson, AZ 85721
(520) 626-1031 = voice, e-mail: lebed@physics.arizona.edu, (520) 621-4721 = fax

Education

Doctor of Sciences (Full Professor's Degree): Landau Institute for Theoretical Physics, Moscow, Russia, 2000;
Ph.D. in Physics: Landau Institute for Theoretical Physics, Moscow, 1985;
MS Degree: Moscow Institute for Physics and Technology (MIPT), Moscow, 1982.

Professional Appointments

Full Professor: Dept. of Physics, Univ. of Arizona, 2010 – present;
Associate Professor (tenured): Dept. of Physics, Univ. of Arizona, 2004-2010;
Research Professor: Dept. of Physics, Boston College, 2002–2004;
Full Professor: Landau Institute for Theoretical Physics, 2000-2008;
Visiting Professor: Kyoto University (Kyoto, Japan), 2000-2001;
Associate Professor: Okayama University (Okayama, Japan), 1998-2000;
Associate Professor: Osaka Prefecture University (Osaka, Japan), 1997-1998;
Associate Professor: Tohoku University (Sendai, Japan), 1995-1997;
Visiting Scientist: Natl. High Magnetic Field Lab. (Tallahassee), 1993-1995;
Scientist: Landau Institute for Theoretical Physics (Moscow), 1990–1998;
Post-doctoral fellow: Brookhaven National Laboratory (Upton, USA), 1989;
Younger Scientist: Landau Institute for Theoretical Physics, 1985–1990.

Five Most Cited Publications

1. L.P. Gor'kov and A.G.Lebed, On the stability of the quasi-one-dimensional metallic phase in magnetic fields against the spin-density-wave formation, Journal de Physique (Paris) Letters, **45**, L-433 (1984) (about 300 citations).
2. A.G. Lebed, *Anisotropy of an instability for a spin-density-wave induced by a magnetic field in Q1D conductors*, JETP Letters, **43**, 174 (1986) (more that 100 citations);
3. A.G. Lebed and P. Bak, *Theory of unusual anisotropy of magnetoresistance in organic superconductors*, Physical Review Letters, **63**, 1315 (1989) (more than 100 citations);
4. A.G. Lebed, Reversible Nature of the Orbital Mechanism for the Suppression of Superconductivity, JETP Letters, **44**, 114 (1986) (about 100 citations);
5. A.G. Lebed and K Yamaji, Restoration of Superconductivity in a High Parallel Magnetic Field in Quasi-Two-Dimensional Compounds, Physical Review Letters, **80**, 2697 (1998) (more than 50 citations).

Honors and Awards

2001: 1-st Prize at *the Landau Institute* scientific competition;
1990: Lenin Komsomol Prize (the *major USSR Government prize* for scientists younger than 34);
1989: 2-nd Prize at the Academy of Sciences of the USSR competition for scientists younger than 34;
1988: 2-nd Prize at *the Landau Institute* scientific competition.

Grants

In USA: the National Science Foundation grant DMR-0705986 (2007-2010);
In Japan: Japanese Society of Promotion of Science (JSPS): 2001, 1998;
Agency for Industrial Science and Technology (AIST): 2000, 1996;
European INTAS grants: #2001-2212 (2002-2004) and #2001-0791 (2002-2005).

Recent Invited Talks

1) *Universal Field-Induced Charge-Density-Wave Phase Diagrams* at the International Conference ISCOM-2009 (Hokkaido, Japan, 2009);
2) *Super-crystalline Phase in Quasi-One-Dimensional Conductors* at the International Conference ECRYS-2008 (Cargese, France, 2008);
3) *Soliton Wall Superlatice in Organic Conductor* $(Per)_2Pt(mnt)_2$ at the International Conference ISCOM-2007 (Barcelona, Spain, 2007);
4) *Type-IV Superconductivity Phenomenon* at the International Workshop "Complex Magnetism in High Magnetic Fields" (Los Alamos, USA, 2006);
5) *Can Superconducting Phase be more Exotic than Unconventional one?*, at the International Conference ISCOM-2005 (Key West, USA, 2005);
6) *1D and 2D Physics Induced by a Magnetic Field*, at the American Physical Society Meeting (Montreal, Canada, 2004);
7) *Magnetic Field Induced Low-Dimensional Physics*, at International Workshop "Novel Conducting Materials" (Boston, 2004);
8) *Magnetic Field Induced 1D and 2D Physics in 3D Conductors*, at International Workshop on High Magnetic Fields Applications (Los Alamos, 2003);
9) *Magnetic Properties at Ultra-High Magnetic Fields*, at International Workshop on Electronic Crystals (St. Freur, France, 2002).

Books: 1) The Physics of Organic Superconductors and Conductors, A.G. Lebed, Editor (Springer, Berlin, 2008); 752 pages, 343 figures; 2) Non-Homogeneous Liquids Near the Critical Point and the Boundary of Stability and Theory of Percolation and Superconductivity of Ceramics, A.V. Chalyi and A.G. Lebed (Harwood Academic Pub; ISBN: 3718652196, 1992).

Ph.D. Advisor: Lev P. Gor'kov, Landau Institute (Moscow, Russia, 1981-1985)
Post-Doc Advisor: Per Bak, Brookhaven National Laboratory (Upton, USA, 1989)

Recent collaborators: Profs. M.J. Naughton, L.P. Gor'kov, K. Machida, M. Ozaki, and K. Yamaji, Drs. Omjyoti Dutta T. Hayashi and N.N. Bagmet.

Supervision: Currently, I am a Ph.D. adviser of a graduate student Otar Sepper and an undergraduate Hispanic student Mario Aletti. Untill August 2010, I was a Ph.D. adviser of a graduate student Si Wu, who received Ph.D. degree under my supervision. Until August 2008, I was a Ph.D. co-advisor of a graduate student Omjyoti Dutta. I was an official Ph.D. advisor and co-advisor of the following graduate students: N.N. Bagmet, Joydeep Roy, T. Hayashi, K. Shankar, J.I. Oh, and Heon-Ick Ha.

Brian LeRoy

University of Arizona
Department of Physics
Tucson, AZ 85721

Education

2003	Harvard University, Cambridge, MA, Ph.D. in Physics, thesis "Imaging coherent electron flow through semiconductor nanostructures"
2001	Harvard University, Cambridge, MA A.M. in Physics
1998	University of Michigan, Ann Arbor, MI, B.S. with highest honors in Physics and high honors in Mathematics.

Research Experience

2006-	**University of Arizona**, Tucson, AZ Assistant Professor
2003-2006	**Delft University of Technology**, Delft, The Netherlands Postdoctoral Researcher in Prof. Cees Dekker's group
1999-2003	**Harvard University**, Cambridge, MA Graduate Student in Prof. Robert Westervelt's group
1997-1998	**University of Michigan**, Ann Arbor, MI Undergraduate Student in Prof. Meigan Aronson's group

Awards and Recognition

- 2010 NSF CAREER Award
- My work has received considerable attention in the scientific press including cover articles in Physics Today, Nature, Nano Letters and Science News and two articles in Physics World.
- White Prize for outstanding teaching, Harvard University.
- Certificate of Distinction in Teaching (based on student evaluations), Harvard University
- Williams Prize for outstanding Senior Thesis in Physics, University of Michigan (second place).
- Graduated with Highest Honors in Physics, High Honors in Mathematics and Distinction in General scholarship, University of Michigan.

Selected Publications

1. "Spatially resolved spectroscopy of monolayer graphene on SiO_2"
   A. Deshpande, W. Bao, F. Miao, C.N. Lau, and **B.J. LeRoy**, *Physical Review B* **79**, 205411 (2009). (Featured in May 2009 issue of Physics)

2. "Electrical generation and absorption of phonons in carbon nanotubes"
   B.J. LeRoy, S.G. Lemay, J. Kong, and C. Dekker, *Nature* **432**, 371 (2004).

3. "Scanning tunneling spectroscopy of suspended single-wall carbon nanotubes"
   B.J. LeRoy, S.G. Lemay, J. Kong, and C. Dekker, *Applied Physics Letters* **84,** 4280 (2004).

4. "Coherent branched flow in a two-dimensional electron gas"
   M.A. Topinka, **B.J. LeRoy**, R. M. Westervelt, S.E.J. Shaw, R. Fleischmann, E.J. Heller, K.D. Maranowski, and A.C. Gossard, *Nature* **410**, 183 (2001). (cover article)

5. "Imaging coherent electron flow from a quantum point contact"
   M.A. Topinka, **B.J. LeRoy**, S.E.J. Shaw, E.J. Heller, R. M. Westervelt, K.D. Maranowski, and A.C. Gossard, *Science* **289**, 2323 (2000).

Invited Talks

Over 25 invited talks on "*Local electronic properties of graphene"*, *"Electrical generation and absorption of phonons in carbon nanotubes"* and "*Imaging coherent electron flow"*.

Synergistic Activities

- Supervised 9 undergraduate students with research projects over the past three years.
- Work with Physics Factory as part of NSF CAREER grant to design demonstrations for local schools.
- Two high school students work in the lab through the High School Apprenticeship Program of the Army Research Office.
- Grant from Research Corporation for a local high school teacher, Pamela Tautz to work in PI's lab during the summer of 2010 and 2011.
- Worked and volunteered at Ann Arbor Hands-on Museum giving science demonstrations and explaining concepts to school children, 1993-1998.
- Reviewer for Physical Review Letters, Physical Review B, Nature Nanotechnology, Reviews of Modern Physics, Nano Letters, European Physics Letters, Journal of Physics: Condensed Matter and physics journals. Also serve as a reviewer for NSF and ARO.

Collaborators

S. Cronin, USC; A. Geim, Manchester; A.C. Gossard, UC Santa Barbara; E.J. Heller, Harvard; J. Kong, MIT; C.N. Lau, UC-Riverside; S.G. Lemay, Delft; B. Quinn, Helsinki; J. Reno, Sandia
Post Doctoral Advisor: Cees Dekker, Delft University of Technology.
Graduate Advisor: Robert M. Westervelt, Harvard.

BIOGRAPHICAL SKETCH
Prof. Srinivas Manne

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EDUCATION

Ph.D. in Physics, University of California at Santa Barbara, March 1994
B.S. in Engineering Physics, University of Arizona, December 1983

HONORS AND AWARDS

NSF CAREER Award, 2001
College of Science Distinguished Teaching Award, University of Arizona, 2000
Langmuir Award, American Chemical Society (Colloid & Surface Science Division), 1998
Procter & Gamble University Exploratory Research Program Award, 1998
Alexander von Humboldt Postdoctoral Fellowship, 1994-1995
AT&T Graduate Student Fellowship, 1990-1994

PROFESSIONAL EXPERIENCE

1997-present	Faculty Member (Tenured 2003), Department of Physics, University of Arizona
1995-1997	Staff Scientist, Princeton Materials Institute, Princeton University
1994-1995	Alexander von Humboldt Postdoctoral Fellow, Biophysics Research Group, Department of Physics, Technical University of Munich, Germany

FIVE RELEVANT PUBLICATIONS

A.E. Murdaugh and S. Manne, "Friction Dependence on Growth Conditions in Epitaxial Films," *Langmuir* 25 (2009) 9792-9796.

E.S. Ulrich, C.M. Limbach and S. Manne, "Imaging Microflows and Nanopore Structures Using Hydrodynamic Force Microscopy," *Applied Physics Letters* 93 (2008) 243103.

R.K. Workman and S. Manne, "Molecular Transfer and Transport in Non-Covalent Microcontact Printing," *Langmuir* 20 (2004) 805-815.

M.B. Hay, R.K. Workman and S. Manne, "Mechanisms of Metal Ion Sorption on Calcite: Composition Mapping by Lateral Force Microscopy," *Langmuir* 19 (2003) 3727-3740.

R.K. Workman, A.M. Schmidt and S. Manne, "Detection of a Diffusive 2D Gas of Amphiphiles by Lateral Force Microscopy," *Langmuir* 19 (2003) 3248-3253.

FIVE OTHER SIGNIFICANT PUBLICATIONS

T. Jutarosaga, S. Manne and S. Seraphin, "Si-SiO_2 Interface Formation in Low-Dose, Low-Energy Separation by Implanted Oxygen Materials," *Applied Surface Science* 250 (2005) 168-181.

M.B. Hay, R.K. Workman and S. Manne, "Two-Dimensional Condensed Phases from Particles with Tunable Interactions," *Phys. Rev. E* (2003) 012401.

R.K. Workman and S. Manne, "Patterned Water Films on Mica," *Langmuir* 18 (2002) 661-666.

R.K. Workman and S. Manne, "Variable Temperature Fluid Stage for AFM," *Rev. Sci. Instrum.* 71 (2000) 431-436.

J.L. Wolgemuth, R.K. Workman and S. Manne, "Surfactant Aggregates at a Flat, Isotropic Hydrophobic Surface," *Langmuir* 16 (2000) 3077-3081.

SYNERGISTIC ACTIVITIES

Development of Novel Techniques in Atomic Force Microscopy

First simultaneous imaging of reactant and product phases during surface reactions (2003), by composition mapping using lateral force microscopy

First atomic-scale, temperature-controlled fluid AFM to operate over entire aqueous range (2000)

First direct imaging of interfacial surfactant micelles (1996), by mapping colloidal stabilization forces

Teaching and Training

Development of graduate physics course, "Intermolecular Forces and Self-Assembly," incorporating theory and hands-on AFM experiments.

Sponsorship of over 20 undergraduate research projects, including four publications with undergraduate co-authors (two with undergraduate first-authors).

External examiner for Ph.D. candidates J. Brinck (University of Lund, Sweden), B. Fleming (University of Newcastle, Australia), and H.N. Patrick and L. Kovacs (both University of Sydney, Australia).

Research Dissemination

Co-convener of ACS symposium "Supramolecular Structure in Confined Geometries" (Dallas TX, 1998), bringing together international speakers from industry and academia; also co-editor of proceedings.

COLLABORATIONS AND OTHER AFFILIATIONS

No collaborators in past 48 months, other than those included in publication list

Advisors

Graduate Advisor: Prof. P.K. Hansma, Department of Physics, University of California, Santa Barbara
Postdoctoral Advisor: Prof. H.E. Gaub, Department of Physics, University of Munich, Germany

Former Graduate Students (5)

Anne Murdaugh (Physics, Ph.D. 2009), Elaine Ulrich (Optical Sciences, Ph.D. 2008), Mary Liddelow (Materials Science, M.S. 2006), Rick Workman (Materials Science, Ph.D. 2004), Geoff Wathen (Physics, M.S. 2003)

Former Undergraduate Student Researchers (21)

Michael Hay (1/00-6/01), Scott Smith (1/02-5/02), Brin Knowles (8/02-12/02), David Harris (1/03-8/03), Ali Schmidt (2/03-8/03), Mathazin Aung (1/03-5/03), Raj Singh (1/03-5/03), Michael McClung (5/03-8/03), David Schuster (8/03-12/03), Enrique Montano Durazo (8/04-12/04), Alex Fay (5/07-12/07), Chris Limbach (5/07-5/08), Jon Zizka (8/07-12/07), Chris Stanley (2/09-12/09), Marco Lopez (8/09-12/09), Derek Huang (8/09-5/10), Sean Campbell (1/10-5/10), Jeff Portouw (1/10-5/10), Zach Wagner (1/10-5/10), Rob Dawson (1/10-5/10), Cameron Nicholas (1/10-5/10)

CURRICULUM VITAE

Sumitendra Mazumdar

Professor of Physics, Optical Sciences and Applied Mathematics
University of Arizona
Tucson, AZ 85721

Education:

M.Sc. (Chemistry), Indian Institute of Technology, Kanpur, India (1975).
Ph.D. (Theoretical Chemistry), Princeton University (1980).

Appointments:

2/2009 – Head, Department of Physics, University of Arizona.
8/97 – Professor of Physics, Optical Sciences and Applied Mathematics, U. Arizona.
8/88 – 7/97, Associate Professor of Physics, University of Arizona.
4/87 – 8/88, Scientist E, National Chemical Laboratory, Pune, India.
10/85 – 12/86, Member of Technical Staff, GTE Laboratories, Waltham, MA.
10/82 – 9/85, Postdoctoral Fellow, Center for Nonlinear Studies, Los Alamos National Laboratory, NM.
10/80 – 9/82. Postdoctoral Fellow, Exxon Research and Engineering Company, NJ.

Honors and Awards:

Associated Western Universities Inc., Faculty Fellow 1991.
Fellow of the American Physical Society, 2003.
Adjunct Professor, Indian Association for the Cultivation of Science, Calcutta, India, 2005.
Henry and Phyllis Koffler Prize for Research, Scholarship and Creativity, University of Arizona, 2006.

Research Interests:

1. Electron-electron interactions and optical properties of π-conjugated polymers, carbon nanotubes and related organic semiconductors.
2. Effects of electron-electron and electron-phonon interactions on low dimensional broken symmetries including superconductivity. Applications to organic charge-transfer solids and transition metal oxides.

Selected Synergistic Activities:

1. Divisional Associate Editor, Physical Review Letters, 1/1999 - 12/2001.
2. Referee for the professional journals: Nature, Nature Materials, Science, Physical Review Letters, Physical Review B, Philosophical Magazine B, Applied Physics Letters, Optics Letters, Journal of Optical Society of America B, Journal of Chemical Physics, Journal of Physical Chemistry, Journal of the American Chemical Society, Chemical Physics Letters, Chemical Physics, Synthetic Metals.
Reviewer of proposals submitted to NSF Materials Theory, NSF Chemistry, DOE Basic Energy Sciences.
3. Organizer, Invited Symposium on Excitons in Carbon Nanotubes, American Physical Society Annual Meeting, March 2006.
4. Member of Organizing Committees, International Conferences on Optical Probes fo Conjugated Polymers, 1991 (Utah), 1994 (Utah), 1997 (SPIE, San Diego), 2003 (Venice, Italy),

2005 (Bangalore, India), 2007 (Turkü, Finland), 2009 (Beijing, China).

Grants and contracts (2004 - present):

1. Electron-electron interaction effects on the photophysics of semiconducting conjugated polymers and single-walled carbon nanotubes, NSF-DMR, $315,000, 8/04-7/07.
2. Theory of Coexisting Density Waves in Low Dimensional Quarter-Filled Band Molecular Solids, DOE, co-PI with R. Torsten Clay. Mazumdar's share: $197,530 for three years 09/06 - 08/09.
3.Photophysics of conjugated polymer thin films and semiconducting single-walled carbon nanotubes, NSF-DMR, $336,000, 9/07 - 8/11 (+ $ 5000 for REU).
4. Charge frustration, spin singlets and superconductivity in the 1/4-filled band paired-electron crystal, DOE, co-PI with R. T. Clay. Mazumdar's share: $ 206,770 for 09/09 - 08/12.
5. Integrated Study of Correlated electrons in organic and inorganic materials, co-PI with Tanusri Saha-Dasgupta, travel grant from Indo-US Science and Technology Forum, $ 47,189.00 01/08 - 12/10.

Selected Publications:

1. "Coulomb Effects on One-Dimensional Peierls Instability," S. Mazumdar and S. N. Dixit, Phys. Rev. Lett. **51**, 292 (1983).
2. "Optical Probes of Excited States in Poly(Para-Phenylenevinylene)," J. M. Leng *et al.*, Phys. Rev. Lett. **73**, 3180 (1994).
3. "Formation Cross-Sections of Singlet and Triplet Excitons in π-Conjugated Polymers," M. Wohlgenannt, K. Tandon, S. Mazumdar, S. Ramasesha and Z. V. Vardeny, Nature (London), **409**, 494 (2001).
4. "Electron-Electron Interaction Effects on Optical Excitations in Semiconducting Single-Walled Carbon Nanotubes," H. Zhao and S. Mazumdar, Phys. Rev. Lett. 93, 157402 (2004).
5. "The Paired-Electron Crystal in the Two-Dimensional Frustrated Quarter-Filled Band," H. Li, R. T. Clay and S. Mazumdar, J. Phys. Condensed Matter **22**, 272201 (2010).

Undergraduate Students Supervised:

Matt Borselli, Duong Nguyen, Siebe van Mensfoort, Roberto Fuentes Badilla, Danel Van Cise.

Graduate Students Supervised:

Dandan Guo, Fangyeong Fuo, Kim-Chau Ung, Michael Chandross, Yongguo Yan (M.S.), Zhendong wang, Hongtao Li (current).

Postdoctoral Scholars Sponsored:

Dr. Aparna Chakrabarti, Dr. Yukihiro Shimoi, Dr. Frank Gallagher, Dr. Birgit starke, Dr. Alok Shukla, Dr. Haranath Ghosh, Dr. R. Torsten Clay, Dr. Hongbo Zhao, Dr. Demetra Psiachos, Dr. Karan Aryanpour (current).

Fulvio Melia

Professor of Physics, Astronomy, and the Applied Math Program, The University of Arizona
Editor of the Series in Theoretical Astrophysics, The University of Chicago Press
Professorial Fellow, School of Physics. Melbourne University, Australia
Professorial Fellow, Physics Department, University of Canterbury, Christchurch, NZ

Phone: Office: (520) 621-9651, Mobile: (520) 977-8269, Home: (520) 797-2592
E-mail: melia@physics.arizona.edu, or melia@as.arizona.edu
Website: http://www.physics.arizona.edu/~melia

Education

1985 MIT, *Ph.D. Physics*.

1980 SUNY at Stony Brook, *M.A. Physics*.

1980 Melbourne University, *M.Sc. Physics* (Thesis).

1978 Melbourne University, *B.Sc. Physics* (Highest University Honors; ranked first in class).

(Selected) Honors and Awards

Simpson Chair, Amherst College (formerly held by Neils Bohr, Robert Frost, Henry Steele Commager, and Richard Wilbur), 2010 - 2011.

PROSE Award, *Cracking the Einstein Code*, AAP 2009.

Sir Thomas Lyle Fellow (Australia) for Distinguished International Visitors, 2008.

Erskine Fellow, University of Canterbury, Christchurch, New Zealand, 2007.

Professorial Fellow, School of Physics, Melbourne University, Australia 2005 - present.

Galileo Circle Fellow, highest scientific award, University of Arizona 2005.

Year's Best Astronomy Book worldwide, *The Edge of Infinity,* Astronomy 2005 Special Issue.

Outstanding Book Award, *The Black Hole at the Center of Our Galaxy*, American Library Association 2004.

Series Editor for Theoretical Astrophysics, The University of Chicago Press, 2004 - present.

Associate Editor, The Astrophysical Journal (Letters) 2002 - present.

Fellow of the American Physical Society, 2002 - present.

Miegunyah Fellow (Australia) for Distinguished Fundamental Researchers, 1999 - 2001.

Sir Thomas Lyle Fellow (Australia) for Distinguished International Visitors, 1998 - 1999.

Scientific Editor, The Astrophysical Journal, 1996 - 2002.

College of Science Distinguished Teaching Award, The University of Arizona, 1998.

Alfred P. Sloan Research Fellow (Physics), 1989 - 1992.

Presidential Young Investigator Award (Physics), 1988 - 1994.

Arthur H. Compton Fellow, Enrico Fermi Institute, University of Chicago, 1987.

Books Published (Excluding foreign translations)

Cracking the Einstein Code (The University of Chicago Press, September 2009)
Written for the general public, developments during the "golden age" of relativity (1960–1975)
High-Energy Astrophysics (Princeton University Press, February 2009)
In the highly selective Princeton Series in Astrophysics
The Galactic Supermassive Black Hole (Princeton University Press, May 2007)
Textbook/monograph for professional astronomers and for graduate/senior undergraduate classes
Edge of Infinity: Supermassive Black Holes in the Universe (Cambridge University Press, October 2003)
Written for the general public
The Black Hole at the Center of Our Galaxy (Princeton University Press, April 2003)
Written for the general public
Electrodynamics (The University of Chicago Press, September 2001)
Textbook (adopted for graduate courses in Arizona, Clemson, U Maryland, among others)

Published in *Refereed* Journals

[169] Nature, **468**, 65 (2010): *A lower limit of 50 microgauss for the magnetic field near the Galactic Centre,* Roland M. Crocker, David Jones, Fulvio Melia et al.
[168] The Astrophysical Journal, **710**, 755 (2010): *X-ray and Radio Variability of M31*,* Michael R. Garcia, Richard Hextall, Fred Baganoff, Jose Galache, Fulvio Melia et al.
[167] Advances in Space Research, **45**, 407 (2010): *Soft gamma-ray constraints on a bright flare from the Galactic Center supermassive black hole,* Guillaume Trap et al., Fulvio Melia

Funding History as Principal Investigator

[23] ONR,	Feb 2008—December 2011	1,100,000
[24] NASA,	June 2010—May 2013	90,000
Total (since 1991)		**4,076,874**

Average Student Evaluations (since 1991): 5.9/6.0

Graduate Students Supervised: 16, including 5 NASA GSRP Fellows, 3 NSF Fellows, 1 Compton GRO Fellow, 1 NRC Fellow, and 1 winner (Siming Liu) of the Trumpler Award for the best Astrophysics/Astronomy Ph.D. Thesis in the United States

Postdocs Supervised: 8

Professional Service (Abridged) : (2010—2012) National Research Council, Research Associateship Program; (2010—present) Science Board, International Space Science Institute, Bern, Switzerland

Invited Talks:

[103] Cracking the Einstein Code, Glasgow University, Public lecture, Scotland, November 2009.
[104] The Cosmic Horizon, Physics Department, Zurich University, November 2009.
[105] Black Hole Horizons, International Space Science Institute, Bern, November 2009.
[106] The Cosmic Horizon, Physics Department, University of Connecticut, February 2010.
[107] The Cosmic Horizon, Physics Department, Franklin and Marshall College, April 2010.
[108] Cracking the Einstein Code, Reading Museum, PA, April 2010.
[109] The Cosmic Horizon, Physics and Astronomy Departments, UMass, Amherst, September 2010.

BIOGRAPHICAL SKETCH, PIERRE MEYSTRE

- PERSONAL DATA: Born in Yverdon (VD) Switzerland, May 7, 1948
  Citizenship: Swiss, permanent US resident

- EDUCATIONAL BACKGROUND:
  1971 Eng-Physicist Diploma, Swiss Federal Institute of Technology, Lausanne, Switzerland
  1974 Ph.D., Swiss Federal Institute of Technology, Lausanne, Switzerland
  1983 Habilitation, (Theoretical Physics), University of Munich, Germany

- EMPLOYMENT HISTORY
  2007-date University of Arizona, Director, B2 Institute
  2005-2007 University of Arizona, Head, Physics Department
  2002-date University of Arizona, Regents Professor
  1998-date University of Arizona Chair of Quantum Optics
  1990-date Dept. of Physics, U. of Arizona, Professor
  1986-date Optical Sciences Center, University of Arizona, Professor
  1984-1986 U. of Munich, Physics Dept., Adjunct Professor (Privatdozent)
  1981-1986 Max-Planck-Inst. for Quantum Optics, Garching, Staff Scientist
  1979-1984 U. of Munich, Physics Department, Lecturer
  1978-1980 Project Group for Laser Research, Garching, Staff Scientist
  1977-1978 Project Group for Laser Research, Garching, Guest Scientist
  1974-1977 U. of Arizona, Dept. of Physics and Optical Sciences Center, Research Associate
  1971-1974 Swiss Federal Inst. of Technology, Lausanne, Switzerland, Physics Instructor

- FIELDS OF MAJOR CURRENT INTEREST

Theoretical quantum optics, statistical properties of optical and matter-wave fields, cavity QED, de Broglie optics of ultracold atoms and molecules, cavity optomechanics.Solar energy production and storage, smart grid management modeling and applications at the Biosphere 2 ”model city”.

- SELECTED PROFESSIONAL SOCIETY AFFILIATIONS, ACTIVITIES, AND HONORS

  - (Fellow of the Optical Society of America, the American Physical Society, and the American Association for the Advancement of Science.
  - Optical Society of America, R. W. Wood Prize 2002.
  - Alexander-von Humboldt Foundation, Research Prize for Senior American Scientists.
  - 1974-1975: Postdoctoral Fellowship of the Swiss National Foundation for Scientific Research.
  - 1992-1998: Member of Editorial Board, Phys. Rev. A.
  - 1992-1996: Editorial Advisor, American Institute of Physics. Atomic, Molecular and Optical Physics Reference Book.
  - 1996-present, Editorial Board, Springer Series in Atomic, Molecular and Optical Physics.
  - 1999-2002 National Research Council, FAMOS Update Panel.
  - 2000-2003: Advisory Board Member, Harvard-Smithsonian Institute for Theoretical Atomic, Molecular and Optical Physics (ITAMP).

- 2000-2004: American Physical Society, DAMOP Executive Committee.
- 2002-2008, Chair, NRC Committee on Atomic, Molecular and Optical Science (CAMOS);vice-chair, 2008-
- 2002-2004: Advisory Board Member, Kavli Institute for Theoretical Physics;
- 2004-2006 Advisory Board member, FOCUS Center, University of Michigan;
- 2004: Chair, Local Committee, DAMOP Annual Meeting;
- 2004-2006: National Research Council AMO2010 committee
- 2006: Chair, Long Range Planning Committee, Harvard-Smithsonian Institute for Theoretical Atomic, Molecular and Optical Physics (ITAMP).
- 2006-2009 Divisional Associate Editor, Physical Review Letters.
- 2006-2010 Vice-Chair (2006-2007), Chair-Elect (2007-2008), Chair (2008-2009), past-chair (2009-2010), DAMOP, American Physical Society.
- 2008- Member, Board on Physics and Astronomy, National Research Council;
- 2008- Advisory Council, Harvard-MIT NSF Physics Frontier Center for Ultracold Atoms.

- 6 KEY PUBLICATIONS (from over 280 refereed papers):

  - F. A. Hopf, P. Meystre, M. O. Scully, and W. H. Louisell, ”Classical theory of a free-electron laser,” Optics Commun. **18**, 413 (1976).
  - A. Dorsel, J. D. McCullen, P. Meystre, E. Vignes, and H. Walther, “Radiation-pressure bistability and optical cavity stabilization,” Phys. Rev. Lett. 51, 1550 (1983).
  - P. Filipowicz, J. Javanainen, and P. Meystre, ”Theory of a microscopic maser,” Phys. Rev. A **34**, 3086 (1986).
  - G. Lenz, P. Meystre, and E. M. Wright,“Nonlinear atom optics,” Phys. Rev. Lett. **71**, 3271 (1993).
  - M. G. Moore and P. Meystre, ”Atomic four-wave mixing: fermions vs. bosons”, Phys. Rev. Lett. **86**, 4199 (2001).
  - S. Singh, M. Bhattacharya, O. Dutta and P. Meystre, “Coupling nanomechanical cantilevers to dipolar molecules,” Phys. Rev. Lett. **101**, 263603 (2008).

- BOOKS:

  - P. Meystre and M. Sargent III, Elements of Quantum Optics (Springer Verlag, Heidelberg 1990), Second Edition (1991), Third Edition (1998); Hong Kong Student Edition (1993); Japanese Edition (1995).
  - P. Meystre, ”Atom Optics”, Springer-Verlag, New York (2001). Japanese Translation, Springer Verlag, Tokyo (2003).

Johann Rafelski is an American theoretical physicist and author. He is Professor of Physics at The University of Arizona (Tucson) and an international level expert in subatomic theoretical physics. His current research interests are centered around study of strange particle signatures of the deconfined quark-gluon plasma formed in relativistic heavy ion collisions; the formation of matter out of quark-gluon plasma in hadronization process in laboratory and in the early Universe; investigation of the vacuum structure in the presence of strong fields; the ascent of ultra short laser light pulses as a new tool in this domain of physics and the related new research opportunities involving positron plasma physics and exploration of inertial forces. He has also in past contributed to the physics of table top catalyzed fusion, and artificial intelligence.

Career

Rafelski received his Ph.D. working with Walter Greiner in Frankfurt (Germany) on Strong Fields, QED Vacuum and Positron Production. In 1973 he began a series of postdoctoral fellowships: first at the University of Pennsylvania (Philadelphia) with Abraham Klein, then at the Argonne National Laboratory, Chicago where he worked with John W. Clark of the Washington University (St. Louis) and Michael Danos of NBS (now NIST, Washington D.C.). He moved in 1977 to CERN (Geneva, Switzerland-France), where he worked with Rolf Hagedorn and John S. Bell. In the Fall of 1979 Rafelski returned to Frankfurt where he was appointed tenured associate professor at the Johann Wolfgang v. Goethe University, where he taught for 4 years. He accepted the chair of Theoretical Physics at the University of Cape Town (South Africa) originating there a Theoretical Physics and Astrophysics Institute before arriving at Arizona in Fall, 1987. During the first 15 years of his career he was also a guest scientist at NIST. In the past 23 years he worked primarily at The University of Arizona, and also pursued research projects at CERN, Paris, Frankfurt, and Munich.

Scientific Influence:

Rafelski contributed decisively to the creation of the quark-gluon plasma (QGP) research field, by demonstrating that it would be possible to form at then existent experimental accelerator facilities (CERN-SPS) this new state of matter. He proposed strangeness as a signature of deconfined state of matter, and contributed further works which guided experimental preparatory effort. He showed how the study of QGP relates to the understanding of quantum vacuum structure and the understanding of the quark era in the early Universe. He developed the statistical hadronization formulation of matter creation.

Scientific Writing:

Rafelski published about 400 original works and has many other written contributions created over the span of 40 years, his refereed work earns 250 citations/year and some of his work is among top cited in respective fields of research. The following are his major review works in the different fields:

- With Abraham Klein and Lewis P. Fulcher, *Fermions and Bosons interaction with arbitrarily strong external fields,* **Physics Reports 38, pp 227-361 (1978)**. (research monograph) http://dx.doi.org/10.1016/0370-1573(78)90116-3
- *Formation and Observables of the Plasma,* **Physics Reports v88, pp331-346 (1982)** http://dx.doi.org/10.1016/0370-1573(82)90083-7 (note: this opens the entire volume, pp321-413 the individual articles are not accessible seperately)
- with Michael Danos: *Perspectives in high energy nuclear collisions.* (research monograph) , published by NBS, Washington DC 1983. NBSIR-83-2725 available from NTIS, Department of Commerce, http://www.ntis.gov/search/product.aspx?ABBR=PB83223982 also in: **Springer Lecture Notes in Physics 231 (1985), pp. 362-455.**
- with Walter Greiner und Berndt Müller: *Quantum electrodynamics of strong fields,* ISBN 3-540-13404-2 Springer, Berlin 1985.
- with John W. Clark and JV Winston, *Brain without mind: Computer simulation of neural networks with modifiable neuronal* interactions **Physics Reports v123 , pp 215-273 (1985**).(research monograph) http://dx.doi.org/10.1016/0370-1573(85)90038-9
- With Peter Koch and Bernd Muller: *Strangeness in Relativistic heavy Ion Collisions,* **Physics Reports v142, pp167-262 (1986**) (research monograph) http://dx.doi.org/10.1016/0370-1573(86)90096-7
- with Jean Letessier: *Hadrons and Quark-Gluon Plasmas (400+pages).* ISBN=0-521-38536-9, Cambridge University Press 2002.
- with J. Kapusta, B. Müller (editors and authors.): *Quark-Gluon Plasma: Theoretical Foundations* ISBN: 0-444-51110-5 Elsevier 2003. http://www.elsevier.com/wps/find/bookdescription..cws_home/672804/description#description
- With G. Mourou and T. Tajima *The light-pulse horizon,* CERN Courier, February 23, 2009 (popular scientific) http://cerncourier..com/cws/article/cern/37860

November 11, 2010

JOHN P. RUTHERFOORD
Professor of Physics
Physics Department
University of Arizona
Tucson, AZ 85721
rutherfo@physics.arizona.edu

CURRICULUM VITAE

Education

Ph.D., Cornell University 1968
"Neutral Pion Photoproduction in the Backward Direction" (Prof. John DeWire and Dr. Eugene Loh, Advisors)
B.S., Union College 1964

Employment

Professor, University of Arizona, 1988 – present
Professor, University of Washington, 1986 – 1988
Research Professor, University of Washington, 1985 – 1986
Research Associate Professor, University of Washington, 1979 – 1985
Research Assistant Professor, University of Washington, 1976 – 1979
Assistant Professor, Tufts University, 1969 – 1976
Research Associate, Tufts University, 1968 – 1969

Service

Fermilab Users Executive Committee 1978 – 1981 and 1990 – 1993, Chair 1979 – 1980 and 1991 – 1992.
Fermilab Physics Advisory Committee 1987 – 1991.
Elected to the Executive Committee of the American Physical Society Division of Particles and Fields 1994 – 1997.

Leadership positions

Spokesperson: Recoil Proton Polarization in Neutral Pion Photoproduction, Cornell 1970 – 1971.
Spokesperson: Large Angle Compton Scattering (TUMM), Cornell 1975 – 1976
Deputy Spokesperson: High-Mass Dimuons (E439), Fermilab 1976-1979
Spokesperson: High resolution dimuon production in proton – nucleus collisions, Fermilab E605, 1984 – 1985.
Project Leader: ATLAS Forward Calorimeter Construction Project, 1994 – 2005.
Chair: ATLAS Liquid Argon Unit, Group Representatives, May 2009 – 2011.

Selected Publications

J.Rutherfoord (with M.A.Shupe, R.H.Milburn, D.J.Quinn, A.R.Stottlemyer, S.S.Hertzbach, R.Kofler, F.D.Lomanno, M.S.Z.Rabin, M.Deutsch, M.M.White, R.S.Galik, R.H.Siemann) “Proton Compton Scattering and Neutral Pion Photoproduction at Large Angles”, Phys. Rev. Lett. **40**, 271 (1978).

J.Rutherfoord (with D.A.Garelick, P.S.Gauthier, M.J.Glaubman, G.S.Hicks, E.W.King, M.Mallary, P.Mockett, J.Moromisato, E.Pothier, S.Smith, E.von Goeler, R.Weinstein, R.W.Williams) “Confirmation of an enhancement in the $\mu^+\mu^-$ mass spectrum at 9.5 GeV”, Phys. Rev. **D18**, 945 (1978).

J.Rutherfoord, “Hadronic Production of Real and Virtual Photons”, Proceedings of the 1985 International Symposium on Lepton and Photon Interactions at High Energies, August 19-24, 1985, Kyoto, p662.

J.Rutherfoord (with C.N.Brown et al.) “Dimuon Production in 800 GeV Proton-Nucleus Collisions”, Phys. Rev. Lett. **63**, 2637 (1989).

J.Rutherfoord (with the ATLAS Liquid Argon Group) “ATLAS Liquid Argon Calorimeter Technical Design Report”, CERN/LHCC/96-41, December 1996.

J.Rutherfoord, “The ATLAS Forward Calorimeters”, Proceedings of the Sixth International Conference on Calorimetry in High Energy Physics”, Ed. A.Antonelli, S.Bianco, A.Calcaterra, F.L.Fabbri, Frascati, June 1996.

J.Rutherfoord, “Signal degradation due to charge buildup in noble liquid ionization calorimeters”, Nucl. Instrum. and Meth. **A482** (2002) 156.

J.Rutherfoord (with B.Toggerson, A.Newcomer, and R.B.Walker) “Onset of space charge effects in liquid argon ionization chambers”, Nucl. Instrum. and Meth. A 608 (2009) 238.

Biographical Sketch

Arvinder Singh Sandhu
Department of Physics
University of Arizona
1118 E. Fourth St., Tucson AZ 85721-0081

sandhu@physics.arizona.edu
Phone: 520-621-6786
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www.physics.arizona.edu/~sandhu

Professional Preparation

G.N.D. University	Physics	B.Sc. 1996
Indian Institute of Technology, Kanpur	Physics	M.Sc. 1998
Tata Institute of Fundamental Research	Physics	Ph.D. 2005
JILA, University of Colorado	Physics	2004 to 2008

Appointments

- Assistant Professor, Dept. of Physics, University of Arizona — 08/01/2007-Present
- Assistant Professor, College of Optical Sciences, Univ. of Arizona — 12/01/2007-Present
- Senior Research Associate, JILA, University of Colorado — 06/01/2006-07/30/2007
- Research Associate, JILA, University of Colorado — 05/11/2004-05/31/2006
- Research Assistant, Tata Inst. of Fundamental Research, Bombay — 07/31/1998-05/10/2004
- Teaching Assistant, Tata Inst. of Fundamental Research, Bombay — 08/01/1999-07/30/2001

Publications

Niranjan Shivaram, Lei Xu, Adam Roberts, and **Arvinder Sandhu**, "In-Situ Spatial Mapping of Gouy Phase Slip for High-Detail Attosecond Pump-Probe Measurements" **(Submitted to Optics Letters)**

Adam Roberts, Niranjan Shivaram, Lei Xu and **Arvinder Sandhu,** Optimization of few-cycle pulse generation: Spatial size, mode quality and focal volume effects in filamentation based pulse compression, **Optics Express 17**, 23894 (2009).

A. S. Sandhu, E. Gagnon, R. Santra, V. Sharma, W. Li, P. Ho, P. Ranitovic, C. L. Cocke, M. M. Murnane, H. C. Kapteyn, Observing the creation of electronic Feshbach resonances in soft x-ray induced O2 dissociation, ***Science*** **322**, 1081 (2008).

E. Gagnon, P. Ranitovic, X.-M. Tong, L. Cocke, M. M. Murnane, H. C. Kapteyn and **A. S. Sandhu**, Soft X-ray driven femtosecond molecular dynamics, ***Science*** **317**, 1374 (2007).

Etienne Gagnon, **A. S. Sandhu,** Ariel Paul, Kim Hagen, Achim Czasch, Till Jahnke, Predrag Ranitovic, Lew Cocke, Barry Walker, Margaret M. Murnane, Henry C. Kapteyn and, Time resolving atomic and molecular dynamics using high harmonics sources and coincident momentum imaging techniques, ***Rev. Sci. Inst.***, ***79***, 063102 (2008).

A. S. Sandhu, E. Gagnon, I. Thomann, A. Paul, A. Lytle, T. Keep, M. M. Murnane, H. C. Kapteyn and Ivan Christov, Generation of Isolated, Carrier-Envelope-Phase insensitive, EUV pulses via Non-linear Stabilization in a Waveguide, ***Phys. Rev. A.*** **74**, 061803 (Rapid) (2006).

I. Thomann, E. Gregonis, **A. Sandhu**, M. Murnane and H. Kapteyn, Temporal characterization of tunable EUV pulses in the sub-optical-cycle regime with FROGCRAB, *Phys. Rev. A* **78**, 011806 (R) (2008).

Etienne Gagnon, Isabell Thomann, Ariel Paul, Amy L. Lytle, Margaret M. Murnane, Henry C. Kapteyn and **A. S. Sandhu**, Long term carrier-envelope phase stability from a cryo-cooled, grating-based, chirped pulse amplifier, ***Optics Letters*** **31**, 1866 (2006).

A. S. Sandhu, G. R. Kumar, S. Sengupta, A. Das, and P. K. Kaw, Laser Pulse Induced Second Harmonic and Hard X-ray Emission: Role of Plasma Wave Breaking, *Phys. Rev. Lett.* **95**, 025005 (2005).

A. S. Sandhu, A. K. Dharmadhikari, P. P. Rajeev, G. R. Kumar, S. Sengupta, A. Das, P. K. Kaw, Laser generated Ultrashort Multi-Megagauss Magnetic Pulses in Plasmas, *Phys. Rev. Lett.* **89**, 225002(2002).

Synergistic Activities

- **Judging**: Student talk and Poster Session Judge, APS 4-Corners meeting, Golden CO (2009)
- **Chair:** Attosecond Session – Frontiers in Optics/Laser Science 2006.
- **Member:** American Physical Society, Optical Society of America, Plasma Science Society, India.
- **Reviewer:** Optics Express, Journal of Physics B: Atomic, Molecular and Optical Physics, Journal of Applied Physics and Applied Physics Letters, Review of Scientific Instruments.

Public Outreach and Student involvement

- Guest Lecture at the Tucson Area Physics Teacher Association meeting (2007).
- Optics demonstration for middle school students, Excel Academy Charter School, Arvada (2006).
- Lab tours/demonstrations for visiting undergrad students and local high school students (2007-2010).
- Design of an exhibit at Flandrau Science Center, Univ. of Arizona, Explaining ultrafast science.
- Mentored 16 Independent/Directed research studies for undergraduate and grad students (2007-2010)
- Mentored undergrad students from other local institutions e.g. Pima Community College, ASU.

Awards

2010 Excellence in Undergraduate Physics Teaching, Department of Physics, University of Arizona.
2010 NSF Career Award, National Science Foundation, USA.
2007 Young Scientist Medal, Indian National Science Academy, New Delhi, India
2005 TAA- Geeta Udgaonkar Award, Outstanding Ph.D. thesis at Tata Inst. of Fundamental Research.
2003 Sarojini Damodran International Fellowship, Tata Institute of Fundamental Research (TIFR).

List of past collaborators (48 months)

Ivan Christov (Sofia University, Bulgaria)
Lew Cocke (Kansas State University)
Henry C. Kapteyn (JILA, University of Colorado)
P. K. Kaw (Institute for Plasma Research, India)
G. Ravindra Kumar (Tata Inst. of Fundamental Research, India)
Margaret M. Murnane (JILA, University of Colorado)
Robin Santra (Argonne National Lab)
Xiao-Min Tong (University of Tsukuba)
Barry Walker (University of Delaware)
June Ye (JILA, University of Colorado)

Post doctoral Advisor(s): Prof.'s Henry Kapteyn and Margaret Murnane (JILA, University of Colorado)
Graduate Advisor: Prof. G. Ravindra Kumar (Tata Inst. Fundamental Research, India).

INA SARCEVIC

EDUCATIONAL BACKGROUND:

1981	B.S., Physics (with highest honors), University of Sarajevo, Bosnia
1986	Ph.D., Physics, University of Minnesota; (Ph.D. advisor: S. Gasiorowitz)

PROFESSIONAL EMPLOYMENT:

1999–present	Professor, Department of Physics, University of Arizona
2009	Visiting Professor, Department of Physics, Brown University
2006–present	Professor, Department of Astronomy, University of Arizona
2000–present	Member of the Theoretical Astrophysics Program, University of Arizona
1993–1999	Associate Professor, Department of Physics, University of Arizona
1994	Visiting Associate Professor, Department of Physics and Astronomy, The Johns Hopkins University
1988–1993	Assistant Professor, Department of Physics, University of Arizona
1986–1988	Director's Postdoctoral Fellow, Los Alamos National Laboratory
1984–1986	Research Assistant, University of Minnesota
1982–1984	Teaching Associate, University of Minnesota

HONORS AND AWARDS

2006–	Fellow, American Physical Society
1989–1991	Humboldt Fellowship
1985–1986	University of Minnesota Doctoral Dissertation Fellowship
1978–1981	University of Sarajevo Fellowships

SELECTED OTHER POSITIONS

1990	Humboldt Fellow, Theory Group, Max Planck Institute, Munich
1993	Visiting Scientist, ITP, University of California, Santa Barbara
1993	Visiting Scientist, LBL, University of California, Berkeley
1999	Visiting Scientist, Theory Group, Brookhaven National Laboratory
2003	Visiting Scientist, INT, University of Washington, Seattle
2005	Visiting Scientist, KITP, University of California, Santa Barbara
2007	Visiting Scientist, CERN, Theory Division, Geneva, Switzerland
2009	Visiting Scientist, Center for Cosmology and Particle Physics Department of Physics, New York University, New York

SELECTED PROFESSIONAL ACTIVITIES

1. Organizer of the Workshop on *Frontiers in Particle Physics*, Aspen Winter Conference on Particle Physics, January 25-31, 1998.

2. International Advisory Committee for the *Advances in Particle Physics, Recent Results and Open Questions*, 1999 Aspen Winter Conference, Aspen Center for Physics, Aspen, CO, January 17-23, 1999.

3. Organizer of the Workshop on *Neutrinos with Mass*, Aspen Center for Physics, Aspen, CO, June 26-July 16, 2000.

4. International Advisory Committee for the 2002 Aspen Winter Conference on *Ultra High Energy Particles from Space*, Aspen Center for Physics, Aspen, CO, Jan 27-Feb 2, 2002.

5. Chair, Neutrino Physics and Astrophysics Session, *Coral Gables XXXII Conference on High Energy Physics and Cosmology*, Fort Lauderdale, December 17-21, 2003.

6. Chair, High Energy Neutrinos Session, *Eighth Workshop on Non-perturbative QCD and Field Theory*, l'Institut Astrophysique de Paris, France, June 7-11, 2004.

7. Chair, Neutrino/Dark Matter Session, *Conference on Elementary Particles, Astrophysics and Cosmology*, Ft. Lauderdale, Florida, December 15-20, 2009.

Five Recent Publications

1. "Muon Flux and Showers from Dark Matter Annihilation in the Galactic Center", (with A. E. Erkoca, G. Gelmini and M. H. Reno), *Phys. Rev.* **D81**, 096007 (2010).

2. "Muon Flux from Dark Matter Annihilation", (with A. E. Erkoca and M. H. Reno), *Phys. Rev.* **D 80**, 043514 (2009).

3. "Higgs Production and Decay from TeV Scale Black Holes at the LHC", (with A. E. Erkoca and G. Nayak), *Phys. Rev.* **D 79**, 094011 (2009).

4. "High Energy Neutrinos from Charm in Astrophysical Sources", (with R. Enberg and M. H. Reno), *Phys. Rev.* **D 79**, 053006 (2009).

5. "Prompt Neutrino Fluxes from Atmospheric Charm", (with R. Enberg and M. H. Reno), *Phys. Rev.* **D 78**, 043005 (2008).

Five Top Cited Publications (100+ citations)

1. "Ultrahigh-Energy Neutrino Interactions", (with R. Gandhi, C. Quigg, and M.H. Reno), *Astropart. Phys.* **5**, 81 (1996); 409 citations.

2. "Neutrino Interactions at Ultrahigh-Energies", (with R. Gandhi, C. Quigg, and M.H. Reno), *Phys. Rev.* **D58**, 093009 (1998); 395 citations.

3. "Propagation of Muons and Taus at High Energies,", (with S. Iyer Dutta, M. H. Reno and D. Seckel), *Phys. Rev.* **D63**, 094020 (2001); 122 citations.

4. "Jet Quenching in the Opposite Direction of a Tagged Photon in High Energy Heavy Ion Collisions", (with X.N. Wang and Z. Huang), Phys. Rev. Lett. **77**, 231 (1996); 157 citations.

5. "Short Range Correlations and the Intermittency Phenomenon in Multihadron Rapidity Distribution" (with P. Carruthers), Phys. Rev. Lett. **63**, 1562 (l989); 168 citations.

Collaborators in the last four years: G. Goldberg (Northeastern U), M. H. Reno (U of Iowa), I. Mocioiu (Penn State U), Y. Huang (U of Iowa), G. Perez (Weizmann Institute), S. Su (Arizona), J. Uscinski (American U), J. Baker (Arizona), M. Djuric (Brown U). G. Nayak (Arizona), A.E. Erkoca (Arizona), G. Gelmini (UCLA), R. Brower (Boston U), C.-I. Tan (Brown U).

I have funded and supervised 12 postdocs: Raj Gandhi (Harish-Chandra Res. Inst.). Peter Lipa (U of Arizona), Hung Jung Lu, Robert Fletcher, Kostas Orginos (College of William and Marry), Jim Huang (BNP/Cooper Neff), Sean Gavin (Weine State U), Jamal Jalilian-Marian (Baruch College), Greg Mahlon (Penn State U) Gouranga Nayak (U of Arizona), Irina Mocioiu (Penn State U), Rikard Enberg (Upsalla U).

Prior graduate students: Peter Valerio, Quian Gao, Hans Eggers, Sara Markoff, Sharada Iyer Dutta, Jeremy Jones, Joseph Baker and Jessica Uscinski.

Given over 200 invited talks at major international conferences, workshops, including seminars and colloquia.

Funding: continous DOE funding since 1989. PI on two DOE grants, with funding of $\$380,000$ for the three-year period.

March 10, 2005

MICHAEL A. SHUPE
Professor of Physics
Physics Department
University of Arizona
Tucson, AZ 85721
shupe@physics.arizona.edu

CURRICULUM VITAE

Education

Ph.D., Physics, Tufts University	1976
S.B., Physics, Massachusetts Institute of Technology	1968

Employment

Professor, University of Arizona	1993-present
Associate Professor, University of Arizona	1988-1993
Associate Professor, University of Minnesota	1986-1988
Assistant Professor, University of Minnesota	1981-1986
Research Associate, University of Minnesota	1979-1981
Research Associate, University of Illinois	1976-1979

Research History

ATLAS, Editor, New Processes in Dijet Ang. Dists.	2010-present
ATLAS Experiment, LHC/CERN	1993-present
Convenor, Radiation Backgrounds Group	1998-present
D0 Experiment, Fermilab	1988-2004
Chair, Graphics	1994-1998
Auger Experiment: Arizona Site Proposal, with T. Bowen, T. Weekes, Babbitt Ranches, Navajo Nation	1997-1998
Positive Ion Mobility in Liquid Argon	1992-2000
GEM Collaboration at SSC	1991-1993
Chair, Workshop on Major SSC Exps, Univ of Arizona	1990
FNAL E621: CP Violation Parameter Eta+-0	1981-1985
FNAL E629: Direct Photon Prod in Had-Nucl Coll.	1980-1981
Soudan II Proton Decay Experiment	1985-1988
Search for Free Quarks by Torsion Pendulum	1982-1985
BNL E785, Spokesman: Single Spin Asymmetries	1985-1986
BNL E755: Hard Scattering Exclusive Reactions	1982-1983
Soudan I Proton Decay Experiment	1979-1988
FNAL E610: Chi Meson Production by Pions	1978-1979
FNAL E369: Photon/Meson Production by Pions	1977-1978
Cornell: Proton Compton Scattering at Large t	1973-1976
SLAC: Polarized Photon Asymmetries	1971-1973
M.I.T. Senior Thesis	1967-1968

BNL Spark Chamber - Statistical model of strangeness angular distributions

Research Interests

QCD/jet physics, quark/lepton compositeness, proton decay, top quark, Higgs boson detection, relativistic vacuum medium, energetic cosmic rays

Academic

Director of Graduate Studies, Physics, 1995-2002
Interim Head, Department of Physics, 2007-2009

Selected Publications

`A Composite Model of Leptons and Quarks,' Phys. Letters 86B, 87-92 (1979), M. Shupe,
Single author, Citations: 245.

`Results from a New Search for Proton Decay,' Phys. Rev. Letters 50, 651 (1983), J. Bartelt et al.

`The Lorentz-Invariant Vacuum Medium,' American Journal of Physics, 53, 122-127. (1985), M. Shupe

`Direct Measurement of the Top Quark Mass', Phys. Rev. Lett. 79, 1197 (1997). Fermilab Pub-97/059-E, the D0 Collaboration, S. Abachi et al.

`Limits on Quark Compositeness from High Energy Jets in Pbar-P Collisions at 1.8 TeV', Phys. Rev. D Rapid Comm. 62, 031101 (2000); Fermilab-Pub-99/357-E; the D0 Collaboration, B. Abbott et al.

BIOGRAPHICAL SKETCH

CHARLES A. STAFFORD

Education and Training

University of California, San Diego, Physics, B.A. Summa Cum Laude, 1985
Princeton University, Physics, M.A., 1989
AT&T Bell Laboratories, Theoretical Physics, Member of Technical Staff, Summers 1989–1991
Princeton University, Physics, Ph.D., 1992
University of Maryland, Physics, Postdoc, 1992–1994
University of Geneva, Theoretical Physics, Maître-Assistant, 1994–1996
University of Fribourg, Switzerland, Theoretical Physics, Maître-Assistant, 1996–1997
Albert-Ludwigs-University, Freiburg, Germany, Physics, Postdoc, 1997–1998

Professional experience

Associate Professor of Physics, University of Arizona, 2004 to present
Assistant Professor of Physics, University of Arizona, 1998–2004

Five Most Important Publications

1. D. M. Cardamone, C. A. Stafford, and S. Mazumdar, "Controlling quantum transport through a single molecule," *Nano Letters* **6**, 2422–2426 (2006); featured on cover.
2. J. Bürki, C. A. Stafford, and D. L. Stein, "Theory of metastability in simple metal nanowires," *Physical Review Letters* **95**, 090601 (2005).
3. C. A. Stafford, D. Baeriswyl, and J. Bürki, "Jellium model of metallic nanocohesion," *Physical Review Letters* **79**, 2863–2866 (1997).
4. C. A. Stafford and Ned S. Wingreen, "Resonant Photon-Assisted Tunneling Through a Double Quantum Dot: An Electron Pump From Spatial Rabi Oscillations," *Physical Review Letters* **76**, 1916–1919 (1996).
5. M. Büttiker and C. A. Stafford, "Charge Transfer Induced Persistent Current and Capacitance Oscillations," Physical Review Letters **76**, 495–498 (1996).

Patents

C. A. Stafford, D. M. Cardamone, and S. Mazumdar, "Quantum Interference Effect Transistor (QuIET)," *U.S. Patent* No. 7,786,472 (2010).

N. S. Wingreen and C. A. Stafford, "Quantum-Dot Cascade Laser," U.S. Patent No. 5,692,003 (1997).

Synergistic Activities

1. Co-Director of the *Chemical Physics Program* at the University of Arizona, which began admitting Ph.D. students in 2010.

2. Supervised the research in nanoscience (for academic credit) of twelve undergraduate students in the past five years, including five members of under-represented groups.

Graduate and Postdoctoral Advisors

Ph.D. Thesis Advisor: Philip W. Anderson, Princeton University
Postdoctoral Sponsors: Sankar Das Sarma, University of Maryland; Markus Büttiker, University of Geneva; Dionys Baeriswyl, University of Fribourg, Switzerland; Hermann Grabert, Albert-Ludwigs-University, Freiburg, Germany

Postdocs Supervised

Jérôme Bürki, California State University, Sacramento

Graduate Students Supervised

Chang-hua Zhang, Ph.D. 2004, Kansas State University; David Cardamone, Ph.D. 2005, University of California, Irvine; Dennis Conner, M.S. 2006; Justin Bergfield, Ph.D. 2010, University of Arizona.

Other Collaborators During the Past 48 Months

Bruce Barrett, University of Arizona; Sumit Mazumdar, University of Arizona; Daniel Stein, New York University; Daniel Urban, Albert-Ludwigs-Universität.

CURRICULUM VITAE

Shufang Su

Research Area

Theoretical elementary particle physics focusing on new physics beyond Standard Model. Phenomenology of low energy supersymmetric models, collider searches, Higgs studies, top-quark physics, electroweak precision analyses and particle cosmology.

Chronology of Education

1995-2000	**Massachusetts Institute of Technology** Ph.D. in Physics Thesis Advisor: Prof. Lisa Randall Thesis: *Search for Supersymmetry: New Physics beyond the Standard Model*
1990-1995	**University of Science and Technology of China** B.S. in Physics Thesis Advisor: Prof. Yunxiu Ye Thesis: Λ *polarization in Relativistic Nucleus-Nucleus Collision*

Chronology of Employment

1995−2000	Research Assistant and Teaching Assistant **Department of Physics, Massachusetts Institute of Technology**
2000−2003	John A. McCone Fellow **Department of Physics, California Institute of Technology**
2003−2009	Assistant professor **Department of Physics, University of Arizona**
2009−present	Associate professor **Department of Physics, University of Arizona**

Most Important Publications

1. "Low Energy Precision Test of Supersymmetry"
M.J. Ramsey-Musolf, S. Su, hep-ph/0612057, *Phys. Rept.* **456** (2008) 1.

2. "Lower Limit on Dark Matter Production at the Large Hadron Collider and International Linear Collider"
J. L. Feng, S. Su, F. Takayama, hep-ph/0503117, *Phys. Rev. Lett.* **96** (2006) 151802.

3. "SuperWIMP Gravitino Dark Matter from Slepton and Sneutrino Decays"
J. L. Feng, S. Su, F. Takayama, hep-ph/0404198, *Phys. Rev.* **D70** (2004) 063514.

4. "Extra Families, Higgs Spectrum and Oblique Corrections"
H. J. He, N. Polonsky, S. Su, hep-ph/0102144, *Phys. Rev.* **D64** (2001) 053004.

5. "Discovering Supersymmetry at the Tevatron in Wino LSP Scenarios"
J. L. Feng, T. Moroi, L. Randall, M. Strassler, S. Su, hep-ph/9904250, *Phys. Rev. Lett.* **83** (1999) 1731.

DOUG TOUSSAINT
Biographical Information
August 24, 2010

Education:

Univ. of North Carolina	Physics	BS 1974
Princeton University	Physics	Ph.D. 1978
Univ. of Calif. Santa Barbara	High Energy Physics	1978-1980
Institute for Theoretical Physics	High Energy Physics	1980-1983

Appointments:

July 1994 - present
Professor, Department of Physics
University of Arizona, Tucson, AZ 85721

May 1997 - Aug 1997
Visiting Professor, Center for Computational Physics
University of Tsukuba, Tsukuba, Ibaraki 305, Japan

Aug. 1988 - June 1994
Associate Professor, Department of Physics
University of Arizona, Tucson, AZ 85721

Jan. 1988 - May 1988
Visiting Scientist, Fermi National Accelerator Laboratory
PO Box 500, Batavia, IL 60510

July 1983 - June 1988
Assistant Professor, Physics Department, B-019
University of California at San Diego, La Jolla, CA 92093

Selected Publications:

1. S. Gottlieb, W. Liu, R. Renken, R. L. Sugar, and Doug Toussaint, "Hybrid Molecular Dynamics Algorithms for the Numerical Simulation of Quantum Chromodynamics," Phys. Rev. D **35**, 2531-2542 (1987).

2. Variants of fattening and flavor symmetry restoration, Kostas Orginos, Doug Toussaint and R.L. Sugar, Phys. Rev. D **60** (1999) 054503.

3. Light pseudoscalar decay constants, quark masses, and low energy constants from three-flavor lattice QCD, MILC Collaboration: C. Aubin, C. Bernard, C. DeTar, Steven Gottlieb, E.B. Gregory, U.M. Heller, J.E. Hetrick, J. Osborn, R. Sugar, D. Toussaint, hep-lat/0407028 , Phys. Rev. D **70**, 114501 (2004).

4. The strange quark condensate in the nucleon in 2+1 flavor QCD, D. Toussaint and W. Freeman [MILC collaboration], arXiv:0905.2432, Phys. Rev. Lett. **103**, 2009, 122002.

5. Full nonperturbative QCD simulations with 2+1 flavors of improved staggered quarks, Authors: A. Bazavov, C. Bernard, C. DeTar, Steven Gottlieb, U.M. Heller, J.E. Hetrick, J. Laiho, L. Levkova, P.B. Mackenzie, M.B. Oktay, R. Sugar, D. Toussaint, R.S. Van de Water , arXiv:0903.3598, Rev. Mod. Phys. **82**, 1349-1417 (2010).

Dr. Ubirajara VAN KOLCK, Professor of Physics
Department of Physics, University of Arizona, 1118 E 4th St., Tucson, AZ 85721
ph: 520-621-4230; fax: 520-621-4721; email: vankolck@physics.arizona.edu

Education:

Ph.D., 1993 (Theoretical Physics)	University of Texas at Austin
M.S., 1987 (Theoretical Physics)	Instituto de Física Teórica, São Paulo, Brazil
B.S., 1984 (Physics)	Universidade de São Paulo, São Paulo, Brazil

Appointments:

2009-date	Professor of Physics, University of Arizona
2004-date	Affiliate Member, Program in Applied Mathematics, University of Arizona
2003-date	Affiliate Associate Professor of Physics, University of Washington
2003-2009	Associate Professor of Physics, University of Arizona
2000-2004	RHIC Physics Fellow, RIKEN-BNL Research Center
2000-2003	Assistant Professor of Physics, University of Arizona
1998-2000	Senior Research Fellow, California Institute of Technology
1996-1997	Research Assistant Professor, University of Washington
1993-1996	Research Associate, University of Washington

Visiting Positions (≥ 1 mo.):

2009	(Mar-June) Visiting Scholar, Institute for Nuclear Theory, Seattle
2007	(Jan-Aug) Visiting Professor, Instituto de Física Teórica, São Paulo
2006-2007	(Oct-Jan) Visiting Scientist, Kernfysisch Versneller Instituut, Groningen
2004	(Sept-Nov) Visiting Scholar, Institute for Nuclear Theory, Seattle
2003	(Sept-Dec) Visiting Scholar, Institute for Nuclear Theory, Seattle
2000	(July-Aug) Visiting Scholar, Institute for Nuclear Theory, Seattle

Honors and Awards:

2004-date	Principal Investigator, DOE grant DE-FG02-04ER41338
2009	Excellence in Graduate Physics Teaching Award, University of Arizona
2008-2009	Sponsor, Visiting Professor R. Morones' Fulbright Scholarship
2002-2006	Alfred P. Sloan Research Fellow, Alfred P. Sloan Foundation
2001,3,4,6	Recipient, Foreign Travel Grants, University of Arizona
2005	Co-Recipient, Foreign Travel Grant, APS Forum on International Physics
2004	Fellow, American Physical Society
2001-2004	Outstanding Junior Investigator, DOE grant DE-FG03-01ER41196
1998-2000	Senior Participant, NSF grants PHY 9420470 and 0071856
1996-1997	Senior Participant, DOE grant DE-FG03-97ER41014
1991-1993	Research Assistant, University of Texas
1992	Recipient, Travel Grant, University of Texas
1987-1992	Doctorate Fellow, CNPq, Brazil
1985-1987	Master's Fellow, CAPES, Brazil
1983	Scientific Initiation Fellow, FAPESP, Brazil

Recent Synergistic Activities:

2009-2013	Member, Editorial Board, *Progress in Particle and Nuclear Physics* (Elsevier)
2008-2012	Vice–Chair, Chair–Elect, Chair, and Past–Chair, APS Group on Few–Body Systems
2009	Organizer, Program on Effective Field Theories in Particle and Nuclear Physics, KITPC
2009	Organizer, Program on Effective Field Theories and the Many–Body Problem, INT
2006-2008	Member, Nuclear Science Advisory Committee, Department of Energy

Publications in Past Three Years:

1. J. Rotureau, I. Stetcu, B.R. Barrett, M.C. Birse, and U. van Kolck, "Three and Four Harmonically Trapped Particles in an Effective Field Theory Framework", `arXiv:1006.3820 [cond-mat.quant-gas]`.

2. J. de Vries, E. Mereghetti, R.G.E. Timmermans, and U. van Kolck, "The Nucleon Electric Dipole Form Factor From Dimension–Six Time–Reversal Violation", `arXiv:1006:2304 [hep-ph]`.

3. W.H. Hockings, E. Mereghetti, and U. van Kolck, "The T–Violating Chiral Lagrangian From the QCD Theta Term", *Ann. Phys.* (to appear), `arXiv:1002:2391 [hep-ph]`.

4. I. Stetcu, J. Rotureau, B.R. Barrett, and U. van Kolck, "An Effective Field Theory Approach to Two Trapped Particles", *Ann. Phys.* **325** (2010) 1644.

5. I. Stetcu, J. Rotureau, B.R. Barrett, and U. van Kolck, "Effective Interactions for Light Nuclei: an effective (field theory) approach", *J. Phys. G* **37** (2010) 064033.

6. B. Long and U. van Kolck, "πN Scattering in the $\Delta(1232)$ Region in an Effective Field Theory", *Nucl. Phys. A* **840** (2010) 39.

7. R. Higa, H.-W. Hammer, and U. van Kolck, "$\alpha\alpha$ Scattering in Halo Effective Field Theory", *Nucl. Phys. A* **809** (2008) 171.

8. B. Long and U. van Kolck, "Renormalization of Singular Potentials and Power Counting", *Ann. Phys.* **323** (2008) 1304.

9. I. Stetcu, B.R. Barrett, J.P. Vary, and U. van Kolck, "Effective Theory for Trapped Few–Fermion Systems", *Phys. Rev. A* **76** (2007) 063613; (E) **77** (2008) 039902.

10. S. Fleming, M. Kusunoki, T. Mehen, and U. van Kolck, "Pion Interactions in the $X(3872)$", *Phys. Rev. D* **76** (2007) 034006.

11. I. Stetcu, B.R. Barrett, and U. van Kolck, "No-Core Shell Model in an Effective–Field–Theory Framework", *Phys. Lett. B* **653** (2007) 358.

Six Most Cited Publications [citations according to Spires]:

1. P.F. Bedaque and U. van Kolck, "Effective Field Theory for Few–Nucleon Systems", *Ann. Rev. Nucl. Part. Sci.* **52** (2002) 339. [280]

2. P.F. Bedaque, H.-W. Hammer, and U. van Kolck, "Renormalization of the Three–Body System with Short–Range Interactions", *Phys. Rev. Lett.* **82** (1999) 463. [208]

3. C. Ordóñez, L. Ray, and U. van Kolck, "The Two–Nucleon Potential from Chiral Lagrangians", *Phys. Rev. C* **53** (1996) 2086. [370]

4. U. van Kolck, "Few–Nucleon Forces from Chiral Lagrangians", *Phys. Rev. C* **49** (1994) 2932. [241]

5. C. Ordóñez, L. Ray, and U. van Kolck, "Nucleon–Nucleon Potential from an Effective Chiral Lagrangian", *Phys. Rev. Lett.* **72** (1994) 1982. [243]

6. C. Ordóñez and U. van Kolck, "Chiral Lagrangians and Nuclear Forces", *Phys. Lett. B* **291** (1992) 459. [212]

Erich W. Varnes

The University of Arizona
Department of Physics
Tucson, AZ 85749
(520) 626-0217
varnes@physics.arizona.edu

EDUCATION

University of California, Berkeley, Ph.D. in Physics, 1997
Thesis title: *Measurement of the Top Quark Mass*
Advisor: Prof. Mark Strovink

University of California, Berkeley, M.A. in Physics, 1994

Johns Hopkins University, B.A. in Physics, 1992

EMPLOYMENT

2008 – Present:
Associate Professor Department of Physics, University of Arizona

2002 – 2008:
Assistant Professor Department of Physics, University of Arizona

1997 – 2002:
Robert H. Dicke Postdoctoral Fellow Department of Physics, Princeton University

1993 – 1997:
Graduate Research Assistant Department of Physics, University of California, Berkeley

KEY LEADERSHIP POSITIONS

2007-Present:
Software Algorithms and Computing Coordinator for the DØ experiment at Fermilab. DØ is one of the leading high-energy physics experiments, consisting of about 600 collaborating researchers.

2004-2006:
Leader of the top quark properties analysis group at DØ.

SELECTED PUBLICATIONS

1. "**Direct Measurement of the Top Quark Mass**", K. Tollefson and E.W. Varnes, in **Annual Review of Nuclear and Particle Science** (1999).
2. **"Model-independent measurement of the W Boson Helicity in Top Quark Decays at DØ"**, V. M. Abazov *et al.*, Phys. Rev. Lett. **100**, 062004 (2008); arXiv:0711.0032; Fermilab-Pub-07/588-E.
3. **"Measurement of the W Boson Helicity in Top Quark Decays at DØ"** V. M. Abazov *et al.*, Phys. Rev. D **75**, 031102(R) (2007); hep-ex/0609045; Fermilab-Pub-06/345-E.

4. "**Search for right-handed W bosons in top quark decay**", V. M. Abazov *et al.*, Phys. Rev. D Rap. Comm **72**, 011104 (R) (2005); hep-ex/0505031, Fermilab-Pub-05/187-E.

5. "**Measurement of** $\sin 2\beta$ **with previously unused hadronic and muonic** J/ψ **decays**", B. Aubert *et al.*, Phys. Rev D-Rapid Commun. **69**, 052001 (2004); SLAC-PUB-1062l; hep-ex/0309039.

6. "**Measurement of branching fractions for exclusive** B **decays to charmonium final states**", B. Aubert *et al.*, Phys. Rev. D **65**, 032001 (2002); SLAC-PUB-8909; hep-ex/0107025.

7. "Measurement of the B^0 and B^+ meson lifetimes with fully reconstructed hadronic final states" B. Aubert *et al.*, Phys. Rev. Lett. **87**, 201803 (2001); SLAC-PUB-8847; hep-ex/0107019.

8. "**Observation of** CP **Violation in the** B^0 **system**" B. Aubert *et al.*, Phys. Rev. Lett. **87**, 091801 (2001); SLAC-PUB-8904; hep-ex/0107013.

9. "**Measurement of** CP**-violating asymmetries in** B^0 **decays to** CP **eigenstates**", B. Aubert *et al.*, Phys. Rev. Lett. **86**, 2515 (2001); SLAC-PUB-8777; hep-ex/0102030.

10. "**The BaBar Detector**", B. Aubert *et al.*, Nucl. Instrum. Methods Phys. Res. A **479**, 1 (2002); SLAC-PUB-8569; hep-ex/0105044.

11. "**Measurement of the Top Quark Mass in the Dilepton Channel**", B. Abbott *et al.*, Phys. Rev. D **60**, 052001 (1999); Fermilab-Pub-98/261-E; hep-ex/9808029.

12. "**Electronics for the BaBar Central Drift Chamber**", J. Albert *et al.*, IEEE Trans. Nucl. Sci. **46**, 2027 (1998); SLAC-PUB-7996.

13. "**The BaBar Drift Chamber**", G. Sciolla *et al.*, Nucl. Instrum. Methods Phys. Res. A**419**, 310 (1998).

14. "**Direct Measurement of the Top Quark Mass by the DØ Collaboration**", B. Abbott *et al.*, Phys. Rev. D **58**, 052001 (1998); Fermilab-Pub-98/031-E; hep-ex/9801025.

15. "**Measurement of the Top Quark Mass Using Dilepton Events**", B. Abbott *et al.*, Phys. Rev. Lett. **80**, 2063 (1998); Fermilab-Pub-97/172-E; hep-ex/9706014.

16. "**Direct Measurement of the Top Quark Mass**", S. Abachi *et al.*, Phys. Rev. Lett. **79**, 1197 (1997); Fermilab-Pub-97/059-E; hep-ex/9703008.

Koen Visscher
Associate Professor, Department of Physics, University of Arizona, P.O. Box 210081, Tucson, AZ 85721-0081; (Voice) 520.626.4276; (Fax) 520.626.8674; (E-mail) visscher@physics.arizona.edu

Professional Preparation

University of Twente, The Netherlands	Technical Physics M.Sc.	1988
University of Amsterdam, The Netherlands	Physics, Ph.D.	1993
Princeton University	Biophysics, Molecular Biology, Postdoc	1994-99

Appointments

2004 - present	Associate Professor of Physics, University of Arizona
1999 - 2004	Assistant Professor of Physics, University of Arizona
1997 - 1999	Scientific Staff Member, Princeton Materials Institute, Princeton University
1994 - 1997	Research Fellow of the Burroughts Wellcome Fund of the Life Sciences Research Foundation, Department of Molecular Biology, Princeton University
1994	Post-Doctoral Research Associate, Department of Molecular Biology, Princeton University
1993 - 1994	Research Associate, Department of Molecular and Cellular Biology, Free University, Amsterdam, The Netherlands

Honors and Awards

Visiting Professor, Institut d'Optique (CNRS/Université Paris-Sud 11), Paliseau, France (2010).
Visiting Professor, Institut d'Optique (CNRS/Université Paris-Sud 11), Paliseau, France (2009).
Joop Los Fellow, FOM Institute for Atomic and Molecular Physics (AMOLF), Amsterdam, The Netherlands (2007)
Beckman Young Investigator Award (2001)
Research Corporation, Research Innovation Award (2000).
Burroughs Wellcome Fund Fellow of the Life Sciences Research Foundation (1994-1997).

Publications [times cited, 08/24/2010]

1. Mazauric, M.-H., Seol, Y., Yoshizawa, S., Visscher, K. & Fourmy, D. Interaction of the HIV-1 frameshift signal with the ribosome. Nucl. Acids Res. 37, 7654-7664 (2009). **[0]**
2. Mazauric, M.-H., Leroy, J.-L., Visscher, K., Yoshizawa, S. & Fourmy, D. Footprinting analysis of BWYV pseudoknot-ribosome complexes. RNA 15, 1775-1786 (2009). **[1]**
3. Seol, Y, Stein, D.L. & Visscher, K. Phase measurements of barrier crossings in a periodically modulated double-well potential. Phys. Rev. Lett. 103, 050601 (2009). **[0]**
4. Aspnes, E., Milster, T., & Visscher, K. Optical force model based on ray-tracing. Applied Optics 48,1642-1650 (2009). **[0]**
5. Kalafut, B. & Visscher, K. An objective, model-independent method for detection of non-uniform steps in noisy signals. Computer Physics Communications, 179, 716-723 (2008). **[1]**
6. Skinner, G.M., Seol, Y, &Visscher, K. Translation against an applied force. In: Biological Physics, 3rd Mexican Meeting on Mathematical and Experimental Physics, Mexico City, Mexico. Editors: Leonardo Dagdug, Leopoldo Garcia-Colin Scherer. AIP Conf. Proceedings 978, 1-10 (2008). **[0]**
7. Skinner, G.M., Visscher K., and Mansuripur M. Biocompatible Writing of Data into DNA J. Bionanosci. 1, 17–21 (2007)
8. Seol, Y., Skinner, G.M., Buhot, A., Halperin, A., and Visscher, K. Stretching of homopolymeric RNA reveals single-stranded helices and base-stacking. Phys Rev. Lett. 98, 158103 (2007) **[25]**
9. Van der Horst, A, Vossen, D.L.J. , Visscher, K., Dogterom, M., and Van Blaaderen, A. Manipulation and imaging of particles with optical tweezers and confocal microscopy. Microscopy and Analysis, 19, 15-17 (2005)
10. Seol, Y., Walton, D.B, & Visscher, K. "Suppression of noise in a noisy optical trap" Phys. Rev. Lett. 93, 160602 (2004). **[7]**
11. Seol, Y., Skinner, G.M. & Visscher K., "Elastic properties of a single-stranded charged homopolymeric ribonucleotide". Phys. Rev. Lett. 93, 118102 (2004). **[34]**
12. Skinner, G.M & Visscher K., "Single-molecule techniques for drug discovery" Assay Drug Dev. Tech. 2, 397-405 (2004). **[6]**

13. Walton, D.B. & Visscher K. Noise suppression and spectral decomposition for state-dependent noise in the presence of a stationary fluctuating input." Phys. Rev. E. 69, 051110 (2004) **[4]**
14. Van Blaaderen A., Hoogenboom J.P., Vossen D.I.J., Yethira A., Van der Horst A., Visscher K., and Dogterom M., "Colloidal epitaxy: Playing with the boundaries conditions of colloidal crystallization.", Faraday Discuss. 123, 107-119 (2003). **[19]**
15. Schnitzer M.J., Visscher K., and Block S.M., "Force production by single kinesin motors.", Nature Cell Biology 2, 718-723 (2000) **[180]**
16. Visscher K., Schnitzer M.J., and Block S.M., "Single kinesin molecules studied with a molecular force clamp." Nature 400, 184-189 (1999). Featured in Nature Cell Biology News&Views: Knight A.E., and Molloy J.E., "Coupling ATP hydrolysis to mechanical work.", Nature Cell Biology 1, E87-E89 (1999). **[412]**
17. Visscher K., and Block S.M., "Versatile optical traps with feedback control.", Meth. In Enzym. 298, 460-489 (1998). **[69]**
18. Visscher K., Gross S.P., and Block S.M., "Construction of multiple beam optical traps with nanometer-resolution position detection"., IEEE J. of Selected Topics in Quantum Electronics 2, 1066-1076 (1996). **[170]**
19. Brakenhoff G.J., and Visscher K., "Real-Time Stereo (3D) Confocal Microscopy.", In Handbook of Biological Confocal Microscopy, Pawley B.J. (ed), Plenum Press, New York (1995).
20. Mueller M., Ghauhalari R., Visscher K., and Brakenhoff G.J., "Double-pulse fluorescence lifetime imaging in confocal microscopy.", J. Micr. 177, 171-179 (1995). **[11]**
21. Visscher K., Brakenhoff G.J., and Visser T.D., "Fluorescence saturation in confocal microscopy.", J. Micr. 172, 162-165 (1994). **[14]**
22. Brakenhoff G.J. and Visscher K., and Gijsbers E.J., "Fluorescence bleach rate imaging.", J. Micr. 175, 154-161 (1994). **[17]**
23. Grimbergen J., Visscher K., Gomes de Mesquita D., and Brakenhoff G.J., "Isolation of single yeast cells by optical trapping.", Yeast 9, 723-732 (1993). **[10]**
24. Imaging modes for bilateral confocal scanning microscopy. Brakenhoff, G.J. & Visscher, K., J. Micr. 171, 17-26, 1993 **[16]**
25. Visscher K., Brakenhoff G.J., and Krol J.J., "Micromanipulation by 'multiple' optical traps created by a single fast scanning trap integrated with the bilateral confocal scanning laser microscope.", Cytometry 14, 105-114 (1993). **[84]**
26. Visscher K., and Brakenhoff G.J., "A theoretical study of optically induced forces on spherical particles in a single beam trap I: Rayleigh scatterers.", Optik 89, 174-180 (1992). **[51]**
27. Visscher K., and Brakenhoff G.J., "A theoretical study of optically induced forces on spherical particles in a single beam trap II: Mie scatterers.", Optik 90, 57-60 (1992). **[19]**
28. Brakenhoff G.J., and Visscher K., "High sensitivity confocal imaging with bilateral scanning and CCD detectors.", SPIE Proc. 1660, 521-531 (1992).
29. Brakenhoff G.J. and, Visscher K., "Confocal Imaging with bilateral scanning and array detectors.", J. Micr. 165, 139-146 (1992). **[40]**
30. Visscher K., and Brakenhoff G.J., "Single beam optical trapping integrated in a confocal microscope for biological applications.", Cytometry 12, 486 - 491 (1991). **[20]**
31. Brakenhoff G.J., Van der Voort H.T.M., and Visscher K., "Confocal microscopy for the biological and material sciences.", SPIE Proc. 1439, 121-127 (1991).
32. Brakenhoff G.J., and Visscher K., "Novel confocal imaging and visualization techniques.", In : Transactions of the Royal Microscopical Society : Micro '90. H.Y. Elder (ed.), Adam Hilger, Bristol, pp. 247-250 (1990).
33. Brakenhoff G.J., Visscher K., and Van der Voort H.T.M., "Size and shape of the confocal spot,: control and relation to 3D imaging and image processing.", In Handbook of Biological Confocal Microscopy, Pawley B.J. (ed), Plenum Press, New York (1989).
34. Terstappen L.W.M.M., De Grooth B.G., Visscher K., Kouterik F.A., and Greve J., "Four differential white blood cell counting entirely based upon light scattering measurements.", Cytometry 9, 39-43 (1988). **[30]**

Invited talks: 42

- One of the pioneers in "Optical Tweezers".
- Invented Constant-Force Optical Tweezers.
- Delivered most comprehensive dataset on the force-dependence of a molecular motor.
- Pioneered use of Optical Tweezers for studying protein synthesis (albeit that we have not been as successful as we had hoped---*Ken, you may delete this*)
- First to characterize the elastic properties of single-stranded RNA.

Cross-departmental contacts are in teaching and research.

Teaching:

- I was involved in teaching in the first IGERT funded program (Tabor—Applied Math; Visscher, Goldstein—Physics, Oland—Neuroscience) on campus. I still serve as a member on the Applied Math Steering Committee.

- Currently teaching laboratory/exploratory course (MCB/PHYS/MATH 303) as part of the Integrated Science Program/Major (current faculty: Joceline Lega—Applied Math, Koen Visscher—Physics, Neel Ghosh—Chemistry, Florence Tama—Biochemistry)

Research:

- Established the Biological Physics Program (Visscher—Physics; Brown—Chemistry; Tama, Miyashita—Biochemistry; Granzier—MCB/Med School).
- Research discussions with Nancy Horton (Biochemistry—DNA-protein interaction).
- Research discussions with Gio Bosco (MCB) and Andy Hausrath (Biochem) for development of new optical microscopy methods.
- Assist Xiaoyi Wu (AME) in construction of Optical Tweezers.
- no current funded on-campus collaborations.

Biographical Sketch

Shufeng Zhang

ADDRESS

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PROFESSIONAL PREPARATION

University of Science and Technology of China	B.S.	1985
New York University	M.S.	1987
New York University	Ph.D.	1991
University of California-San Diego	Postdoc	1991-1992

APPOINTMENTS

Professor, University of Arizona, 2008-present
Professor, University of Missouri, 2005-2008
Assistant/Associate Professor, University of Missouri, 1998-2005
Research Assistant Professor, New York University, 1993-1998
Visiting Scientist, Hewlett-Packard Laboratories, 1992-1993

HONORS

New York University Outstanding Dissertation Award, 1991
Hewlett-Packard Faculty Fellowship, 1995
Elected APS Fellow, 2005
Young Distinguished Oversea Chinese Scholar Award, 2005

RECENT SYNERGISTIC ACTIVITIES

APS-GMAG excutive committee member (2010-2013).
Co-organizer of APS-focused sessions (2011, 2007).
Member of Program Committee, Annual Magnetism (MMM) conferences (2007-2011).
External Board Member of Univ. Nebraska-Lincoln MRSEC center (2003-2008).
Co-organizer of 52^{th} Midwest Solid State Conference (2005).

COLLABORATORS AND OTHER AFFILIATIONS

Collaborators (last 48 months)

A. Fert (Paris-Orsay), C. Li (U. Missouri), S. S. P. Parkin (IBM),
A. Rebei (Seagate), J. Sun (IBM).

Graduate and Postdoctoral Advisers

Graduate Adviser: P. M. Levy (NYU)
Postdoctoral Adviser: D. R. Fredkin (UCSD)

Thesis and Postdoctoral Advisees (last 48 months)

J. He (Ph.D, 2003-2008), Y. -Z. Yang (PH.D, 2002-2007), Z. Li (Postdoc, 1999-2006),
A. Manchon (Postdoc, 2007-2009)

PUBLICATIONS

Six Most Related Publications

1. A. Manchon and S. Zhang, *Theory of spin torque due to spin-orbit coupling* Phys. Rev. B **79** 094422 (2009).

2. S. S.-L. Zhang and S. Zhang, *Interplay between magnetization dynamics and spin transport*, IEEE Trans. Magn. **46**, 2297 (2010).

3. Z. Li and S. Zhang, *Thermally assisted magnetization reversal in the presence of a spin-transfer torque*, Phys. Rev. B **69**, 134416 (2004).

4. Z. Yang, S. Zhang, and Y. C. Li, *Chaotic Dynamics of Spin-Valve Oscillators*, Phys. Rev. Lett. **99**, 134101 (2007).

5. A. Manchon and S. Zhang, *Influence of interfacial magnons on spin transfer torque in magnetic tunnel junctions*, Phys. Rev. B **79**, 174401 (2009).

6. S. Zhang and Z. Li, *Roles of non-equilibrium conduction electrons on ferromagnets*, Phys. Rev. Lett. **92**, 127204 (2004).

Six Other Significant Publications

1. A. Manchon and S. Zhang, *Theory of nonequilibrium intrinsic spin torque in a single nanomagnet*, Phys. Rev. B **78**, 212405 (2008).

2. S. Zhang and S. S.-L. Zhang, *Generalization of the Landau-Lifshitz-Gilbert equation for conducting ferromagnets*, Phys. Rev. Lett. **102**, 086601 (2009).

3. S. Zhang, *Spin Hall Effect in the Presence of Spin Diffusion*, Phys. Rev. Lett. **85**, 393 (2000).

4. S. Zhang, *Electron Screening in Ferromagnetic Surfaces and Magnetic Tunnel Junctions*, Phys. Rev. Lett. **83**, 640 (1999).

5. S. Zhang, P. M. Levy and A. Fert, *Mechanisms of spin-polarized current-driven magnetization switching*, Phys. Rev. Lett. **88**, 236601 (2002).

6. S. Zhang, P. M. Levy, A. C. Marley and and S. S. P. Parkin, *Quenching of Magnetoresistance by Hot electrons in Magnetic Tunnel Junctions*, Phys. Rev. Lett. **79**, 3744 (1997).

B Physics Department Advisory Board

- Dr. Philip Lacovara
  Chair of the Advisory Board
  Chairman, Ambalux Corporation
- Dr. Ronald Carsten
  Chief Engineer, Raytheon Missile Systems
- Prof Neil Gehrels
  Chief, Astroparticle Physics Laboratory, NASA/GSFC
  Professor of Astronomy, University of Maryland
- Prof. Richard C. Powell
  Professor Emeritus, College of Optical Science, University of Arizona
  Vice President for Research, University of Arizona, 1999-2005
  Professor and Director, College of Optical Sciences, University of Arizona, 1992-1998
  President, Optical Society of America, 2001
- Prof Kenneth S. Krane
  Professor Emeritus, Physics Department, Oregon State University
  Department Chair, Oregon State University, 1984-1998
  Alumnus, University of Arizona Physics Department, B.S. 1965
- Prof Douglas Donahue
  Professor Emeritus of Physics
  University of Arizona
- Prof Larry McIntyre
  Professor Emeritus of Physics
  University of Arizona

C Teaching Evaluations

department course/instructor summary report

Fall 2009

instructor	course				Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]										
53267-02-02	PHYS	241	010	LAB	20 / 90%	3.6 (3.2 - 4.0)	3.1 (2.6 - 3.6)	3.1 (2.6 - 3.7)	- (- - -)	230
53269-02-02	PHYS	241	011	LAB	14 / 100%	3.8 (3.3 - 4.3)	3.6 (2.9 - 4.2)	3.5 (3.0 - 4.0)	- (- - -)	230
[redacted]										
53155-02-02	PHYS	141	009	LAB	17 / 80%	4.5 (4.0 - 5.0)	4.2 (3.8 - 4.6)	4.1 (3.6 - 4.5)	- (- - -)	230
[redacted]										
53277-02-02	PHYS	261H	001	LAB	8 / 100%	3.9 (3.1 - 4.6)	4.0 (3.5 - 4.5)	3.9 (3.1 - 4.6)	- (- - -)	230
81183-02-02	PHYS	261H	002	LAB	17 / 85%	4.2 (3.7 - 4.6)	3.5 (3.0 - 4.1)	3.4 (2.9 - 4.0)	- (- - -)	230
13 [redacted]										
81207-01	PHYS	552	001	LEC	4 / 66%	4.8 (4.2 - 5.0)	4.3 (3.2 - 5.0)	3.8 (2.3 - 5.0)	4.0 (3.1 - 4.9)	234
[redacted]										
53219-01-02	PHYS	182	001	LAB	9 / 81%	4.8 (4.5 - 5.0)	4.0 (3.5 - 4.5)	4.2 (3.9 - 4.5)	- (- - -)	230
53225-01-02	PHYS	182	004	LAB	13 / 86%	4.4 (4.0 - 4.8)	3.8 (3.4 - 4.2)	3.7 (3.2 - 4.2)	- (- - -)	230
53231-01-02	PHYS	182	007	LAB	18 / 94%	4.0 (3.5 - 4.5)	3.6 (3.0 - 4.2)	3.7 (3.2 - 4.1)	- (- - -)	230
[redacted]										
86485-01-02	PHYS	102	004	LEC	67 / 49%	3.8 (3.6 - 4.0)	3.1 (2.8 - 3.4)	3.4 (3.1 - 3.6)	3.9 (3.7 - 4.1)	234
53195-01-02	PHYS	181	010	LAB	23 / 95%	3.8 (3.5 - 4.2)	3.4 (2.9 - 3.8)	3.4 (3.1 - 3.8)	- (- - -)	230
[redacted]										
53161-02-02	PHYS	142	001	LAB	15 / 75%	4.9 (4.8 - 5.0)	4.7 (4.3 - 5.0)	4.5 (4.0 - 4.9)	- (- - -)	230
[redacted]										
53299-01-01	PHYS	331	001	LEC	28 / 58%	4.0 (3.6 - 4.3)	3.5 (3.2 - 3.7)	3.8 (3.5 - 4.1)	4.3 (4.1 - 4.6)	234
[redacted]										
53251-02-02	PHYS	241	002	LAB	20 / 86%	4.0 (3.7 - 4.3)	3.7 (3.2 - 4.1)	3.5 (3.1 - 3.8)	- (- - -)	230
53265-02-02	PHYS	241	009	LAB	20 / 83%	4.2 (3.8 - 4.5)	3.4 (3.0 - 3.8)	3.5 (3.1 - 3.9)	- (- - -)	230
[redacted]										
53179-01-02	PHYS	181	002	LAB	21 / 87%	4.0 (3.6 - 4.3)	3.4 (3.1 - 3.8)	3.2 (2.8 - 3.6)	- (- - -)	230
53209-01-02	PHYS	181	017	LAB	19 / 86%	4.0 (3.6 - 4.4)	3.5 (3.1 - 4.0)	2.9 (2.7 - 3.2)	- (- - -)	230
53211-01-02	PHYS	181	018	LAB	21 / 87%	4.0 (3.6 - 4.4)	3.4 (3.1 - 3.8)	3.1 (2.8 - 3.5)	- (- - -)	230

instructor	course			Responses		Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]										
53157-02-02	PHYS 141	010	LAB	18 /	75%	3.1 (2.7 - 3.6)	3.0 (2.5- 3.5)	3.1 (2.5- 3.6)	- (- - -)	230
[redacted]										
53117-01-02	PHYS 102	001	LEC	75 /	55%	3.5 (3.2 - 3.7)	2.9 (2.6- 3.1)	3.3 (3.1- 3.6)	3.9 (3.7- 4.1)	234
85907-01-02	PHYS 182	009	LAB	7 /	87%	4.7 (4.3 - 5.0)	4.3 (3.7- 4.9)	4.1 (3.4- 4.9)	- (- - -)	230
[redacted]										
53187-01-03	PHYS 181	006	LAB	22 /	95%	4.4 (4.0 - 4.7)	3.6 (3.2- 4.0)	3.6 (3.1- 4.0)	- (- - -)	230
53217-01-02	PHYS 181	021	LAB	17 /	73%	4.4 (4.1 - 4.8)	4.3 (4.0- 4.6)	3.9 (3.5- 4.3)	- (- - -)	230
86455-01-02	PHYS 181	022	LAB	19 /	100%	4.4 (4.1 - 4.7)	4.3 (4.0- 4.7)	4.1 (3.7- 4.4)	- (- - -)	230
[redacted]										
86435-02-02	PHYS 141	015	LAB	4 /	30%	5.0 (5.0 - 5.0)	5.0 (5.0- 5.0)	4.3 (3.7- 4.8)	- (- - -)	230
53173-02-02	PHYS 161H	001	LAB	23 /	95%	4.3 (4.0 - 4.5)	3.5 (3.3- 3.8)	3.4 (3.1- 3.6)	- (- - -)	230
8[illegible]177-02-02	PHYS 161H	002	LAB	18 /	81%	4.3 (4.0 - 4.6)	3.7 (3.3- 4.0)	3.6 (3.1- 4.0)	- (- - -)	230
86437-10-02	PHYS 161H	003	LAB	6 /	100%	4.3 (3.9 - 4.8)	3.8 (3.0- 4.7)	3.8 (2.8- 4.9)	- (- - -)	230
[redacted]										
53289-01-01	PHYS 305	002	LEC	18 /	78%	4.3 (3.9 - 4.7)	3.8 (3.4- 4.2)	4.2 (3.8- 4.6)	4.1 (3.7- 4.4)	234
[redacted]										
53235-01	PHYS 195A	001	CLQ	17 /	89%	2.6 (2.1 - 3.2)	2.9 (2.4- 3.3)	3.1 (2.5- 3.6)	2.2 (1.8- 2.7)	282
53483-01	PHYS 515B	001	LEC	12 /	75%	3.3 (2.6 - 3.9)	3.0 (2.2- 3.8)	3.1 (2.4- 3.7)	3.0 (2.6- 3.4)	234
[redacted]										
53289-01-02	PHYS 305	002	LEC	7 /	30%	4.3 (3.7 - 4.9)	4.0 (3.5- 4.5)	3.8 (3.2- 4.5)	4.7 (4.3- 5.0)	234
[redacted]										
53185-01-02	PHYS 181	005	LAB	21 /	95%	3.6 (3.2 - 4.0)	3.3 (2.8- 3.7)	3.0 (2.6- 3.4)	- (- - -)	230
53201-01-03	PHYS 181	013	LAB	15 /	71%	4.3 (3.9 - 4.6)	3.7 (3.2- 4.2)	3.2 (2.7- 3.7)	- (- - -)	230
53203-01-03	PHYS 181	014	LAB	19 /	86%	3.9 (3.6 - 4.3)	3.8 (3.3- 4.2)	3.6 (3.2- 4.1)	- (- - -)	230
[redacted]										
53119-01-02	PHYS 102	002	LEC	65 /	51%	4.2 (4.0 - 4.4)	3.5 (3.3- 3.7)	3.9 (3.7- 4.1)	4.0 (3.9- 4.2)	234
[redacted]										
53181-01-02	PHYS 181	003	LAB	18 /	81%	4.5 (4.2 - 4.8)	4.2 (3.8- 4.7)	4.1 (3.6- 4.5)	- (- - -)	230
53183-01-02	PHYS 181	004	LAB	15 /	88%	4.7 (4.3 - 5.0)	4.3 (3.9- 4.8)	4.1 (3.6- 4.5)	- (- - -)	230
53213-01-02	PHYS 181	019	LAB	17 /	73%	4.2 (3.8 - 4.6)	3.5 (2.9- 4.0)	3.5 (3.1- 3.9)	- (- - -)	230

instructor	course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]									
53139-01	PHYS 141	001	LEC	105 / 35%	3.0 (2.7 - 3.2)	2.6 (2.4- 2.9)	3.1 (2.9- 3.4)	4.5 (4.4- 4.6)	234
53311-01-01	PHYS 381	003	LAB	6 / 66%	4.8 (4.5 - 5.0)	4.3 (3.6- 5.0)	4.3 (3.6- 5.0)	- (- - -)	230
[redacted]									
53139-02-02	PHYS 141	001	LAB	19 / 86%	4.6 (4.3 - 4.9)	4.5 (4.2- 4.8)	4.0 (3.7- 4.3)	- (- - -)	230
[redacted]									
53125-01-01	PHYS 103	001	LEC	83 / 62%	4.5 (4.3 - 4.7)	4.1 (3.9- 4.3)	4.2 (4.0- 4.4)	4.2 (4.1- 4.3)	234
53249-01	PHYS 241	001	LEC	156 / 61%	4.2 (4.1 - 4.4)	3.7 (3.5- 3.9)	3.9 (3.7- 4.1)	4.6 (4.5- 4.7)	234
53303-01-01	PHYS 371	001	LEC	26 / 56%	4.8 (4.6 - 5.0)	4.7 (4.5- 4.9)	4.6 (4.3- 4.9)	4.3 (4.0- 4.6)	234
[redacted]									
53485-01	PHYS 528	001	LEC	11 / 78%	3.7 (3.2 - 4.3)	3.9 (3.3- 4.4)	4.0 (3.5- 4.5)	4.6 (4.3- 4.9)	234
[redacted]									
53129-01-02	PHYS 105A	001	LAB	15 / 65%	4.3 (4.0 - 4.6)	4.1 (3.5- 4.6)	4.5 (4.2- 4.9)	- (- - -)	230
[redacted]									
53295-01-01	PHYS 321	001	LEC	11 / 50%	3.5 (2.9 - 4.0)	3.3 (2.8- 3.8)	3.3 (2.9- 3.7)	3.8 (3.2- 4.4)	234
[redacted]									
53247-01-01	PHYS 204	001	LEC	21 / 58%	4.0 (3.5 - 4.4)	3.4 (2.9- 3.9)	3.9 (3.3- 4.4)	4.4 (4.2- 4.7)	234
[redacted]									
53173-01	PHYS 161H	001	LEC	36 / 69%	4.8 (4.6 - 5.0)	4.4 (4.1- 4.7)	4.2 (4.0- 4.5)	4.1 (3.9- 4.3)	234
[redacted]									
53307-01-03	PHYS 381	001	LAB	9 / 64%	4.2 (3.8 - 4.7)	4.1 (3.5- 4.8)	4.0 (3.2- 4.8)	- (- - -)	230
53309-01-02	PHYS 381	002	LAB	13 / 86%	4.2 (3.8 - 4.6)	3.6 (3.1- 4.2)	3.8 (3.2- 4.4)	- (- - -)	230
53311-01-02	PHYS 381	003	LAB	6 / 66%	4.8 (4.5 - 5.0)	4.2 (3.5- 4.8)	4.3 (3.6- 5.0)	- (- - -)	230
[redacted]									
53133-01-01	PHYS 131	001	LEC	77 / 56%	3.4 (3.2 - 3.6)	2.8 (2.5- 3.0)	3.6 (3.4- 3.9)	4.6 (4.5- 4.8)	234
53481-01	PHYS 511	001	LEC	11 / 73%	4.0 (3.5 - 4.5)	3.5 (2.9- 4.0)	3.3 (2.6- 3.9)	4.0 (3.5- 4.5)	234
[redacted]									
53143-02-02	PHYS 141	003	LAB	17 / 89%	4.6 (4.3 - 4.8)	4.2 (3.8- 4.5)	3.8 (3.4- 4.3)	- (- - -)	230
53153-02-02	PHYS 141	008	LAB	22 / 91%	4.3 (4.0 - 4.6)	4.1 (3.7- 4.5)	3.9 (3.6- 4.2)	- (- - -)	230
53159-02-02	PHYS 141	011	LAB	15 / 83%	4.2 (3.6 - 4.8)	3.7 (3.1- 4.4)	3.3 (2.5- 4.0)	- (- - -)	230

instructor	course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]									
53177-01-02	PHYS 181	001	LAB	20 / 95%	3.7 (3.1 - 4.2)	3.0 (2.5- 3.5)	3.3 (2.9- 3.7)	- (-- -)	230
53189-01-02	PHYS 181	007	LAB	21 / 87%	4.2 (3.8 - 4.7)	3.6 (3.1- 4.1)	3.3 (2.9- 3.8)	- (-- -)	230
53193-01-02	PHYS 181	009	LAB	22 / 95%	4.4 (4.0 - 4.7)	3.8 (3.3- 4.3)	3.6 (3.1- 4.1)	- (-- -)	230
[redacted]									
53261-02-02	PHYS 241	007	LAB	20 / 90%	4.6 (4.3 - 4.8)	4.6 (4.3- 4.8)	4.3 (4.0- 4.6)	- (-- -)	230
[redacted]									
53129-01-01	PHYS 105A	001	LAB	15 / 65%	4.3 (3.9 - 4.8)	3.9 (3.3- 4.5)	4.3 (3.8- 4.8)	- (-- -)	230
[redacted]									
53245-01-01	PHYS 201	001	LEC	8 / 88%	3.6 (3.1 - 4.2)	3.5 (2.7- 4.3)	3.4 (2.8- 3.9)	3.0 (2.6- 3.4)	234
[redacted]									
53351-01-01	PHYS 440	001	LEC	11 / 68%	3.4 (2.9 - 3.8)	3.4 (2.7- 4.0)	3.0 (2.4- 3.6)	3.0 (2.6- 3.4)	234
[redacted]									
53307-01-01	PHYS 381	001	LAB	14 / 100%	4.1 (3.7 - 4.6)	3.9 (3.4- 4.5)	3.8 (3.3- 4.4)	- (-- -)	230
53309-01-01	PHYS 381	002	LAB	8 / 53%	4.6 (4.2 - 5.0)	4.4 (3.6- 5.0)	3.8 (2.9- 4.6)	- (-- -)	230
[redacted]									
53291-01-01	PHYS 320	001	LEC	19 / 76%	4.1 (3.8 - 4.3)	3.5 (3.2- 3.8)	3.6 (3.2- 3.9)	3.2 (2.9- 3.5)	234
[redacted]									
53221-01-02	PHYS 182	002	LAB	15 / 83%	4.6 (4.3 - 4.9)	4.3 (4.0- 4.7)	3.9 (3.4- 4.3)	- (-- -)	230
53223-01-02	PHYS 182	003	LAB	20 / 90%	4.6 (4.2 - 4.9)	4.4 (4.0- 4.7)	4.1 (3.7- 4.4)	- (-- -)	230
[redacted]									
81175-02-02	PHYS 141	012	LAB	16 / 84%	2.9 (2.5 - 3.4)	3.1 (2.7- 3.5)	3.2 (2.7- 3.7)	- (-- -)	230
86435-10	PHYS 141	013	LAB	16 / 80%	3.7 (3.3 - 4.0)	3.4 (3.0- 3.8)	3.4 (2.9- 4.0)	- (-- -)	230
[redacted]									
53367-01	PHYS 472	001	LEC	15 / 88%	3.9 (3.5 - 4.2)	3.8 (3.4- 4.2)	4.0 (3.5- 4.5)	4.2 (3.7- 4.7)	234
[redacted]									
53191-01-03	PHYS 181	008	LAB	18 / 100%	4.6 (4.3 - 4.9)	4.2 (3.8- 4.6)	3.8 (3.2- 4.3)	- (-- -)	230
53197-01-03	PHYS 181	011	LAB	23 / 100%	4.5 (4.2 - 4.8)	4.0 (3.5- 4.4)	4.0 (3.6- 4.3)	- (-- -)	230
53199-01-03	PHYS 181	012	LAB	19 / 90%	4.7 (4.5 - 5.0)	4.3 (3.9- 4.7)	3.8 (3.4- 4.3)	- (-- -)	230
[redacted]									
53503-01	PHYS 560A	001	LEC	10 / 90%	4.7 (4.4 - 5.0)	4.2 (3.8- 4.6)	3.9 (3.3- 4.5)	3.0 (2.7- 3.3)	234

instructor	course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]									
53121-01-02	PHYS 102	003	LEC	48 / 48%	4.1 (3.8 - 4.4)	3.5 (3.2- 3.8)	3.6 (3.2- 3.9)	3.9 (3.7- 4.2)	234
[redacted]									
53147-02-02	PHYS 141	005	LAB	15 / 75%	4.5 (4.2 - 4.7)	3.6 (3.2- 4.0)	3.7 (3.2- 4.1)	- (- - -)	230
[redacted]									
53287-01-01	PHYS 305	001	LEC	7 / 35%	3.3 (2.4 - 4.2)	4.0 (3.5- 4.5)	4.2 (3.3- 5.0)	4.7 (4.3- 5.0)	234
[redacted]									
53259-02-02	PHYS 241	006	LAB	19 / 82%	3.4 (2.8 - 3.9)	3.0 (2.4- 3.6)	3.0 (2.5- 3.5)	- (- - -)	230
81181-02-02	PHYS 241	012	LAB	20 / 90%	3.4 (3.0 - 3.8)	3.1 (2.7- 3.4)	2.8 (2.5- 3.1)	- (- - -)	230
[redacted]									
53277-01	PHYS 261H	001	LEC	23 / 82%	4.4 (4.1 - 4.7)	4.1 (3.8- 4.5)	4.3 (3.9- 4.6)	3.9 (3.7- 4.2)	234
[redacted]									
53161-01	PHYS 142	001	LEC	18 / 27%	3.9 (3.6 - 4.2)	3.1 (2.6- 3.5)	3.3 (2.9- 3.8)	4.0 (3.6- 4.4)	234
[redacted]									
53249-02-02	PHYS 241	001	LAB	19 / 90%	4.3 (3.9 - 4.7)	3.8 (3.5- 4.2)	3.7 (3.3- 4.2)	- (- - -)	230
53255-02-02	PHYS 241	004	LAB	15 / 93%	4.1 (3.7 - 4.6)	3.7 (3.2- 4.1)	3.5 (3.1- 3.9)	- (- - -)	230
[redacted]									
53145-02-02	PHYS 141	004	LAB	19 / 90%	4.6 (4.4 - 4.9)	4.5 (4.2- 4.8)	4.2 (3.8- 4.5)	- (- - -)	230
53151-02-02	PHYS 141	007	LAB	16 / 80%	4.5 (4.2 - 4.8)	3.9 (3.4- 4.4)	3.8 (3.4- 4.2)	- (- - -)	230
[redacted]									
53205-01-03	PHYS 181	015	LAB	19 / 90%	4.7 (4.5 - 4.9)	4.4 (4.1- 4.7)	4.1 (3.6- 4.6)	- (- - -)	230
53207-01-02	PHYS 181	016	LAB	18 / 85%	4.7 (4.4 - 4.9)	4.4 (4.1- 4.8)	3.7 (3.3- 4.1)	- (- - -)	230
53215-01-02	PHYS 181	020	LAB	17 / 89%	4.9 (4.7 - 5.0)	4.4 (4.1- 4.8)	3.9 (3.5- 4.3)	- (- - -)	230
[redacted]									
53271-01	PHYS 242	001	LEC	8 / 72%	4.4 (4.0 - 4.8)	4.4 (3.8- 4.9)	4.8 (4.4- 5.0)	4.0 (3.4- 4.6)	234
[redacted]									
53253-02-02	PHYS 241	003	LAB	20 / 83%	2.9 (2.5 - 3.3)	2.6 (2.1- 3.0)	2.8 (2.3- 3.2)	- (- - -)	230
53257-02-02	PHYS 241	005	LAB	17 / 89%	3.5 (3.0 - 3.9)	3.1 (2.6- 3.5)	3.2 (2.7- 3.7)	- (- - -)	230
[redacted]									
53141-02-02	PHYS 141	002	LAB	17 / 80%	4.1 (3.7 - 4.5)	3.5 (3.0- 4.0)	3.4 (3.0- 3.7)	- (- - -)	230

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instructor	course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted] 53345-01-01	PHYS 426	001	LEC	11 / 55%	3.5 (2.9 - 4.0)	3.3 (2.7- 3.8)	3.5 (2.9- 4.0)	4.1 (3.7- 4.5)	234

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Spring 2010

Instructor	Course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]									
50779-02-02	PHYS 141	002	LAB	20 / 90%	4.6 (4.4 - 4.8)	4.2 (3.8- 4.5)	3.9 (3.4- 4.3)	- (-- -)	230
50797-02-02	PHYS 141	011	LAB	18 / 81%	4.6 (4.3 - 4.8)	4.1 (3.7- 4.5)	3.9 (3.4- 4.4)	- (-- -)	230
[redacted]									
50795-02-02	PHYS 141	010	LAB	21 / 95%	4.3 (4.0 - 4.6)	3.8 (3.5- 4.1)	3.8 (3.5- 4.1)	- (-- -)	230
[redacted]									
51179-01-02	PHYS 381	001	LAB	6 / 75%	5.0 (5.0 - 5.0)	4.7 (4.0- 5.0)	4.8 (4.5- 5.0)	- (-- -)	230
51183-01-02	PHYS 381	003	LAB	6 / 35%	4.0 (3.0 - 5.0)	3.8 (2.8- 4.9)	3.7 (2.6- 4.7)	- (-- -)	230
51185-01-02	PHYS 381	004	LAB	6 / 60%	4.5 (3.8 - 5.0)	4.3 (3.4- 5.0)	4.3 (3.6- 5.0)	- (-- -)	230
[redacted]									
50957-01-01	PHYS 202	001	LEC	41 / 82%	3.0 (2.7 - 3.4)	2.6 (2.3- 2.9)	3.2 (2.9- 3.5)	4.1 (3.9- 4.3)	234
[redacted]									
50793-02-02	PHYS 141	009	LAB	17 / 85%	4.2 (3.8 - 4.6)	4.0 (3.5- 4.5)	3.8 (3.4- 4.2)	- (-- -)	230
[redacted]									
50761-01-02	PHYS 102	003	LEC	23 / 21%	3.5 (3.0 - 4.1)	3.4 (3.0- 3.9)	3.8 (3.3- 4.3)	4.0 (3.6- 4.3)	234
[redacted]									
50973-02-02	PHYS 241	006	LAB	22 / 100%	4.0 (3.7 - 4.2)	3.6 (3.2- 3.9)	3.6 (3.3- 3.8)	- (-- -)	230
50975-02-02	PHYS 241	007	LAB	15 / 75%	4.4 (4.1 - 4.7)	4.0 (3.5- 4.5)	4.0 (3.6- 4.4)	- (-- -)	230
[redacted]									
50785-02-02	PHYS 141	005	LAB	20 / 95%	3.3 (2.8 - 3.8)	2.9 (2.4- 3.3)	2.7 (2.4- 3.0)	- (-- -)	230
50787-02-02	PHYS 141	006	LAB	18 / 81%	3.2 (2.7 - 3.6)	2.9 (2.6- 3.3)	2.7 (2.3- 3.1)	- (-- -)	230
[redacted]									
50803-02-02	PHYS 141	014	LAB	22 / 95%	3.6 (3.2 - 3.9)	3.1 (2.8- 3.4)	3.0 (2.7- 3.4)	- (-- -)	230
50807-02-02	PHYS 141	016	LAB	19 / 86%	3.9 (3.5 - 4.4)	3.5 (3.0- 3.9)	3.5 (3.1- 3.9)	- (-- -)	230
[redacted]									
50825-01-02	PHYS 181	004	LAB	16 / 88%	4.6 (4.4 - 4.9)	4.6 (4.2- 5.0)	4.6 (4.2- 5.0)	- (-- -)	230
50833-01-03	PHYS 181	008	LAB	21 / 91%	4.8 (4.5 - 5.0)	4.5 (4.1- 4.8)	4.0 (3.5- 4.4)	- (-- -)	230
50837-01-03	PHYS 181	010	LAB	19 / 86%	4.8 (4.7 - 5.0)	4.4 (4.2- 4.7)	4.3 (3.9- 4.6)	- (-- -)	230

Instructor	Course			Responses		Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]										
50791-02-02	PHYS 141	008	LAB	22 /	95%	4.7 (4.4 - 5.0)	4.4 (3.9- 4.8)	4.0 (3.6- 4.5)	- (- - -)	230
89891-02-02	PHYS 141	018	LAB	21 /	91%	4.5 (4.2 - 4.8)	3.9 (3.6- 4.2)	3.8 (3.5- 4.0)	- (- - -)	230
[redacted]										
51157-01	PHYS 305	001	LEC	5 /	27%	4.0 (3.3 - 4.7)	3.6 (3.1- 4.1)	3.6 (3.1- 4.1)	4.6 (4.1- 5.0)	234
[redacted]										
51171-01-01	PHYS 332	001	LEC	17 /	62%	2.9 (2.4 - 3.5)	2.9 (2.4- 3.4)	3.0 (2.4- 3.6)	3.6 (3.1- 4.0)	234
[redacted]										
84189-01	PHYS 579A	001	LEC	10 /	71%	3.6 (2.9 - 4.3)	3.1 (2.2- 4.0)	3.1 (2.3- 4.0)	4.3 (3.9- 4.6)	234
[redacted]										
50769-01-01	PHYS 105A	001	LAB	10 /	71%	4.8 (4.5 - 5.0)	4.6 (4.3- 4.9)	4.8 (4.5- 5.0)	- (- - -)	230
83927-01-01	PHYS 105A	002	LAB	13 /	76%	4.3 (3.8 - 4.8)	4.2 (3.6- 4.9)	4.4 (3.8- 5.0)	- (- - -)	230
[redacted]										
50971-02-02	PHYS 241	005	LAB	14 /	87%	4.1 (3.7 - 4.4)	3.8 (3.4- 4.2)	3.8 (3.3- 4.2)	- (- - -)	230
50979-02-02	PHYS 241	009	LAB	20 /	90%	4.1 (3.6 - 4.5)	3.6 (3.1- 4.0)	3.9 (3.4- 4.3)	- (- - -)	230
[redacted]										
50819-01-01	PHYS 181	001	LAB	19 /	95%	4.6 (4.3 - 4.9)	4.2 (3.8- 4.6)	3.9 (3.6- 4.3)	- (- - -)	230
50827-01-03	PHYS 181	005	LAB	16 /	88%	4.7 (4.3 - 5.0)	4.3 (3.8- 4.7)	4.0 (3.6- 4.4)	- (- - -)	230
50835-01-03	PHYS 181	009	LAB	21 /	91%	4.4 (4.1 - 4.8)	4.1 (3.8- 4.5)	4.0 (3.6- 4.3)	- (- - -)	230
[redacted]										
50757-01-02	PHYS 102	001	LEC	102 /	75%	4.3 (4.2 - 4.5)	3.5 (3.3- 3.7)	3.7 (3.5- 3.9)	4.1 (3.9- 4.2)	234
[redacted]										
50845-01-01	PHYS 182	001	LAB	19 /	76%	4.4 (4.0 - 4.7)	4.1 (3.7- 4.5)	3.6 (3.3- 4.0)	- (- - -)	230
50853-01-01	PHYS 182	005	LAB	22 /	91%	4.5 (4.2 - 4.7)	4.0 (3.7- 4.4)	4.0 (3.7- 4.4)	- (- - -)	230
90931-01-01	PHYS 182	015	LAB	20 /	86%	4.6 (4.3 - 4.9)	4.1 (3.7- 4.5)	3.7 (3.3- 4.1)	- (- - -)	230
[redacted]										
51179-01-01	PHYS 381	001	LAB	5 /	62%	4.4 (3.1 - 5.0)	4.4 (3.1- 5.0)	4.6 (3.7- 5.0)	- (- - -)	230
[redacted]										
50781-02-02	PHYS 141	003	LAB	18 /	81%	4.1 (3.7 - 4.4)	3.9 (3.5- 4.4)	3.7 (3.3- 4.1)	- (- - -)	230

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Instructor	Course				Responses		Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]											
50777-01	PHYS	141	001	LEC	216 /	57%	4.4 (4.3 - 4.5)	4.0 (3.8- 4.1)	4.1 (4.0- 4.2)	4.2 (4.1- 4.3)	234
51375-01-01	PHYS	426	001	LEC	15 /	60%	4.9 (4.7 - 5.0)	4.9 (4.7- 5.0)	4.9 (4.7- 5.0)	3.9 (3.7- 4.2)	234
51399-01-01	PHYS	472	001	LEC	25 /	83%	4.9 (4.8 - 5.0)	4.7 (4.5- 4.9)	4.7 (4.5- 4.9)	4.2 (3.9- 4.4)	234
[redacted]											
89891-01	PHYS	141	018	LEC	39 /	86%	3.0 (2.7 - 3.3)	2.5 (2.2- 2.8)	3.0 (2.7- 3.3)	4.5 (4.3- 4.6)	234
[redacted]											
51793-01	PHYS	586	001	LEC	7 /	77%	4.1 (3.6 - 4.7)	4.0 (3.5- 4.5)	3.9 (3.0- 4.7)	3.3 (2.5- 4.0)	234
[redacted]											
50829-01-02	PHYS	181	006	LAB	19 /	86%	4.9 (4.7 - 5.0)	4.7 (4.5- 4.9)	4.5 (4.2- 4.8)	- (-- -)	230
[redacted]											
83933-02-02	PHYS	162H	002	LAB	16 /	100%	4.3 (4.0 - 4.7)	4.1 (3.6- 4.5)	4.2 (3.8- 4.6)	- (-- -)	230
[redacted]											
50987-01-01	PHYS	263H	001	LEC	23 /	57%	3.0 (2.5 - 3.5)	3.0 (2.6- 3.5)	3.2 (2.7- 3.7)	3.0 (2.5- 3.5)	234
[redacted]											
50967-02-02	PHYS	241	003	LAB	12 /	66%	4.8 (4.5 - 5.0)	4.4 (4.0- 4.8)	4.4 (3.9- 4.9)	- (-- -)	230
50969-02-02	PHYS	241	004	LAB	17 /	100%	5.0 (5.0 - 5.0)	4.9 (4.7- 5.0)	4.9 (4.7- 5.0)	- (-- -)	230
[redacted]											
75221-01	PHYS	161H	001	LEC	20 /	80%	4.0 (3.6 - 4.4)	3.7 (3.2- 4.1)	3.9 (3.5- 4.3)	4.5 (4.1- 4.8)	234
[redacted]											
51183-01-04	PHYS	381	003	LAB	6 /	35%	4.3 (3.9 - 4.8)	3.7 (2.6- 4.7)	3.7 (2.8- 4.6)	- (-- -)	230
51185-01-04	PHYS	381	004	LAB	7 /	70%	4.6 (3.9 - 5.0)	4.4 (3.8- 5.0)	4.1 (3.4- 4.9)	- (-- -)	230
51373-01	PHYS	422	001	LEC	11 /	64%	4.4 (3.9 - 4.9)	3.9 (3.3- 4.6)	4.2 (3.5- 4.9)	4.8 (4.6- 5.0)	234
[redacted]											
75239-01	PHYS	560B	001	LEC	6 /	100%	4.2 (3.5 - 4.8)	3.8 (3.2- 4.5)	4.5 (3.8- 5.0)	3.7 (3.2- 4.1)	234
[redacted]											
51179-01-03	PHYS	381	001	LAB	7 /	87%	4.1 (3.4 - 4.9)	4.3 (3.5- 5.0)	4.3 (3.5- 5.0)	- (-- -)	230
51183-01-03	PHYS	381	003	LAB	6 /	35%	4.2 (3.5 - 4.8)	3.8 (2.8- 4.9)	3.8 (2.8- 4.9)	- (-- -)	230
51185-01-03	PHYS	381	004	LAB	6 /	60%	4.7 (4.0 - 5.0)	4.5 (3.8- 5.0)	4.8 (4.5- 5.0)	- (-- -)	230
[redacted]											
51759-01	PHYS	515A	001	LEC	12 /	80%	4.8 (4.6 - 5.0)	4.7 (4.3- 5.0)	4.1 (3.8- 4.4)	3.4 (3.0- 3.8)	234

Instructor	Course			Responses		Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]										
50765-01-01	PHYS 103	001	LEC	206 /	69%	3.7 (3.6 - 3.9)	3.2 (3.0- 3.3)	3.8 (3.6- 3.9)	4.4 (4.3- 4.5)	234
51165-01-01	PHYS 321	001	LEC	28 /	77%	4.6 (4.3 - 4.8)	4.4 (4.0- 4.7)	4.6 (4.3- 4.9)	4.2 (3.9- 4.4)	234
[redacted]										
50783-02-02	PHYS 141	004	LAB	21 /	91%	4.0 (3.6 - 4.5)	3.7 (3.2- 4.1)	3.4 (3.0- 3.8)	- (-- -)	230
50799-02-02	PHYS 141	012	LAB	24 /	100%	4.0 (3.7 - 4.4)	3.7 (3.4- 4.0)	3.5 (3.2- 3.8)	- (-- -)	230
75221-02-02	PHYS 161H	001	LAB	22 /	95%	3.6 (3.3 - 3.9)	3.2 (2.8- 3.5)	3.1 (2.8- 3.4)	- (-- -)	230
[redacted]										
50805-02-02	PHYS 141	015	LAB	19 /	79%	4.3 (3.9 - 4.6)	3.8 (3.4- 4.3)	3.4 (2.8- 3.9)	- (-- -)	230
[redacted]										
50961-01-01	PHYS 204	001	LEC	7 /	43%	3.0 (2.0 - 4.0)	3.3 (2.1- 4.5)	4.7 (4.1- 5.0)	4.6 (3.9- 5.0)	234
84107-01	PHYS 469	001	LEC	10 /	58%	3.2 (2.5 - 3.9)	3.3 (2.5- 4.1)	3.8 (3.3- 4.3)	4.0 (3.7- 4.3)	234
[redacted]										
50963-01	PHYS 241	001	LEC	122 /	64%	4.2 (4.1 - 4.4)	3.8 (3.7- 4.0)	4.1 (4.0- 4.3)	4.4 (4.3- 4.5)	234
[redacted]										
50859-01-01	PHYS 182	008	LAB	17 /	80%	4.8 (4.6 - 5.0)	4.0 (3.6- 4.4)	3.9 (3.6- 4.3)	- (-- -)	230
50865-01-01	PHYS 182	011	LAB	19 /	86%	4.5 (4.2 - 4.8)	3.9 (3.5- 4.3)	3.8 (3.5- 4.1)	- (-- -)	230
50867-01-01	PHYS 182	012	LAB	17 /	80%	4.8 (4.5 - 5.0)	4.5 (4.2- 4.8)	4.3 (4.0- 4.6)	- (-- -)	230
[redacted]										
50809-02-02	PHYS 142	001	LAB	15 /	83%	3.5 (3.0 - 4.1)	3.5 (3.0- 3.9)	3.5 (3.0- 4.1)	- (-- -)	230
50817-02-02	PHYS 162H	001	LAB	17 /	100%	2.4 (1.9 - 2.9)	1.9 (1.5- 2.4)	2.2 (1.7- 2.6)	- (-- -)	230
[redacted]										
50773-01-01	PHYS 132	001	LEC	55 /	60%	3.3 (3.0 - 3.6)	3.1 (2.8- 3.4)	3.6 (3.3- 3.9)	3.8 (3.6- 4.0)	234
[redacted]										
90923-01-03	PHYS 181	014	LAB	16 /	72%	4.3 (3.9 - 4.6)	4.1 (3.6- 4.5)	3.9 (3.5- 4.4)	- (-- -)	230
[redacted]										
50821-01-01	PHYS 181	002	LAB	19 /	79%	4.5 (4.2 - 4.8)	4.3 (3.9- 4.7)	4.0 (3.5- 4.5)	- (-- -)	230
50823-01-01	PHYS 181	003	LAB	22 /	95%	4.4 (4.0 - 4.7)	3.7 (3.2- 4.2)	3.9 (3.4- 4.3)	- (-- -)	230
50841-01-01	PHYS 181	012	LAB	21 /	95%	4.1 (3.7 - 4.6)	3.8 (3.4- 4.2)	3.7 (3.2- 4.2)	- (-- -)	230
[redacted]										
51175-01-01	PHYS 371	001	LEC	13 /	56%	4.3 (3.9 - 4.7)	4.1 (3.6- 4.6)	4.2 (3.6- 4.7)	4.3 (3.9- 4.7)	234

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Instructor	Course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted]									
50777-02-02	PHYS 141	001	LAB	21 / 95%	4.5 (4.2 - 4.9)	4.3 (3.9- 4.6)	3.9 (3.4 - 4.4)	- (- - -)	230
50789-02-02	PHYS 141	007	LAB	22 / 100%	4.6 (4.4 - 4.8)	4.4 (4.2- 4.6)	4.0 (3.8 - 4.3)	- (- - -)	230
SU,SHUFANG									
51779-01	PHYS 570B	001	LEC	11 / 78%	4.0 (3.5 - 4.5)	3.7 (3.2- 4.3)	3.7 (3.2 - 4.2)	3.8 (3.4 - 4.2)	234
[redacted]									
50855-01-01	PHYS 182	006	LAB	20 / 86%	4.1 (3.5 - 4.6)	3.4 (2.9- 3.9)	3.3 (2.7 - 3.9)	- (- - -)	230
50869-01-01	PHYS 182	013	LAB	24 / 100%	4.5 (4.2 - 4.8)	4.0 (3.6- 4.4)	3.8 (3.4 - 4.2)	- (- - -)	230
90925-01-01	PHYS 182	014	LAB	19 / 90%	4.6 (4.4 - 4.9)	4.1 (3.7- 4.5)	3.7 (3.2 - 4.1)	- (- - -)	230
[redacted]									
50847-01-01	PHYS 182	002	LAB	22 / 88%	4.9 (4.7 - 5.0)	4.7 (4.4- 4.9)	4.3 (4.0 - 4.6)	- (- - -)	230
50849-01-01	PHYS 182	003	LAB	24 / 100%	5.0 (4.9 - 5.0)	4.6 (4.3- 4.8)	4.3 (3.9 - 4.7)	- (- - -)	230
50851-01-01	PHYS 182	004	LAB	22 / 95%	5.0 (4.9 - 5.0)	4.8 (4.6- 5.0)	4.5 (4.3 - 4.8)	- (- - -)	230
[redacted]									
50831-01-03	PHYS 181	007	LAB	23 / 95%	3.4 (2.9 - 3.9)	3.1 (2.7- 3.5)	2.8 (2.3 - 3.3)	- (- - -)	230
50839-01-03	PHYS 181	011	LAB	18 / 85%	3.6 (3.1 - 4.1)	3.4 (2.9- 3.9)	3.1 (2.5 - 3.6)	- (- - -)	230
90917-01-03	PHYS 181	013	LAB	17 / 73%	4.2 (3.7 - 4.6)	3.9 (3.4- 4.4)	3.6 (3.2 - 4.1)	- (- - -)	230
[redacted]									
51379-01	PHYS 431	001	LEC	11 / 84%	4.4 (3.9 - 4.8)	4.2 (3.6- 4.8)	4.0 (3.3 - 4.7)	2.4 (2.1 - 2.7)	234
[redacted]									
50759-01-02	PHYS 102	002	LEC	64 / 47%	4.4 (4.2 - 4.6)	3.5 (3.2- 3.8)	3.8 (3.5 - 4.0)	3.9 (3.7 - 4.2)	234
[redacted]									
50857-01-01	PHYS 182	007	LAB	18 / 81%	4.2 (3.7 - 4.8)	3.6 (3.1- 4.1)	3.7 (3.2 - 4.2)	- (- - -)	230
50861-01-01	PHYS 182	009	LAB	23 / 95%	4.2 (3.9 - 4.5)	3.5 (3.1- 3.8)	3.6 (3.3 - 3.9)	- (- - -)	230
50863-01-01	PHYS 182	010	LAB	21 / 87%	3.9 (3.5 - 4.2)	3.8 (3.4- 4.2)	3.6 (3.2 - 4.0)	- (- - -)	230
[redacted]									
50809-01-01	PHYS 142	001	LEC	31 / 34%	3.7 (3.3 - 4.0)	3.4 (3.1- 3.8)	3.5 (3.2 - 3.9)	3.3 (3.0 - 3.6)	234
50817-01	PHYS 162H	001	LEC	26 / 78%	3.1 (2.7 - 3.6)	3.1 (2.7- 3.5)	3.6 (3.3 - 4.0)	3.9 (3.6 - 4.1)	234
[redacted]									
50963-02-02	PHYS 241	001	LAB	14 / 73%	3.7 (3.3 - 4.2)	3.5 (2.7- 4.3)	3.3 (2.7 - 3.8)	- (- - -)	230
50965-02-02	PHYS 241	002	LAB	12 / 85%	3.5 (2.9 - 4.1)	3.5 (2.9- 4.1)	3.4 (2.8 - 4.1)	- (- - -)	230
[redacted]									
50801-02-02	PHYS 141	013	LAB	21 / 91%	4.3 (4.0 - 4.6)	3.8 (3.5- 4.2)	3.7 (3.2 - 4.1)	- (- - -)	230

Instructor	Course			Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[redacted] 51169-01-01	PHYS 331	001	LEC	10 / 45%	3.8 (3.2 - 4.4)	3.2 (2.7 - 3.7)	3.5 (2.9 - 4.1)	4.0 (3.7 - 4.3)	234

D Committees

PHYSICS DEPARTMENT

2010-2011 COMMITTEE ASSIGNMENTS

Executive Committee:	Mazumdar, Barrett, Johns, Stafford
CAPE:	Varnes, Su, to be appointed, to be elected
Promotion and Tenure:	Zhang, Lebed, Shupe, van Kolck
Space:	Shupe, Beck, Eklund, Rafelski, Sarcevic

Grad Committees:

Director of Graduate Studies:	Visscher
Grad Advisors:	Visscher, Fleming, Sandhu, Stafford, Toussaint
Grad Admissions:	Visscher, Fang, Su, LeRoy, Rutherfoord, Cronin
Grad Recruitment:	Visscher,, Cronin, Fang, Johns, Manne, Mazumdar, Rafelski, Su
Curriculum:	Rutherfoord, Fang, Jacquod, Toussaint
Examinations:	Fang, Fleming, Sandhu, Shupe, van Kolck, Wing
PSM:	Watchman, Rutherfoord

Undergraduate Committees:

Director of Undergraduate Studies:	Milsom
Lab courses/Lab equipment/ Lab reform:	Wing, Bickel, Haar, Novodvorsky, Rutherfoord, Jackson
Curriculum:	Milsom, Bickel, Cheu, Cronin, Garcia, Toussaint
Arts and Science Advisors:	Toussaint, Bickel, Garcia, Manne, Milsom, Rutherfoord, Stafford
Science Education Advisor:	Novodvorsky
Undergraduate Recruitment:	Cheu, Jackson, Johns, Mazumdar, Milsom

Other Committees:

Awards and Prizes, Faculty and Staff:	Sarcevic, Arnold, Lebed, Toussaint
Awards and Prizes, Students:	Barrett, Cheu, Cronin, Fleming
Colloquium:	Rafelski, Cronin, Varnes, Zhang
Computing:	Eklund, Jacquod, Toussaint
Library contact:	Jacquod
Public Relations, Outreach, Recruitment:	Manne, Cheu, Garcia, Jackson, Johns, Mazumdar, Novodvorsky, Visscher
Gender Equity and Diversity:	Johns, Mazumdar, Sarcevic, Su
APR:	Johns and to be announced
Study of CAPE procedures/policies:	Melia

E B.S. Requirements

REQUIREMENTS FOR THE BS IN PHYSICS

General education requirements

Foreign language to second semester level

English Composition [placement by English Department]

General Education study areas other than science (science & math are automatically satisfied)

[*See the College of Science advising staff (Gould-Simpson 1017) for details*]

Tier 1: four courses (2 TRAD & 2 INDV)

Tier 2: four courses (ART, HUM, INDV, DIVERSITY) The Diversity requirement can be a course which also satisfies one of the other three (so usually only three are needed).

Physics requirements

Our introductory sequence:

Physics 161H, 162H, 261H, 263H *(141, 142, 241 and 263H can be taken if necessary)*

PHYS 105A	(Introduction to Scientific Computing)
PHYS 204	(Mathematical Techniques in Physics)
PHYS 305	(Computational physics)
PHYS 321	(Classical Mechanics I)
PHYS 331	(Electricity and magnetism I)
PHYS 332	(Electricity and magnetism II)
PHYS 371	(Quantum Theory I)
PHYS 381, 382	(Methods in Experimental Physics I and II)
PHYS 426	(Thermal and Statistical Physics)
PHYS 472	(Quantum Theory II)

Six units chosen from:

Physics 320 (optics), 405 (digital electronics), 422 (classical mechanics II), 431 (biophysics), 436A (atmospheric science), 450 (nuclear physics), 460 (solid state physics), 469 (general relativity), 473 (spectroscopy), 476 (mathematical methods), and 483 (advanced lab III)

Research requirement:

Three units chosen from Physics 483 (advanced lab project), 492 (directed research), 498 (senior capstone)

Math prerequisites for required physics courses

MATH 124 or 125	(Calculus I)
MATH 129	(Calculus II)
MATH 223	(Vector calculus)
MATH 254	(Differential equations)

Chemistry 151 and 152 are strongly recommended.

NOTES

Physics 381 and 382 are writing emphasis courses.

F B.A. Requirements

REQUIREMENTS FOR THE BA IN PHYSICS

General education requirements

Foreign language to second semester level

English Composition [placement by English Department]

General Education study areas other than science (science & math automatically satisfied)

[*See the College of Science advising staff (Gould-Simpson 1017) for details*]

Tier 1: four courses (2 TRAD & 2 INDV)

Tier 2: four courses (ART, HUM, INDV, DIVERSITY) The Diversity requirement can be a course which will satisfy one of the other three; so usually only three are needed.

Physics requirements

One of the introductory sequences:

I. Physics 161H, 162H, 261H, 263H

II. Physics 141, 142, 241, 263H

Although not recommended, the sequence:

III. 102, 103, 181, 182, 263H will be accepted under special circumstances.

PHYS 305	(Computational physics)
PHYS 321	(Mechanics I)
PHYS 331	(Electricity and magnetism I)
PHYS 371	(Quantum Theory I)
PHYS 381, 382	(Advanced Lab I and II)

Six units of additional upper-division physics courses

A minor is required for the BA degree

Math prerequisites for required physics courses

MATH 124 or 125	(Calculus I)
MATH 129	(Calculus II)
MATH 223	(Vector calculus)
MATH 254	(Differential equations)

Chemistry 151 and 152 and Phys 204 are strongly recommended.

NOTES

Physics 381 and 382 are writing-emphasis courses.

G Ph.D. Requirements

Departmental Requirements for the Ph.D. Degree

Examinations

A. Comprehensive Examination

1. Written Exam: Given at the beginning of each Fall semester (three afternoons, three hours each). May also be offered early in the Spring Semester provided there are at least five students taking the exam. This exam covers classical mechanics, quantum mechanics, electromagnetism, and statistical mechanics at the graduate level. It must be passed at the Ph.D. level in a maximum of two attempts occuring during consecutive administrations of the exam, and must be attempted no later than the fourth semester in residence, barring serious deficiencies. Copies of old exams are available for review purposes.
2. Oral Exam: Should generally be taken within six months of successful passage of the written exam. The oral part of the comprehensive exam will ask students to defend their proposed PhD research in a well prepared presentation (~45 minutes), which then is to be followed (and/or interspersed) with general physics questions geared towards the research topic. This format is obligatory for students entering Fall 2010 or later. Student who have entered the program before Fall 2010 may choose either this or the previous format--but have to inform the DGS and committee of their choice in a timely manner. We advise students to meet with each of the committee members to discuss/introduce their research well ahead of the exam. Furthermore, students will supply committee members with a short 1 page description of the research project (well ahead of the exam). The makeup of the **Oral Exam Committee** shall conform to all regulations of the Graduate College, and consist of a minimum of five members of the faculty in the Physics Department. The duration of the Oral Exam shall not be less than one hour or exceed three hours. Students shall be allowed a maximum of two attempts at passing the Oral portion of the Comprehensive Exam, and shall not change the composition of the Oral Exam Committee between attempts except with the permission of the Director of Graduate Studies. **Pre-Fall 2010 format:** The Oral Exam tests the "core knowledge of the field" including the topical areas of the Written Exam. At the joint discretion of the student and the Oral Exam Committee, the Oral Exam may also include a short student presentation and questions emphasizing the student's future research specialty, with the aim of assessing the student's ability and preparation to undertake research in the student's chosen field.

B. Dissertation Defense

Ph.D. students are required to defend their dissertation in an oral examination before their degree can be granted. This examination is distinct from the Comprehensive Exam and occurs at the end of the dissertation work, by mutual agreement between the student and the dissertation director. The examining committee is the committee that has supervised the dissertation work, and may be a continuation of the Comprehensive Oral Exam Committee.

Other Requirements

1. Colloquium

In the first year, graduate students are required to attend all Physics Department Colloquia (usually held Friday afternoons) as an introduction to the excitement and breadth of current research in physics.

2. Dissertation Reports

In semesters when students are taking Dissertation credits (PHYS 920), they must report their progress to all members of their dissertation committee. Normally this is a short written summary each semester. Students may instead choose, with the consent of their dissertation director, to give a seminar, once per year, in place of the written report. This option is encouraged as an important aspect of professional development; communication of results is an essential aspect of physics research.

3. Satisfactory Progress

Starting no later than the fourth semester, each graduate student must have a substantive affiliation with a Ph.D. advisor or research group and be making demonstrable progress towards the completion of the Ph.D. degree. Each semester, this progress shall be evaluated by the Ph.D. advisor, and if necessary the student may consult with the Director of Graduate Studies or the Graduate Advisors if special circumstances exist. While students always remain free to change Ph.D. advisors or alter the direction of their research program, there must be constant, forward progress towards the Ph.D. degree. Maintaining active status in the Ph.D. program shall be contingent on continuing satisfactory progress.

Note that according to Graduate College regulations, students who do not complete all requirements for the Ph.D. within five years of passing the Comprehensive Exam will be required to retake the Comprehensive Exam, with the permission of the Physics Department. In such situations, students are strongly encouraged to consult the Director of Graduate Studies or the Graduate Advisors to see if waivers can be granted.

4. EOAA meeting

As one step towards the Department's goal of maintaining a healthy and supportive working environment for all Department members, including women and minorities, the Department will schedule periodic meetings between graduate students and a representative of the University's
Equal Opportunity and Affirmative Action (EOAA) Office. These information sessions are designed to explain University policies and procedures, and to educate students

concerning their rights and obligations under these policies. In order to ensure that all graduate students receive this training, all graduate students are required to attend at least one of these scheduled meetings during their residence, preferably soon after their entrance into the graduate program.

Course Work

Credit Hour Minimum Requirements:

36 in Physics (or cross-listed) graduate-level courses
12 in the Minor field (which also may be Physics)
18 Dissertation credits (Physics 920)

Core Courses:

(Not required, but this material is tested in the Comprehensive Examination and highly recommended for all students regardless of research direction)

511 Analytical Mechanics
515a,b Electromagnetic Theory
528 Statistical Mechanics
570a,b & 580 Quantum Mechanics

It is our intent to help students succeed in the Physics Department. The material studied in the above courses represents what we expect every student to master. Depending upon student preparation and the results of the diagnostic Qualifying Examination, we may recommend to individual students that they take other courses whose material is essential as prerequisite to these core courses.

Prior to passing the written portion of the Comprehensive Examination, students are required to take 9 credits per semester. After that, only 6 credits are required.

We strongly recommend the following course schedule for entering graduate students:

Year 1: Fall: 570a, 511, 599
Spring: 570b (+580), 515a, other
Year 2: Fall: 528, 515b, 599

Phys 599 is Independent Study, intended to involve research with a group or individual faculty. For certain students, Phys 528 may be substituted for Phys 599 in the first semester upon consultation with the Director of Graduate Studies or the Graduate Advisors.

No more than half of the 36 required credit hours of graduate-level physics courses may be taken as Phys 599 or Phys 920. Remaining courses should consist of the core courses listed above as well as more advanced specialty courses. Students may register for Phys 920 only after they have passed both portions of the Comprehensive Examination.

If Physics is chosen as the Minor as well as the Major, the Minor requirement is fulfilled by 12 additional credits consisting of at least four graduate-level courses. Together, these four courses should provide at least three credits from each of four of the following eight areas. Courses below are listed merely as examples, and additional courses (including courses from outside the Physics Department) may be considered as part of these areas with the approval of the Director of Graduate Studies.

1. classical mechanics and mathematical physics: 513, 541, 575, 576
2. atomic molecular and optical physics: 535, 544(Op.Sci.), 642(Op.Sci.), 648(Op.Sci.)
3. condensed matter physics: 505, 560a, 560b, 561, 562, 563, 564, 566
4. quantum and particle physics: 579a, 579b, 579c, 581, 584a, 584b
5. nuclear physics: 551, 552
6. gravity, astrophysics and cosmology: 571, 577, 582, 587, 589, 596b, 596f
7. experimental physics: 505, 545, 573, 574, 586, 685
8. biophysics: 530, 596a, 603

Because these are the only actual course requirements for the Ph.D. degree, it is expected that this Minor requirement be satisfied through actual courses rather than Independent Studies. However, exceptions can be granted in appropriate situations.

Students choosing a Minor in a different Department must satisfy whatever additional Minor requirement(s) that other Department demands, in addition to the 12 credits of appropriate coursework. This may include taking the Comprehensive Exam in that Department, if applicable.

A student who does not pass the Comprehensive Exam at the Ph.D. level but who completes all other requirements for a Masters Degree (MS) may obtain a Masters Degree if and only if the score on the Comprehensive Exam exceeds the Masters cutoff determined for that exam. This cutoff shall not exceed the passing line for the Ph.D. program. Change in degree goal (e.g., from Ph.D. to M.S.) shall not entitle a student to additional attempts at the Written Comprehensive Exam; thus the scores from the same two attempts shall be used for determining eligibility for either the M.S. or Ph.D. degree. A student who passes either attempt at the M.S. level shall be judged to have satisfied the Written Comprehensive requirement for the M.S. degree regardless of the score on the other attempt.

H Professional Science Masters in Medical Physics Requirements

Academic Plan for Professional Science Masters
Medical Physics

First Fall Semester

Medical Physics	PHYS 540	3 units
Project Management	MIS 578	3 units
Radiation Dosimetry	RONC 601A	3 units
Medical Physics Seminar	RONC 596C	1 units

Total: 10 units

*Choose 3 from 545 A-F

First Spring Semester

Techniques in Particle Physics	PHYS 586	3 units
Experimental Physics	PHYS 544/545	0-6 units
Therapeutic Radiological Physics	RONC 601B	3 units

Total: 6-12 units

Summer(s)

Internship in Medical Physics 1 3 units

Second Fall Semester

Biomedical Imaging	BME 516	3 units
Health Physics	RONC 502	3 units
Physics Elective/Internship 2	PHYS	3 units

Total: 9 units

Second Spring Semester

Advanced Medical Optics	OPTI 638	3 units
Radiation Biology	RONC 601D	3 units
Physics Electives	PHYS	0-3 units

Total: 6-9 units

Total units 36+ units

I Minority Bridge Plan

PROPOSED PLAN FOR THE ESTABLISHMENT OF A MINORITY BRIDGE PROGRAM (MBP) BETWEEN THE DEPARTMENT OF PHYSICS, UNIVERSITY OF ARIZONA (UA) AND MINORITY SERVING INSTITUTIONS (MSIs).

The UA Physics Department strongly endorses the American Physical Society (APS) proposal to establish bridge programs between Doctorate Granting Institutions (DGIs) and MSIs, whose goal is to significantly enhance the number of Ph.D.s granted to underrepresented minorities (URMs). The Graduate Program at the UA Physics Department currently has a low enrollment of minorities and women. We recognize that this situation will not be ameliorated without dedicated and persistent effort.

The MBP gives us the opportunity to address this issue proactively. We will utilize the existing strengths and programs at the UA to jumpstart our own program. While the UA Physics Department has not actively tried to establish collaborations with MSIs in the past, the UA as a whole has had significant success in attracting URMs – 17% of all enrolled graduate students at the UA come from URM backgrounds, making it the top Research I University in terms of URM enrollment. Additionally, the UA ranks among the top five Universities nationally in the number of Hispanic and Native Americans who obtain Ph.D.s.

Our initial plan is to collaborate with the APS at the ``Partnership Level'' (see APS Draft document ``Structural Elements for Doctoral Granting Institutions''). We aim to establish collaborations with the Departments of Physics and Astronomy at **Northern Arizona University, New Mexico State University at Las Cruces, and University of Texas at El Paso.** Other MSIs that we could work with include **Arizona Western College, College of the Southwest, and Western New Mexico University.** Within the UA we anticipate collaborations with the **College of Science** and the **Graduate College**. We will also tap into the expertise of local and regional organizations such as **VIGRE** (an NSF program led at the UA by the Department of Mathematics) and **SACNAS** (a national organization of scientists dedicated to fostering the success of Hispanic/Chicano and Native American scientists). Details of our plan follow.

1. Site Director. We have identified Professor Srinivas Manne of the Physics Department as our Site Director. The responsibilities of the Site Director will include recruiting, creating individual academic plans, building a supportive atmosphere for the incoming students, and overall mentoring. Our choice of Professor Manne as the Site Director is based on his exemplary track records as a classroom teacher (Manne is a recipient of the Distinguished Teaching Award of the UA College of Science) as well as a research supervisor of female Masters and Ph.D. students. The Site Director will make use of existing resources on the UA campus such as the local SACNAS chapter to assist with creating a welcoming atmosphere for the incoming students.

2. Recruiting and Community Building Visits. The Department Head Sumit Mazumdar is in the process of contacting the leadership of all of the above Institutions. Faculty members from the UA Physics Department that would be responsible for recruitment include Mazumdar, Manne, Associate Department Head Ken Johns, and the Director of Graduate Studies (DGS) Koen Visscher. In early Fall of each year two faculty members from this list will visit each of the

above MSIs to learn about student and faculty needs at the MSIs and to establish formal links. We expect the MSI faculty to help in identifying seniors particularly likely to succeed in a rigorous Physics Ph.D. program, and in encouraging them to apply for admission into the MS programs at MSIs as MBP students. In addition, we will encourage motivated juniors to apply to the **Summer Research Institute** sponsored by the UA Graduate College (see below).

3. Research Links. We recognize that common research interests between DGIs and MSIs provide a number of opportunities to support the MBP. Scholarly exchange in the form colloquia and seminars will serve to highlight DGI research programs to MSI students as well as give MSI faculty opportunity to broaden their research contacts. In some cases one can envision that the research component undertaken by MSI MS students could be carried out in association with a DGI research program.

4. Admissions. The existing MS programs at MSI serve as the bridge into our Ph.D. program. The MS program entails both independent research and advanced coursework, often some of the same core courses taken by DGI graduate students. Our initial goal is to admit two to three students from the MSIs into the Ph.D. program each year. We expect to take advantage of **Graduate Diversity Fellowships** ($10,000) awarded to incoming domestic students by the UA Graduate College. These will be supplemented with other intraunit support such as teaching assistantships. The DGS will be responsible for formulating an appropriate admission process which will recognize that even highly promising MSI students may not have had sufficient exposure to advanced training in STEM areas. Diagnostic examinations may be used to determine remedial courses that may or may not be necessary for individual students. The Department expects to benefit from the advice from the faculty at the MSIs, the UA Graduate College, and the APS Committee on Minorities (COM).

5. The Summer Research Institute (SRI) and REU Summer Bridge Program . Promising MSI students for the MBP program will be identified early in their careers. Juniors at the MSIs will be encouraged to apply for participation in the UA's Summer Research Institute, which offers an outstanding opportunity on how to conduct research and prepare for graduate studies at the UA.
   Detailed information about this program can be found in **http://grad.arizona.edu/sri/.**
   Their mission statement notes that over 90% of participants have gone on to graduate, medical, law, and other post-baccalaureate programs, both at the UA as well as at other prestigious Universities. The MBP Site Director Manne will be heavily involved in mentoring the participants and identifying fruitful research projects for them within the Physics Department.

   Note the cost of participating in the Summer Research Institute is about $4000 per student, which includes transportation and local expense. The UA College of Science will commit funds towards the support of three students, provided matching funds for the support of two additional students are borne by the APS.

In addition to the SRI, the UA Physics Department currently hosts an REU Summer Bridge program aimed at providing a smooth transition for local community college physics students transferring to the UA. We envision recruiting MSI students into this program as well (since it is not strictly limited to local community college students). Finally, we plan to integrate the educational and outreach components of new grants in the UA Physics Department with the MBP program as much as possible.

6. Annual workshops and reporting. The MBP students, the Department Head, Associate Head, the DGS and the Site Director will attend the Annual APS-hosted workshops on student counseling and career guidance. Collaborations with other DGIs and MSIs will be established at these workshops. Annual reports that evaluate the program as a whole as well as document the progress of individual MBP students will be submitted to the APS at the end of the academic year. Future directions and goals will also be included in the yearly report.

J Unit Profile Data

PHYSICS, ENROLLED MAJORS, 2003 - 2009

MAJORS BY DEGREE LEVEL	TERM*						
	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Applied & Industrial Physics (AIP)							
Masters, PSM	0	2	5	2	4	5	6
Engineering Physics (EPH)							
Baccalaureate, BSEPH**	38	36	52	36	44	35	17
Physics (PHYS)							
Baccalaureate, BA	7	4	9	7	4	5	3
Baccalaureate, BS	155	164	154	141	149	150	194
Masters, MS	10	8	7	6	6	1	0
Doctorate, PHD	69	76	75	69	65	69	73
Total PHYS	243	253	248	223	228	230	270
Total Baccalaureate	200	204	215	184	197	190	214
Total Graduate	79	86	87	77	75	75	79
Total Majors	281	291	305	261	276	270	293

*Enrollment at Fall Census Date.
**The BS in Engineering Physics Program was disestablished, effective in June 2009.

PHYSICS, MAJORS BY CLASSIFICATION, 2003 - 2009

UNDERGRADUATES BY CLASSIFICATION	TERM*						
	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Engineering Physics (EPH) **							
First Time Freshmen	11	8	17	6	16	4	N/A
Other First Year	0	1	2	0	1	0	N/A
Second Year	6	7	12	15	6	10	1
Third Year	8	7	9	7	11	6	6
Fourth Year and Beyond	13	13	12	8	10	15	10
Total EPH	38	36	52	36	44	35	17
Physics (PHYS)							
First Time Freshmen	25	27	36	33	39	32	55
Other First Year	4	5	4	3	3	3	9
Second Year	28	28	17	22	31	31	24
Third Year	38	39	43	26	26	35	49
Fourth Year and Beyond	69	70	66	64	58	59	66
Total PHYS	164	169	166	148	157	160	203

*Count at Fall Census Date
**The BS in Engineering Physics Program was disestablished, effective in June 2009.

PHYSICS, STUDENT FULL TIME EQUIVALENT (FTE) ENROLLMENT, 2003 - 2009

Fall FTE Enrollment by Course Level	TERM*						
	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Undergraduate	471.54	476.59	421.17	428.18	426.76	420.79	438.90
Graduate	52.53	48.70	50.30	57.25	54.20	59.22	38.79
Total FTE Enrollment	524.07	525.29	471.47	485.43	480.96	480.01	477.69

*Count at Fall Census Date

PHYSICS, COMPLETED MAJORS*, 2003 - 2009

MAJORS COMPLETED, BY DEGREE LEVEL	FISCAL YEAR (Aug/Dec/May)							
	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10	Grand Total
Applied & Industrial Physics (AIP)								
Masters, PSM	1	0	2	1	2	5	1	12
Engineering Physics (EPH)								
Baccalaureate, BSEPH**	4	4	4	4	2	5	6	29
Physics (PHYS)								
Baccalaureate, BA	2	1	5	3	1	1	1	14
Baccalaureate, BS	29	39	21	32	19	25	17	187
Masters, MS	5	11	16	7	8	5	7	59
Doctorate, PHD	3	6	4	10	6	10	7	46
Total PHYS	39	57	46	52	34	41	32	269
Total Baccalaureate	35	44	30	39	22	31	24	230
Total Graduate	9	17	22	18	16	20	15	117
Grand Total	**44**	**61**	**52**	**57**	**38**	**51**	**39**	**347**

*Majors completed is not equivalent to degrees awarded.
**The BS in Engineering Physics Program was disestablished, effective in June 2009.

PHYSICS, COMPLETED MAJORS*/ INSTRUCTIONAL FACULTY, 2003 - 2009
(Includes AIP, EPH, and PHYS Majors)

Faculty FTE - State Funds - Fall	FISCAL YEAR (Aug/Dec/May)						
	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10
Instructional Faculty + Dept Head FTE	28.00	29.20	31.54	28.27	29.00	28.60	26.14
Undergraduate Completed Majors	35	44	30	39	22	31	24
Completed UG Majors per Faculty FTE	1.25	1.51	0.95	1.38	0.76	1.08	0.92
Graduate Completed Majors	9	17	22	18	16	20	15
Completed Grad Majors per Faculty FTE	0.32	0.58	0.70	0.64	0.55	0.70	0.57

*Completed majors is not equivalent to degrees awarded.

PHYSICS, ENROLLED MINORS, 2003 - 2009

MINORS BY DEGREE LEVEL	TERM*						
	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Engineering Physics (EPH)							
Baccalaureate**	0	0	0	1	1	0	N/A
Physics Teaching Minor (PHED)							
Baccalaureate**	2	0	0	0	0	0	N/A
Physics (PHYS)							
Baccalaureate	27	18	29	36	30	17	25
Doctorate	17	19	16	19	17	15	13
Total PHYS	44	37	45	55	47	32	38
Total Minors	46	37	45	56	48	32	38

*Count at Fall Census Date
**The Engineering Physics Minor and the Physics Teaching Minor were disestablished, effective in June 2009.

PHYSICS, INCOMING FRESHMAN SAT/ACT SCORES, 2003 - 2009

Note: Numbers are for first-time, full-time freshmen, some of whom take both exams; thus, the count exceeds the actual number of enrolled students.

	ENGINEERING PHYSICS**			PHYSICS			COLLEGE OF SCIENCE			UNIVERSITY OF ARIZONA		
	FRESHMAN	AVERAGE COMPOSITE SCORES		FRESHMAN	AVERAGE COMPOSITE SCORES		FRESHMAN	AVERAGE COMPOSITE SCORES		FRESHMAN	AVERAGE COMPOSITE SCORES	
TERM	COUNT	ACT	SAT	COUNT	ACT	SAT	COUNT	ACT	SAT	COUNT	ACT	SAT
Fall 09	N/A	N/A	N/A	102	27.4	1,273	1,405	24.7	1,150	8,233	23.7	1,103
Fall 08	5	30.0	1,497	73	28.0	1,293	1,203	24.5	1,135	8,017	23.6	1,096
Fall 07	17	28.7	1,290	85	27.6	1,296	1,198	25.0	1,175	7,959	23.5	1,102
Fall 06	8	27.0	1,337	81	28.4	1,266	1,106	25.7	1,192	7,233	23.4	1,106
Fall 05	19	27.7	1,324	85	28.3	1,304	1,315	25.3	1,198	7,415	23.5	1,121
Fall 04	10	28.4	1,248	82	28.8	1,338	1,193	25.3	1,184	7,269	23.7	1,118
Fall 03	13	25.8	1,274	85	28.5	1,247	1,158	24.9	1,157	7,625	23.6	1,115

**The BS in Engineering Physics Program was disestablished, effective in June 2009.

PHYSICS, MAJORS IN THE HONORS PROGRAM, 2003 - 2009

	ENGINEERING PHYSICS**				PHYSICS				COLLEGE OF SCIENCE				UNIVERSITY OF ARIZONA			
TERM*	TOTAL UNDER-GRADUATES	NON-HONORS STUDENTS	ACTIVE HONORS STUDENTS	% HONORS	TOTAL UNDER-GRADUATES	NON-HONORS STUDENTS	ACTIVE HONORS STUDENTS	% HONORS	TOTAL UNDER-GRADUATES	NON-HONORS STUDENTS	ACTIVE HONORS STUDENTS	% HONORS	TOTAL UNDER-GRADUATES	NON-HONORS STUDENTS	ACTIVE HONORS STUDENTS	% HONORS
Fall 09	17	13	4	23.5%	200	138	62	31.0%	5,340	4,366	974	18.2%	30,346	26,401	3,945	13.0%
Fall 08	35	20	15	42.9%	160	106	54	33.8%	3,064	2,327	737	24.1%	29,714	26,034	3,690	12.4%
Fall 07	44	24	20	45.5%	155	102	53	34.2%	3,009	2,263	746	24.8%	29,035	24,941	4,094	14.1%
Fall 06	36	25	11	30.6%	148	97	51	34.5%	2,950	2,213	737	25.0%	28,442	24,569	3,873	13.6%
Fall 05	52	35	17	32.7%	163	101	62	38.0%	3,018	2,278	740	24.5%	28,462	24,443	4,019	14.1%
Fall 04	36	26	10	27.8%	169	107	62	36.7%	2,887	2,151	736	25.5%	28,368	24,140	4,228	14.9%
Fall 03	38	29	9	23.7%	162	111	51	31.5%	2,809	2,114	695	24.7%	28,482	24,386	4,096	14.4%

*Count at Fall Census Date

**The BS in Engineering Physics Program was disestablished, effective in June 2009.

PHYSICS, MAJORS BY RESIDENCY, 2003 - 2009

(Includes AIP, EPH, and PHYS majors)

		TERM*						
RESIDENCY	**Degree Level**	**Fall 03**	**Fall 04**	**Fall 05**	**Fall 06**	**Fall 07**	**Fall 08**	**Fall 09**
In-State	Baccalaureate	137	140	152	130	134	136	151
	Masters	5	6	8	4	4	4	4
	Doctorate	14	15	14	8	5	7	6
	Total	156	161	174	142	143	147	161
Out-of-State	Baccalaureate	65	65	66	54	67	59	69
	Masters	5	4	4	4	6	2	2
	Doctorate	55	61	61	61	60	62	67
	Total	125	130	131	119	133	123	138
Department Totals								
Undergraduate Enrolled		202	205	218	184	201	195	220
Undergradute In-State		137	140	152	130	134	136	151
Percent Undergraduate In-State		67.8%	68.3%	69.7%	70.7%	66.7%	69.7%	68.6%
Graduate Enrolled		79	86	87	77	75	75	79
Graduate In-State		19	21	22	12	9	11	10
Percent Graduate In-State		24.1%	24.4%	25.3%	15.6%	12.0%	14.7%	12.7%

*Count as of Fall Census Date

PHYSICS, BACCALAUREATE GRADUATION GPA, 2003 - 2009
GPA = Grade Point Average

FISCAL YEAR: AUG, DEC, MAY	ENGINEERING PHYSICS*		PHYSICS		COLLEGE OF SCIENCE		UNIVERSITY OF ARIZONA	
	UNDERGRAD MAJORS COMPLETED**	AVERAGE GRADUATION GPA	UNDERGRAD MAJORS COMPLETED	AVERAGE GRADUATION GPA	UNDERGRAD MAJORS COMPLETED	AVERAGE GRADUATION GPA	UNDERGRAD MAJORS COMPLETED	AVERAGE GRADUATION GPA
FY 09-10***	1	3.513	4	2.762	377	3.041	2,544	3.074
FY 08-09	5	3.130	26	3.292	541	3.292	5,914	3.183
FY 07-08	2	3.218	20	3.231	541	3.293	2,412	3.084
FY 06-07	4	2.672	35	3.188	537	3.245	5,569	3.199
FY 05-06	4	3.210	26	3.438	537	3.311	5,613	3.177
FY 04-05	4	3.404	40	3.208	558	3.250	5,749	3.182
FY 03-04	4	3.265	31	3.352	500	3.282	5,302	3.171

*The BS in Engineering Physics Program was disestablished, effective in June 2009.
**Completed majors are not equivalent to degrees awarded.
***Only Aug and Dec 2009 graduates are recorded; data for May 2010 graduates are unavailable.

PHYSICS, BACCALAUREATE - TIME TO GRADUATION, 2003 - 2009
(Average number of years for first-year, full-time freshmen to complete their degree)

FISCAL YEAR	ENGINEERING PHYSICS**		PHYSICS*		COLLEGE OF SCIENCE		UNIVERSITY OF ARIZONA	
	NUMBER OF GRADUATES	AVERAGE YEARS TO DEGREE	NUMBER OF GRADUATES	AVERAGE YEARS TO DEGREE	NUMBER OF GRADUATES	AVERAGE YEARS TO DEGREE	NUMBER OF GRADUATES	AVERAGE YEARS TO DEGREE
FY09-10***	N/A	N/A	1	4.500	115	4.700	829	4.604
FY08-09	2	4.500	13	4.269	296	4.323	3,009	4.378
FY07-08	1	4.000	8	4.500	279	4.504	2,771	4.490
FY06-07	1	6.500	12	4.583	280	4.656	3,319	4.593
FY05-06	1	5.250	11	5.023	261	4.772	3,069	4.674
FY04-05	1	4.000	11	6.136	252	4.863	3,179	4.716
FY03-04	3	4.833	12	4.646	241	4.649	2,954	4.759

*Only students who graduated with EPH or PHYS majors are counted; their initial major may have been outside the department/college.
**The BS in Engineering Physics Program was disestablished, effective in June 2009.
***Only Aug and Dec 2009 graduates are recorded; data for May 2010 graduates are unavailable.

PHYSICS, MAJORS/ COMPLETED MAJOR*, 2003 - 2009
(Includes AIP, EPH, and PHYS Majors)

MAJORS BY DEGREE LEVEL	FISCAL YEAR (Aug/Dec/May)						
	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10
Undergraduate Enrolled Majors - Fall Census Date	202	205	218	184	201	195	214
Undergraduate Completed Majors - Fiscal Year	35	44	30	39	22	31	24
Enrolled UG Majors per Completed Major	5.77	4.66	7.27	4.72	9.14	6.29	8.92
Graduate Enrolled Majors - Fall Census Date	79	86	87	77	75	75	79
Graduate Completed Majors Fiscal Year	9	17	22	18	16	20	15
Enrolled Graduate Majors per Completed Major	8.78	5.06	3.95	4.28	4.69	3.75	5.27

*Completed majors is not equivalent to degrees awarded.

PHYSICS, MAJORS BY GENDER, 2003 - 2009

DEGREE LEVEL	GENDER	TERM* Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Applied & Industrial Physics (AIP)								
Masters	Female	0	0	1	0	0	1	1
	Male	0	2	4	2	6	4	5
Engineering Physics (EPH)								
Baccalaureate	Female	3	6	10	6	9	8	4
	Male	35	30	42	30	35	27	13
Physics (PHYS)								
Baccalaureate	Female	53	48	49	32	33	29	45
	Male	111	121	117	116	124	130	157
Masters	Female	4	2	1	0	1	0	0
	Male	6	6	6	6	5	1	0
Doctorate	Female	13	14	15	14	13	12	10
	Male	56	62	60	55	52	57	63
Baccalaureate	**Total Enrolled**	202	205	218	184	201	194	219
	Total Female	56	54	59	38	42	37	49
Baccalaureate	**Percent Female**	27.7%	26.3%	27.1%	20.7%	20.9%	19.1%	22.4%
Graduate	**Total Enrolled**	79	86	87	77	77	75	79
	Total Female	17	16	17	14	14	13	11
Graduate	**Percent Female**	21.5%	18.6%	19.5%	18.2%	18.2%	17.3%	13.9%

*Count at the Fall Census Date.

PHYSICS, ENROLLED MAJORS BY ETHNICITY, 2003 - 2009
(Includes AIP, EPH, and PHYS Majors)

DEGREE LEVEL	ETHNICITY	ENROLLED MAJORS BY TERM* Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Baccalaureate	African American	3	3	3	0	2	1	6
	Asian American	9	6	6	8	12	11	12
	Hispanic	13	21	23	16	23	19	23
	Native American	3	3	2	1	3	8	9
	Non-resident/International	15	10	8	6	4	9	8
	Unknown / Other	14	16	19	15	18	13	8
	White	145	146	157	138	139	134	154
Baccalaureate Total		202	205	218	184	201	195	220
Underrepresented Minorities (African American, Asian American, Hispanic, Native American)		28	33	34	25	40	39	50
Percent Underrepresented Minorities		13.9%	16.1%	15.6%	13.6%	19.9%	20.0%	22.7%
Masters	African American	0	0	0	0	0	0	0
	Asian American	0	0	0	0	0	0	0
	Hispanic	0	0	1	2	0	0	0
	Native American	0	0	0	0	0	0	0
	Non-resident/International	2	1	0	0	1	0	2
	Unknown / Other	0	0	0	1	2	1	0
	White	8	9	11	5	7	5	4
Masters Total		10	10	12	8	10	6	6
Doctorate	African American	0	0	0	0	0	0	0
	Asian American	3	3	3	2	1	1	1
	Hispanic	2	2	3	0	1	1	1
	Native American	0	0	0	0	0	0	0
	Non-resident/International	25	35	37	37	37	32	35
	Unknown / Other	4	4	3	1	3	7	8
	White	35	32	29	29	23	28	28
DoctorateTotal		69	76	75	69	65	69	73
Graduate Total		79	86	87	77	75	75	79
Underrepresented Minorities (African American, Asian American, Hispanic, Native American)		5	5	7	4	2	2	2
Percent Underrepresented Minorities		6.3%	5.8%	8.0%	5.2%	2.7%	2.7%	2.5%

*Count at the Fall Census Date.

PHYSICS, PERSONNEL FTE, 2003 - 2009
(and Graduate Assistants)

PERSONNEL Full Time Equivalent (FTE)	TERM*						
	Fall 03	Fall 04	Fall 05	Fall 06	Fall 07	Fall 08	Fall 09
Personnel - All funds							
Dept Heads and Directors (academic)	1.00	1.00	1.00	1.00	0.00	0.00	1.00
Instructional Faculty	27.00	28.30	30.60	27.71	29.11	30.08	25.93
Other Faculty	0.50	2.59	3.13	5.61	4.92	4.47	3.76
Professional	15.56	14.60	21.21	19.45	20.37	22.50	21.60
Staff	31.09	29.85	28.49	24.49	21.50	19.39	21.10
Graduate Assistants - Teaching	16.75	18.50	18.51	17.00	18.75	18.14	20.07
Graduate Assistants - Research	8.99	8.75	10.74	10.00	5.25	10.00	9.74
Personnel - State funds							
Dept Heads and Directors (academic)	1.00	1.00	1.00	1.00	0.00	0.00	1.00
Instructional Faculty	27.00	28.20	30.54	27.27	29.00	28.60	25.14
Other Faculty	0.00	2.42	1.48	3.86	3.23	2.80	1.31
Professional	1.84	2.00	3.84	3.79	3.12	3.49	3.00
Staff	15.59	15.57	16.72	15.55	14.15	12.05	9.88
Graduate Assistants -Teaching	16.50	18.00	16.26	15.17	17.50	16.64	18.32
Graduate Assistants - Research	0.75	0.75	1.50	1.00	1.98	1.50	2.25
Total Instructional Faculty**	28.00	29.20	31.54	28.27	29.00	28.60	26.14
Faculty FTE** per Staff - State funds	1.80	1.88	1.89	1.82	2.05	2.37	2.65
Total Staff & Professional FTE - State funds	17.43	17.57	20.56	19.34	17.27	15.54	12.88
Faculty FTE** per Staff/Professional - State funds	1.61	1.66	1.53	1.46	1.68	1.84	2.03

*Count as of Fall Census Date
**Instructional Faculty includes Department Head and Instructional Faculty only (tenured, tenure-track, and permanently funded lecturers) on State funds.

PHYSICS, STUDENT CREDIT HOURS/ INSTRUCTIONAL FACULTY, 2003 - 2009

Student Credit Hours (SCH) - Fall + Spring Census Date	FISCAL YEAR (Fall + Spring)						
	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10
Undergraduate SCH	13,501.14	12,986.44	11,861.42	11,938.99	12,683.86	12,802.31	13,633.80
Graduate SCH	1,059.89	984.04	1,062.19	1,030.50	1,086.02	1,066.06	870.90
Total SCH	14,561.03	13,970.48	12,923.61	12,969.49	13,769.88	13,868.37	14,504.70
Instructional Faculty + Head (Fall FTE) State Funds	28.00	29.20	31.54	28.27	29.00	28.60	26.14
SCH per Faculty FTE	**520.04**	**478.44**	**409.75**	**458.77**	**474.82**	**484.91**	**554.89**

PHYSICS SPONSORED PROJECT REVENUE, 2004 - 2010

Department of Physics	FISCAL YEAR (Fall + Spring)						
	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10
Annual Sponsored Project Revenue	3,778,786	3,706,354	4,518,258	3,887,063	3,582,211	3,785,072	4,209,944

PHYSICS, STATE EXPENDITURE/ COMPLETED MAJOR*, 2003 - 2009
(Includes AIP, EPH, and PHYS Majors)

Department of Physics	FISCAL YEAR (Aug/Dec/May)						
	FY03-04	FY04-05	FY05-06	FY06-07	FY07-08	FY08-09	FY09-10
State Allocation	4,584,148.60	4,954,548.67	5,483,803.01	5,527,296.04	5,601,386.08	5,485,869.43	5,049,775.38
Completed Majors	44	61	52	57	38	51	39
State Expenditure per Completed Major	104,185.20	81,222.11	105,457.75	96,970.11	147,404.90	107,566.07	129,481.42

*Completed majors is not equivalent to degrees awarded.

UA SCIENCE

College of Science

Time to Degree Completion: PhD Programs (Please see page 27 for footnotes on this data)

PhD Programs Included in National Research Council[1] (NRC) Assessment of Research Doctorate Programs

Completion Rates (includes only students who were full-time every semester) | First-Time Application, Admission and Enrollment Data

6-yr Completion Rates use 5 entering cohorts of Always Full-Time Students: Academic Years 1996-2000	All: Students in Entering Cohorts	All: Completions	All: 6-yr Completion Rate	Female: Students in Entering Cohorts	Female: Completions	Female: 6-yr Completion Rate	All: Median Time to Degree[2]	All: n	Fall 2007: Applied	Fall 2007: Admitted	Fall 2007: Enrolled	Fall 2007: % Admitted	Fall 2007: % Enrolled	Fall 2008: Applied	Fall 2008: Admitted	Fall 2008: Enrolled	Fall 2008: % Admitted	Fall 2008: % Enrolled
Applied Mathematics	29	12	41%	9	4	44%	6.00	11	95	12	11	13%	92%	135	23	12	17%	52%
Astronomy	27	10	37%	10	4	40%	6.00	9	147	7	7	5%	100%	139	10	10	7%	100%
Atmospheric Sciences	9	2	22%	6	0	0%	5.25	4	24	6	3	25%	50%	35	12	7	34%	58%
Biochemistry	8	3	38%	4	1	25%	5.00	3	41	3	3	7%	100%	43	7	7	16%	100%
Biochemistry & Molecular & Cellular Biology	4	1	25%	2	1	50%	2.75	2	103	13	3	13%	23%	87	14	9	16%	64%
Chemistry	122	45	37%	44	12	27%	5.50	26	422	31	26	7%	84%	116	38	35	33%	92%
Computer Science	25	6	24%	1	0	0%	5.50	6	303	69	22	23%	32%	281	76	23	27%	30%
Ecology & Evolutionary Biology	23	6	26%	11	1	9%	5.00	5	70	9	9	13%	100%	75	19	10	25%	53%
Geosciences	41	18	44%	20	9	45%	4.75	10	123	44	20	36%	45%	143	32	17	22%	53%
Mathematics	39	16	41%	10	4	40%	6.00	14	96	29	15	30%	52%	69	16	10	23%	63%
Molecular & Cellular Biology	20	4	20%	12	2	17%	4.00	10	27	2	2	7%	100%	22	6	5	27%	83%
Neuroscience	26	14	54%	17	10	59%	5.50	13	29	2	2	7%	100%	39	5	4	13%	80%
Physics	47	12	26%	12	3	25%	5.25	12	194	13	10	7%	77%	170	17	16	10%	94%
Speech, Language and Hearing Sciences*	16	9	56%	11	8	73%	4.50	5	120	26	19	22%	73%	154	26	22	17%	85%
Total	436	158	**36%**															

* Non-NRC data; compiled by UA Graduate College

1. NRC data were reviewed by each program for accuracy.
2. **Median Time to Degree** is calculated using doctoral degrees awarded in academic years 2003, 2004 and 2005 for students who were full-time every semester of their program study.

Full data set with all colleges located at: http://grad.arizona.edu/assessment/node/18