

Physics Department Self-Study Report for the Academic Program Review

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Abstract

This report contains material for the Physics Department Academic Program Review

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1 Self Study Summary

1.1 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 17 Full, nine Associate, and two Assistant professors in the Department.

There are two lecturers in the Department: Shawn Jackson and 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 latter will likely cease due to low enrollment. A Physics minor is offered for non-Physics majors. A B.S.C. 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 Medical Physics.

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

1.2 Department Summary

As mentioned above, the goals of the Physics Department are excellence and achievement in education, research, and service.

Our (the Department's) view of the Physics Department is that it provides strong and healthy degree programs for both undergraduate and graduate students. Notable is that a majority of 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

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

Table 1: List of Physics Faculty

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

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

that research is carried out by faculty who are acknowledged leaders in their fields.

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, a few faculty lead broad and outstanding outreach programs as part of their administrative duties outside the Department. Beyond this, to date the other service and outreach activities of the Department are more modest. The new Department Head, Sumit Mazumdar, has made outreach a priority in the Department and named an appropriate faculty member to lead this effort. Our vision is to build on existing outreach efforts already ongoing in the College of Science and we have already 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 future for both the State and the University is one 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 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.

2 Unit Description

2.1 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. 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 2008, 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.

Also associated with the Physics Department is the Science Teacher Preparation Program (STPP). This program is housed in the College of Science. 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.

- *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, competing for external funding for that research, and participation in interdisciplinary physics with other campus units involved in research on 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 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 is the Department’s Physics Phun Nite, 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.

2.2 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. 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 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 plans in more detail.

- *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 C.1), 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 (Leroy and 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 of those who do not want to pursue a traditional academic career. We are in the process of creating a new Advisory Board for the Department whose charge will include advising the Department Head on employment opportunities for physicists outside the academic world. A significant fraction of the Advisory Board members are from local industrial concerns.

- *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 (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 (J. D. Garcia), a female faculty member who also heads the Department's teacher preparation program (Ingrid Novodvorsky), Directors of Undergraduate and Graduate Studies (Drew Milsom and Koen Visscher), the Department Head (Sumit Mazumdar) and Associate Head (Ken Johns), and the Associate Dean of the College of Science (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. 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 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 will train junior and senior physics majors in demonstrating and explaining physics experiments to K-12 students. This outreach program aligns closely with service learning activities planned or in existence in the College of Science.

2.3 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.

- *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 might have to give way to 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 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.

3 Unit History

3.1 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. Following Stein’s stepping down and departure for NYU, 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. No consensus candidate emerged after the first round of faculty voting, and following a second round of elections,

Dean Ruiz appointed Pierre Meystre, Prof. of Optical Sciences, as the Department Head. 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 as a consequence of these appointments (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 likely 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, wife of Goldstein, 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, Dimitrios Psaltis and Feryal Özel moved to the Astronomy Department in 2008, severing their connections to Physics. 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.

3.2 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, see below) whose 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 9). Subsequent to the creation of the Chemical Physics program in 2010, a half dozen Physics faculty have participated in the recruiting workshop of the Chemistry Department. Reaching out more vigorously to international students is planned.

- *“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 Prep 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 exist 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 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.

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

At the request of Dean Joaquin Ruiz, a "Blue Ribbon Committee" (BRC) consisting of five prominent scientists and scientific administrators and the Chair of the then Physics Advisory Board visited the Physics Department and the UA on November 15-16, 2007. At this time the

Department was headed by Interim Head Prof. Michael Shupe. The BRC's mission was less extensive than an APR's, and 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 Lunar and Planetary Laboratories, have begun. The unit Heads expect to recommend to the Dean of the College of Science a suitable faculty member for the position of chairperson of the TAP by the end of Fall semester of 2010.

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.

4 Academic Quality

4.1 External Rankings

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

For the undergraduate physics program we know of no external ranking. The University of Arizona (UA) as a whole is ranked 120th in the National University category by U.S. News and World Report. Measures using peer assessment, graduation and retention rates, student selectivity, financial resources, faculty resources, alumni giving, and high school counselor undergraduate academic reputation ratings are used for this rating.

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, 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 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 UA Physics Department to be 58-113 and the R-ranking range to be 51-99.

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. One of the Department’s long term goals is to continue to improve its research and educational

excellence as outlined in the strategic plan.

4.2 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.

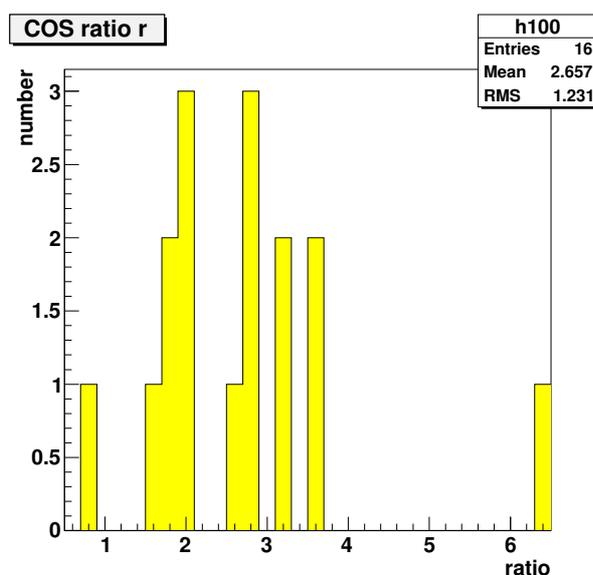


Figure 1: Ratio r used for COS quality for the departments in the COS

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 are currently without funding. 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. 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. Four faculty have received NSF Presidential Young Investigator or CAREER awards and two have received DOE Outstanding Junior Investigator awards. These are among the most meritorious awards for young faculty. Likewise several faculty have been named Sloan Fellows.

Locally, a number faculty have been recognized by the UA for their research accomplishments. These are listed in Table 4

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

Table 4: 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 5.

Name	Award
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 5: List of Physics faculty international and national awards

5 Faculty

5.1 Faculty Research

For convenience, the list of faculty, their rank, and their primary research field are reproduced in Table 6.

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

Table 6: List of Physics Faculty

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.

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 the atom optics. Here, faculty have pioneered techniques that exploit the 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 recently 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 study of 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 10 and Section 11. 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 recently received an NSF CAREER Award to study electron transport in carbon nanostructures.

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 the Divisional Associate Editor of Physical Review Letters.

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

The nuclear theory group carries out internationally recognized research in nuclear physics from the perspective of 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 for describing the formation 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, Rutherford, Shupe, and Varnes)

The primary focus of this group is the ATLAS experiment at the CERN LHC (Large Hadron Collider) and the D0 experiment at the Fermilab Tevatron. A large variety of both Standard Model and Beyond the Standard Model physics is 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 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.

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 and explored the connections between particle physics and cosmology. 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))

UA has operated the NSF-Arizona Accelerator Mass Spectrometry (AMS) Laboratory as an NSF Facility since 1981. The present director is Two machines have been used: a 2.5MV General Ionex 4130 AMS (1981) and a 3MV National Electrostatics Pelletron AMS (2000). This NSF facility 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 extrater-

restrial 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 Robert Noyce Scholarship Programs by the NSF, 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 graduates who aren't teaching have gone on to professional school, preparing to become doctors.

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.

5.2 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 Magnetism 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 Dines is currently the Program Director for the Theoretical High Energy 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, review committees for the Veritas and CMS experiments, Nuclear Science Advisory Committee, Science Committee for USQCD collaboration, allocation committee for the NSF Supercomputer center, organizing committee for NAS/Humboldt Foundation meetings, NRC committees on the Future of AMO Science and AMO2010 Decadal Survey, and the NRC Board on Physics and Astronomy among others.

5.3 Faculty Teaching and Outreach

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 A 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 7. Other faculty in the Department have been finalists for these and other awards as well.

Name	Award
Elliott Cheu	COS Blitzer Award for Teaching
Alex Cronin	UA Henry and Phyllis Kofler Teaching Prize
Keith Dienes	COS Distinguished Early-Career Teaching Award
K.C. Hsieh	UA El Paso Energy Foundation Faculty Achievement Award
K.C. Hsieh	COS Blitzer Award for Teaching
K.C. Hsieh	COS Distinguished Award for Teaching
Fulvio Melia	COS Distinguished Teaching Award
Shawn Jackson	COS Distinguished Early-Career Teaching Award
Srin Manne	COS Distinguished Teaching Award

Table 7: List of Physics Faculty Teaching Awards

Details on faculty outreach can be found in the Section 10 of the Self-Study Report.

5.4 Faculty Views on the Strategic Plan

The strategic plan for the Department detailed in Section 3 was submitted to all faculty for feedback and comments. The elements of the strategic plan were also discussed in a faculty meeting in November 2010. 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. However 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. However at this time (late 2010) the size of cuts are still unknown.

5.5 Faculty Recruiting

In the last ten years, thirteen faculty and three instructors were hired in the Physics Department. Additionally, Professor Meystre joined the Department as Department Head in 2006. During this same period, nine faculty retired, five faculty and one instructor resigned to accept positions at other universities or departments, one instructor was terminated because of budget cuts, and two faculty passed away (Table 8). 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 growth that we have referred to.

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 (Oxford)
Ozel, Feryal	2009	Resigned (UA Astronomy)
Psaltis, Dimitrios	2009	Resigned (UA Astronomy)
Stein, Dan	2005	Resigned (NYU)
McCullen, John, Larry	2005	Deceased
Patrascioiu, Adrian	2002	Deceased

Table 8: 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 9.

Name	Year	Promotion to
Cheu, Elliott	2002, 2008	Associate, Full
Cronin, Alex	2008	Associate
Dienes, Keith	2003, 2009	Associate, Full
Fleming, Sean	2010	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 9: Faculty tenure decisions and promotions

5.6 Faculty Compensation

The average academic year compensation for different faculty ranks is given in Table 10. 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 10: 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 80-85% below average. The low salaries for full professors results 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 its resulting compression may limit the ability of the Physics Department to compete with our peers in attracting outstanding hires to the Department. Very recently, the Department Head was able to secure modest raises from the University for a select number of full professors that improves the situation somewhat.

5.7 Biographical Sketches

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

6 Unit Administration

6.1 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 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 Kenneth Johns) in matters of the Head's choosing. A Director of Undergraduate Studies (DUS) (currently Drew Milsom) and Director of Graduate Studies (DGS) (currently 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.

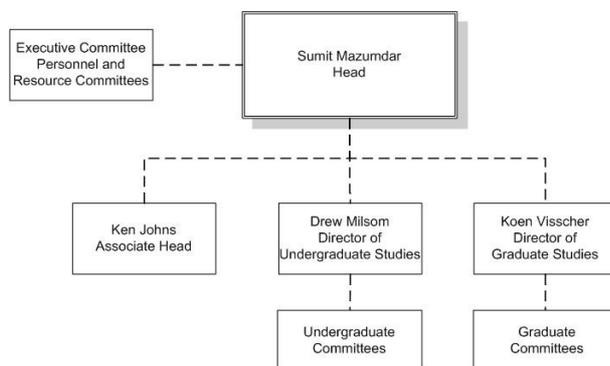


Figure 2: Organization chart of the Physics Department

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 C. 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 current Head also makes frequent use of email to keep the faculty up-to-date on departmental news and decisions. The current Head is readily accessible to the faculty through email or face-to-face meetings.

6.2 Unit Staff

A list of the professional staff in the Physics Department is given in Table 11. 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 instructor 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	Instructor	Teaching	ICR, Temp Teaching
Milsom, Drew	Senior Lecturer	Teaching	State (15%), ICR, Temp Teaching
Novodvorksky, Ingrid	Director STPP	STPP	State
Biddulph, Dana	Assistant Research Scientist	AMS	Other
Burr, George	Senior Research Scientist	AMS	Other
Cheng, Li	Assistant Research 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 11: List of Professional Staff

A list of the classified staff in the Physics Department is given in Table 12. 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 ICR, 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.

Budget cuts to the Physics Department in the last several years have resulted in reductions to

Name	Title	Program	Funding
Arnold, Susan	Administrative Secretary	Academic support office	State
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
Passarelli, Linda	Administrative Secretary	Academic support office	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 12: List of Classified Staff

the professional and classified staff. In the last three years, the Physics Department has lost the personnel given in Table 13. 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.

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
Stemrick, Jerene	Public Relations/Outreach Coordinator	Outreach office
Valine, Bill	Laboratory Coordinator	Instructional support
Woerner, Karen	Senior Office Specialist	Main office

Table 13: Professional and classified staff who have left and not been replaced

Since the numbers of professional and classified staff have been reduced, so to have possibilities for staff reconfiguration. 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 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 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.

7 Unit Resources

7.1 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 lecturers, 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 lecturers 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 faculty at one course per semester.

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 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 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. It provides council to faculty, staff and students for non-academic related questions and concerns. 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 Accounting person in the Business Office was 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 dedicated to public relation and outreach activities is highly desirable. Our emerging outreach program would greatly benefit from such an additional staff person.

8 Undergraduate Program

8.1 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. The B.A. degree will be discontinued going forward because of low enrollment. 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 slightly increase by one or two such Tier1 or Tier2 Natural Science courses offered by the Department.

Enrollment data for undergraduate majors is given in Table 14. 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. As mentioned above we will discontinue the B.A. Physics degree in the near future. 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 twice this number. Perhaps uncertainties arise because of the large number of double majors with astronomy or math.

Completed major data is given in Table 15. 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	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 14: Enrolled Physics Majors

	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 15: 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. 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.

The data show a slight decrease in B.S. completed majors in the last three years. One of the Physics Department 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.

8.2 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 in the College of Science and engineering majors in 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 lecturers versus one faculty lecturer.

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 problems in the PHYS 141 series. Recently, for example, such a meeting concluded engineering students would benefit from additional outside class tutoring in PHYS 141. The Physics Department hopes to implement additional tutoring for engineering students beginning in Spring 2011 with support from the College of Engineering and the College of Science. No such higher level meetings presently occur for the PHYS 102 series however one of the Director of Undergraduate Studies' (DUS') goals is to initiate such meetings in 2011.

8.3 Undergraduate Major Program

The requirements for B.S. degree can be found in Appendix D. There is no accrediting body which prescribes 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).

As mentioned, the B.S. curriculum is very similar in scope to that of most Research I universities. While the introductory and intermediate level courses are primarily theoretical, the faculty are aware of the need to include as many recent ideas and advances as is 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 consolidation of introductory courses as well as limits on the number and frequency of specialized courses that can be offered.

Research experience for undergraduates is strongly stressed in the Physics Department. 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. (Note the 77% is a bit odd since at least one semester of independent research is required to graduate. So perhaps the students took the question to mean research projects beyond that requirement).

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 Department strives for 100% participation of Physics majors in independent research. 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. In May of each year, the Department sponsors a formal Undergraduate Research Symposium (complete with a banquet lunch and awards) that showcases research carried out by Physics majors. Faculty comments on the student presentations are used as part of assessment measures.

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 has interest in eventually developing an online Natural Science course for non-Science majors. We are closely following the development of other such online courses in the College of Science and will monitor their popularity and effectiveness.

8.4 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 ???. The following tables average these data over the last seven years (2003-2009).

In Table 16, 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 16: Seven year average of freshman counts and average SAT scores in Physics, the College of Science, and the University of Arizona

Table 17 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 17: 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 18 it is seen that the time to graduation for Physics majors from 2003-2009 is slightly longer than that compared to all students in the College of Science and to all students at the University of Arizona. However, the data from the last three years show a time to graduation (4.46 years) that is comparable 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 18: 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 19 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 19: 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 faculty, J.D. 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.

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. Also, each May the Department holds an Undergraduate Research Symposium where students can present their research. The Symposium includes a lunch and an award for best research presentation. Undergraduate research opportunities are advertised on the Department web page as well as on a University web site ur.arizona.edu. We have also started an initiative for two of the junior level instructors to give a brief talk on how to go about finding and securing a research position in Physics or a related department.

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 Major Days 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 advisors. The faculty advisors in general have extensive experience teaching at the undergraduate level. The effectiveness of the advising has not been well measured to date. One problem is that it is not mandatory for students to meet with their advisor. We are investigating various scenarios to encourage students to meet with their advisors before registration begins for the following semester. 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 year of data. A 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.)

8.5 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 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.

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. A variety of data is used to assess the undergraduate program. The 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.

Assessment in the Physics Department is carried out by the Assessment Coordinator who is assigned by the Department Head. 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.

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. Course grades, student evaluations, and faculty surveys are also used in program assessment.

8.6 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.

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.

We are hopeful that the new Physics Advisory Board will also help enhance the undergraduate education for Physics majors. The new board consists primarily of local industry leaders. One of its goals is to focus on providing training and guidance for Physics majors not choosing a path to graduate school. 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 at least one 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.

9 Graduate Program

9.1 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 E. 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 that was discontinued because of low enrollment. 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 program requires a minimum of 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. In 2009, a Chemical Physics Program was added as a new track. 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 20 shows the number of Ph.D. students per year and the number of matriculated 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
Matriculated Ph.D. students	11	14	13	13	10	13	12

Table 20: Enrolled and matriculated Ph.D. students

Averaged over the last six years, the number of instructional 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” 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 $32/27 = 1.2$. Optimally this number should approach two. 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. 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 4. 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. 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 on University.

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.

9.2 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 as the minimum enrollment for a graduate course is four students. 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. Cubical 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 GSPC (Graduate and Professional Student Council). Within the department, the C.Y. Fan "FanFare" Award is a memorial 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\$. 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.

9.3 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 which 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 21. The total number of Ph.D. students each year is approximately 70.

	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 21: Women in the Graduate Ph.D. Program

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 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. aip ref. 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. ref. We understand that 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 talk with 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 22. 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. (ref aip and mbp). 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 22: 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 F. We have participated in all APS MBP meetings. Two faculty from UA and two faculty from UTEP have given or will give colloquia and seminars as visitors. 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.

9.4 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 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.

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. A variety of data is used to assess the graduate program. The 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.

Assessment in the Physics Department is carried out by the Assessment Coordinator who is assigned by the Department 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.

Institutional and departmental data are used to provide an overview of and monitor the graduate program. The knowledge of core disciplines in physics can be evaluated using the comprehensive written and oral exam results. Course grades, student evaluations, and faculty surveys are also used in program assessment.

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.

9.5 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.

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.

10 Academic Outreach

10.1 Outreach

The Department faculty are involved in a wide range of outreach activities, primarily local. As stated in our strategic plan, one of the future 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 that are discussed at the end.

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, LPL, 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 REU program. 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 Elliott Cheu, Associate Dean of the College of Science, and 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 appointment, 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.

11 Collaboration

11.1 Collaboration with Other Units

The Physics Department maintains dynamic collaborations with other units on campus including the departments of Applied Math, Biochemistry, Chemistry, Lunar and Planetary Sciences (LPL), 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, Sumit Mazumdar, meets regularly with the Heads of Astronomy, LPL and Chemistry, and in order to explore coherence in hiring, potential interdisciplinary proposals, and education.

11.2 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, Lunar and Planetary Labs, 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 LPL. Many of these connections are through membership in the TAP (Theoretical Astrophysics Program). The TAP program is a top-ranked interdisciplinary program involving Astronomy, LPL, 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 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 is currently supervising a graduate 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, paleoclimatology, and archeology.

11.3 Collaborations in Education

The Department (Visscher) is an active participant in the Integrated Science Major. Prof. 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 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.

12 Diversity

12.1 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.

12.2 Faculty and Staff

The gender composition of the faculty and staff in the Physics Department is given in Table 23. 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 23: 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 under-represented 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 example, during our 2009 faculty search, one of the five finalists was a woman. 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”.

12.3 Undergraduate and Graduate Students

The gender composition of undergraduate and graduate students in the Physics Department is given in Table 24. 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 24: Fraction of women among undergraduate and graduate students

proximately 21% in 2007. The percentage of Ph.D.’s earned by women nationally was approxi-

mately 18% in 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 9. 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 25.

	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 25: 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 to achieve these goals, especially increasing URM Ph.D. students.

As discussed in Section 9, 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 a total of 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.

12.4 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 undertaken by the Department include (in no particular order)

- Ensured 100% participation in the “Preventing Sexual Harassment”, 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 presentation research opportunities available in the Department
- Created surveys for undergraduate and graduate students who did not matriculate to UA to learn of 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

13 Unit Profiles

13.1 Responses to Questions and Comments

Data supplied to the Physics Department from the Office of Academic Affairs can be found in Appendix ???. 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 will submit Low Productivity Reports for both programs. The B.A. program will be discontinued because of low enrollment. The Professional Science Masters (PSM) program will hopefully continue. Currently there is only one track for the PSM - Medical Physics. This program 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 Y 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.

- *“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 Y 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. At the same time, the research efforts of the Department bring in funds to the University through ICR (Indirect Cost Return).

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.

- *“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?”*

On 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.

- *“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 26 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 26: 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 ration. 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 27. The numbers are averages over the last seven years.

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 GEO 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	GEO
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 27: 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 28. Here we use averages from the last three years 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	GEO
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 28: 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 29. 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	GEO
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 29: State expenditures and completed majors for the three departments. The data is averaged from 2003-2009

Appendices

A Teaching Evaluations

department course/instructor summary report

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Fall 2009

instructor	course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[REDACTED]	PHYS 241	20 / 90%	3.6 (3.2- 4.0)	3.1 (2.6- 3.6)	3.1 (2.6- 3.7)	- (- - -)	230
53267-02-02	PHYS 241	14 / 100%	3.8 (3.3- 4.3)	3.6 (2.9- 4.2)	3.5 (3.0- 4.0)	- (- - -)	230
53269-02-02	PHYS 241						
[REDACTED]	PHYS 141	17 / 80%	4.5 (4.0- 5.0)	4.2 (3.8- 4.6)	4.1 (3.6- 4.5)	- (- - -)	230
53155-02-02	PHYS 141						
[REDACTED]	PHYS 261H	8 / 100%	3.9 (3.1- 4.6)	4.0 (3.5- 4.5)	3.9 (3.1- 4.6)	- (- - -)	230
53277-02-02	PHYS 261H	17 / 85%	4.2 (3.7- 4.6)	3.5 (3.0- 4.1)	3.4 (2.9- 4.0)	- (- - -)	230
81183-02-02	PHYS 261H						
[REDACTED]	PHYS 552	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
81207-01	PHYS 552						
[REDACTED]	PHYS 182	9 / 81%	4.8 (4.5- 5.0)	4.0 (3.5- 4.5)	4.2 (3.9- 4.5)	- (- - -)	230
53219-01-02	PHYS 182	13 / 86%	4.4 (4.0- 4.8)	3.8 (3.4- 4.2)	3.7 (3.2- 4.2)	- (- - -)	230
53225-01-02	PHYS 182	18 / 94%	4.0 (3.5- 4.5)	3.6 (3.0- 4.2)	3.7 (3.2- 4.1)	- (- - -)	230
53231-01-02	PHYS 182						
[REDACTED]	PHYS 102	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
86485-01-02	PHYS 102	23 / 95%	3.8 (3.5- 4.2)	3.4 (2.9- 3.8)	3.4 (3.1- 3.8)	- (- - -)	230
53195-01-02	PHYS 181						
[REDACTED]	PHYS 142	15 / 75%	4.9 (4.8- 5.0)	4.7 (4.3- 5.0)	4.5 (4.0- 4.9)	- (- - -)	230
53161-02-02	PHYS 142						
[REDACTED]	PHYS 331	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
53299-01-01	PHYS 331						
[REDACTED]	PHYS 241	20 / 86%	4.0 (3.7- 4.3)	3.7 (3.2- 4.1)	3.5 (3.1- 3.8)	- (- - -)	230
53251-02-02	PHYS 241	20 / 83%	4.2 (3.8- 4.5)	3.4 (3.0- 3.8)	3.5 (3.1- 3.9)	- (- - -)	230
53265-02-02	PHYS 241						
[REDACTED]	PHYS 181	21 / 87%	4.0 (3.6- 4.3)	3.4 (3.1- 3.8)	3.2 (2.8- 3.6)	- (- - -)	230
53179-01-02	PHYS 181	19 / 86%	4.0 (3.6- 4.4)	3.5 (3.1- 4.0)	2.9 (2.7- 3.2)	- (- - -)	230
53209-01-02	PHYS 181	21 / 87%	4.0 (3.6- 4.4)	3.4 (3.1- 3.8)	3.1 (2.8- 3.5)	- (- - -)	230
53211-01-02	PHYS 181						

instructor	course		Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
			18 / 75%	3.1 (2.7- 3.6)	3.0 (2.5- 3.5)	3.1 (2.5- 3.6)	- (- - -)	230
	PHYS 141	010 LAB						
			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
	PHYS 102	001 LEC						
			7 / 87%	4.7 (4.3- 5.0)	4.3 (3.7- 4.9)	4.1 (3.4- 4.9)	- (- - -)	230
	PHYS 182	009 LAB						
			22 / 95%	4.4 (4.0- 4.7)	3.6 (3.2- 4.0)	3.6 (3.1- 4.0)	- (- - -)	230
	PHYS 181	006 LAB						
			17 / 73%	4.4 (4.1- 4.8)	4.3 (4.0- 4.6)	3.9 (3.5- 4.3)	- (- - -)	230
	PHYS 181	021 LAB						
			19 / 100%	4.4 (4.1- 4.7)	4.3 (4.0- 4.7)	4.1 (3.7- 4.4)	- (- - -)	230
	PHYS 181	022 LAB						
			4 / 30%	5.0 (5.0- 5.0)	5.0 (5.0- 5.0)	4.3 (3.7- 4.8)	- (- - -)	230
	PHYS 141	015 LAB						
			23 / 95%	4.3 (4.0- 4.5)	3.5 (3.3- 3.8)	3.4 (3.1- 3.6)	- (- - -)	230
	PHYS 161H	001 LAB						
			18 / 81%	4.3 (4.0- 4.6)	3.7 (3.3- 4.0)	3.6 (3.1- 4.0)	- (- - -)	230
	PHYS 161H	002 LAB						
			6 / 100%	4.3 (3.9- 4.8)	3.8 (3.0- 4.7)	3.8 (2.8- 4.9)	- (- - -)	230
	PHYS 161H	003 LAB						
			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
	PHYS 305	002 LEC						
			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
	PHYS 195A	001 CLQ						
			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
	PHYS 515B	001 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
	PHYS 305	002 LEC						
			21 / 95%	3.6 (3.2- 4.0)	3.3 (2.8- 3.7)	3.0 (2.6- 3.4)	- (- - -)	230
	PHYS 181	005 LAB						
			15 / 71%	4.3 (3.9- 4.6)	3.7 (3.2- 4.2)	3.2 (2.7- 3.7)	- (- - -)	230
	PHYS 181	013 LAB						
			19 / 86%	3.9 (3.6- 4.3)	3.8 (3.3- 4.2)	3.6 (3.2- 4.1)	- (- - -)	230
	PHYS 181	014 LAB						
			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
	PHYS 102	002 LEC						
			18 / 81%	4.5 (4.2- 4.8)	4.2 (3.8- 4.7)	4.1 (3.6- 4.5)	- (- - -)	230
	PHYS 181	003 LAB						
			15 / 88%	4.7 (4.3- 5.0)	4.3 (3.9- 4.8)	4.1 (3.6- 4.5)	- (- - -)	230
	PHYS 181	004 LAB						
			17 / 73%	4.2 (3.8- 4.6)	3.5 (2.9- 4.0)	3.5 (3.1- 3.9)	- (- - -)	230
	PHYS 181	019 LAB						

instructor	course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	ICE Form
[REDACTED]	PHYS 141	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
53139-01	PHYS 141	6 / 66%	4.8 (4.5- 5.0)	4.3 (3.6- 5.0)	4.3 (3.6- 5.0)	- (- - -)	230
53311-01-01	PHYS 381						
[REDACTED]	PHYS 141	19 / 86%	4.6 (4.3- 4.9)	4.5 (4.2- 4.8)	4.0 (3.7- 4.3)	- (- - -)	230
53139-02-02	PHYS 141						
[REDACTED]	PHYS 103	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
53125-01-01	PHYS 103						
53249-01	PHYS 241	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	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]	PHYS 528	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
53485-01	PHYS 528						
[REDACTED]	PHYS 105A	15 / 65%	4.3 (4.0- 4.6)	4.1 (3.5- 4.6)	4.5 (4.2- 4.9)	- (- - -)	230
53129-01-02	PHYS 105A						
[REDACTED]	PHYS 321	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
53295-01-01	PHYS 321						
[REDACTED]	PHYS 204	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
53247-01-01	PHYS 204						
[REDACTED]	PHYS 161H	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
53173-01	PHYS 161H						
[REDACTED]	PHYS 381	9 / 64%	4.2 (3.8- 4.7)	4.1 (3.5- 4.8)	4.0 (3.2- 4.8)	- (- - -)	230
53307-01-03	PHYS 381						
53309-01-02	PHYS 381	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	6 / 66%	4.8 (4.5- 5.0)	4.2 (3.5- 4.8)	4.3 (3.6- 5.0)	- (- - -)	230
[REDACTED]	PHYS 131	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
53133-01-01	PHYS 131						
53481-01	PHYS 511	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]	PHYS 141	17 / 89%	4.6 (4.3- 4.8)	4.2 (3.8- 4.5)	3.8 (3.4- 4.3)	- (- - -)	230
53143-02-02	PHYS 141						
53153-02-02	PHYS 141	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	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	20 / 95%	3.7 (3.1- 4.2)	3.0 (2.5- 3.5)	3.3 (2.9- 3.7)	- (- - -)	230
[REDACTED]	53189-01-02 PHYS 181	21 / 87%	4.2 (3.8- 4.7)	3.6 (3.1- 4.1)	3.3 (2.9- 3.8)	- (- - -)	230
[REDACTED]	53193-01-02 PHYS 181	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	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	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	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	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	14 / 100%	4.1 (3.7- 4.6)	3.9 (3.4- 4.5)	3.8 (3.3- 4.4)	- (- - -)	230
[REDACTED]	53309-01-01 PHYS 381	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	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	15 / 83%	4.6 (4.3- 4.9)	4.3 (4.0- 4.7)	3.9 (3.4- 4.3)	- (- - -)	230
[REDACTED]	53223-01-02 PHYS 182	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	16 / 84%	2.9 (2.5- 3.4)	3.1 (2.7- 3.5)	3.2 (2.7- 3.7)	- (- - -)	230
[REDACTED]	86435-10 PHYS 141	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	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	18 / 100%	4.6 (4.3- 4.9)	4.2 (3.8- 4.6)	3.8 (3.2- 4.3)	- (- - -)	230
[REDACTED]	53197-01-03 PHYS 181	23 / 100%	4.5 (4.2- 4.8)	4.0 (3.5- 4.4)	4.0 (3.6- 4.3)	- (- - -)	230
[REDACTED]	53199-01-03 PHYS 181	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	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]	PHYS 102	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
53121-01-02	LEC						
[REDACTED]	PHYS 141	15 / 75%	4.5 (4.2- 4.7)	3.6 (3.2- 4.0)	3.7 (3.2- 4.1)	- (- - -)	230
53147-02-02	LAB						
[REDACTED]	PHYS 305	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
53287-01-01	LEC						
[REDACTED]	PHYS 241	19 / 82%	3.4 (2.8- 3.9)	3.0 (2.4- 3.6)	3.0 (2.5- 3.5)	- (- - -)	230
53259-02-02	LAB						
[REDACTED]	PHYS 241	20 / 90%	3.4 (3.0- 3.8)	3.1 (2.7- 3.4)	2.8 (2.5- 3.1)	- (- - -)	230
81181-02-02	LAB						
[REDACTED]	PHYS 261H	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
53277-01	LEC						
[REDACTED]	PHYS 142	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
53161-01	LEC						
[REDACTED]	PHYS 241	19 / 90%	4.3 (3.9- 4.7)	3.8 (3.5- 4.2)	3.7 (3.3- 4.2)	- (- - -)	230
53249-02-02	LAB						
[REDACTED]	PHYS 241	15 / 93%	4.1 (3.7- 4.6)	3.7 (3.2- 4.1)	3.5 (3.1- 3.9)	- (- - -)	230
53255-02-02	LAB						
[REDACTED]	PHYS 141	19 / 90%	4.6 (4.4- 4.9)	4.5 (4.2- 4.8)	4.2 (3.8- 4.5)	- (- - -)	230
53145-02-02	LAB						
[REDACTED]	PHYS 141	16 / 80%	4.5 (4.2- 4.8)	3.9 (3.4- 4.4)	3.8 (3.4- 4.2)	- (- - -)	230
53151-02-02	LAB						
[REDACTED]	PHYS 181	19 / 90%	4.7 (4.5- 4.9)	4.4 (4.1- 4.7)	4.1 (3.6- 4.6)	- (- - -)	230
53205-01-03	LAB						
[REDACTED]	PHYS 181	18 / 85%	4.7 (4.4- 4.9)	4.4 (4.1- 4.8)	3.7 (3.3- 4.1)	- (- - -)	230
53207-01-02	LAB						
[REDACTED]	PHYS 181	17 / 89%	4.9 (4.7- 5.0)	4.4 (4.1- 4.8)	3.9 (3.5- 4.3)	- (- - -)	230
53215-01-02	LAB						
[REDACTED]	PHYS 242	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
53271-01	LEC						
[REDACTED]	PHYS 241	20 / 83%	2.9 (2.5- 3.3)	2.6 (2.1- 3.0)	2.8 (2.3- 3.2)	- (- - -)	230
53253-02-02	LAB						
[REDACTED]	PHYS 241	17 / 89%	3.5 (3.0- 3.9)	3.1 (2.6- 3.5)	3.2 (2.7- 3.7)	- (- - -)	230
53257-02-02	LAB						
[REDACTED]	PHYS 141	17 / 80%	4.1 (3.7- 4.5)	3.5 (3.0- 4.0)	3.4 (3.0- 3.7)	- (- - -)	230
53141-02-02	LAB						

instructor	course	LEC	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
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

Department Course/Instructor Summary Report

Spring 2010

Instructor	Course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[REDACTED]	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
[REDACTED]	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]	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]	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
[REDACTED]	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
[REDACTED]	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]	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]	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]	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]	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
[REDACTED]	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]	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
[REDACTED]	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]	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
[REDACTED]	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]	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
[REDACTED]	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
[REDACTED]	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]	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
[REDACTED]	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]	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]	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]	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]	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
[REDACTED]	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]	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
[REDACTED]	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]	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
[REDACTED]	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
[REDACTED]	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]	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]	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
[REDACTED]	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
[REDACTED]	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]	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]	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

Instructor	Course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[REDACTED]	PHYS 141	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
50777-01	PHYS 141	LEC					
51375-01-01	PHYS 426	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	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]	PHYS 141	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
89891-01	PHYS 141	LEC					
[REDACTED]	PHYS 586	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
51793-01	PHYS 586	LEC					
[REDACTED]	PHYS 181	19 / 86%	4.9 (4.7 - 5.0)	4.7 (4.5 - 4.9)	4.5 (4.2 - 4.8)	- (- - -)	230
50829-01-02	PHYS 181	LAB					
[REDACTED]	PHYS 162H	16 / 100%	4.3 (4.0 - 4.7)	4.1 (3.6 - 4.5)	4.2 (3.8 - 4.6)	- (- - -)	230
83933-02-02	PHYS 162H	LAB					
[REDACTED]	PHYS 263H	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
50987-01-01	PHYS 263H	LEC					
[REDACTED]	PHYS 241	12 / 66%	4.8 (4.5 - 5.0)	4.4 (4.0 - 4.8)	4.4 (3.9 - 4.9)	- (- - -)	230
50967-02-02	PHYS 241	LAB					
50969-02-02	PHYS 241	LAB	17 / 100%	4.9 (4.7 - 5.0)	4.9 (4.7 - 5.0)	- (- - -)	230
[REDACTED]	PHYS 161H	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
75221-01	PHYS 161H	LEC					
[REDACTED]	PHYS 381	6 / 35%	4.3 (3.9 - 4.8)	3.7 (2.6 - 4.7)	3.7 (2.8 - 4.6)	- (- - -)	230
51183-01-04	PHYS 381	LAB					
51185-01-04	PHYS 381	LAB	7 / 70%	4.4 (3.8 - 5.0)	4.1 (3.4 - 4.9)	- (- - -)	230
51373-01	PHYS 422	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]	PHYS 560B	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
75239-01	PHYS 560B	LEC					
[REDACTED]	PHYS 381	7 / 87%	4.1 (3.4 - 4.9)	4.3 (3.5 - 5.0)	4.3 (3.5 - 5.0)	- (- - -)	230
51179-01-03	PHYS 381	LAB					
51183-01-03	PHYS 381	LAB	6 / 35%	4.2 (3.5 - 4.8)	3.8 (2.8 - 4.9)	- (- - -)	230
51185-01-03	PHYS 381	LAB	6 / 60%	4.7 (4.0 - 5.0)	4.5 (3.8 - 5.0)	- (- - -)	230
[REDACTED]	PHYS 515A	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
51759-01	PHYS 515A	LEC					

Instructor	Course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
	50765-01-01 PHYS 103	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	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
	50783-02-02 PHYS 141	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	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	22 / 95%	3.6 (3.3 - 3.9)	3.2 (2.8 - 3.5)	3.1 (2.8 - 3.4)	- (- - -)	230
	50805-02-02 PHYS 141	19 / 79%	4.3 (3.9 - 4.6)	3.8 (3.4 - 4.3)	3.4 (2.8 - 3.9)	- (- - -)	230
	50961-01-01 PHYS 204	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
	54107-01 PHYS 469	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
	50963-01 PHYS 241	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
	50859-01-01 PHYS 182	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	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	17 / 80%	4.8 (4.5 - 5.0)	4.5 (4.2 - 4.8)	4.3 (4.0 - 4.6)	- (- - -)	230
	50809-02-02 PHYS 142	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	17 / 100%	2.4 (1.9 - 2.9)	1.9 (1.5 - 2.4)	2.2 (1.7 - 2.6)	- (- - -)	230
	50773-01-01 PHYS 132	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
	90923-01-03 PHYS 181	16 / 72%	4.3 (3.9 - 4.6)	4.1 (3.6 - 4.5)	3.9 (3.5 - 4.4)	- (- - -)	230
	50821-01-01 PHYS 181	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	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	21 / 95%	4.1 (3.7 - 4.6)	3.8 (3.4 - 4.2)	3.7 (3.2 - 4.2)	- (- - -)	230
	51175-01-01 PHYS 371	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

Instructor	Course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
[REDACTED]	PHYS 141	21 / 95%	4.5 (4.2- 4.9)	4.3 (3.9- 4.6)	3.9 (3.4- 4.4)	- (- - -)	230
50777-02-02	PHYS 141	22 / 100%	4.6 (4.4- 4.8)	4.4 (4.2- 4.6)	4.0 (3.8- 4.3)	- (- - -)	230
SU,SHUFANG	PHYS 570B	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
51779-01							
[REDACTED]	PHYS 182	20 / 86%	4.1 (3.5- 4.6)	3.4 (2.9- 3.9)	3.3 (2.7- 3.9)	- (- - -)	230
50855-01-01	PHYS 182	24 / 100%	4.5 (4.2- 4.8)	4.0 (3.6- 4.4)	3.8 (3.4- 4.2)	- (- - -)	230
50869-01-01	PHYS 182	19 / 90%	4.6 (4.4- 4.9)	4.1 (3.7- 4.5)	3.7 (3.2- 4.1)	- (- - -)	230
90925-01-01							
[REDACTED]	PHYS 182	22 / 88%	4.9 (4.7- 5.0)	4.7 (4.4- 4.9)	4.3 (4.0- 4.6)	- (- - -)	230
50847-01-01	PHYS 182	24 / 100%	5.0 (4.9- 5.0)	4.6 (4.3- 4.8)	4.3 (3.9- 4.7)	- (- - -)	230
50829-01-01	PHYS 182	22 / 95%	5.0 (4.9- 5.0)	4.8 (4.6- 5.0)	4.5 (4.3- 4.8)	- (- - -)	230
50851-01-01							
[REDACTED]	PHYS 181	23 / 95%	3.4 (2.9- 3.9)	3.1 (2.7- 3.5)	2.8 (2.3- 3.3)	- (- - -)	230
50831-01-03	PHYS 181	18 / 85%	3.6 (3.1- 4.1)	3.4 (2.9- 3.9)	3.1 (2.5- 3.6)	- (- - -)	230
50839-01-03	PHYS 181	17 / 73%	4.2 (3.7- 4.6)	3.9 (3.4- 4.4)	3.6 (3.2- 4.1)	- (- - -)	230
90917-01-03							
[REDACTED]	PHYS 431	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
51379-01							
[REDACTED]	PHYS 102	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
50759-01-02							
[REDACTED]	PHYS 182	18 / 81%	4.2 (3.7- 4.8)	3.6 (3.1- 4.1)	3.7 (3.2- 4.2)	- (- - -)	230
50857-01-01	PHYS 182	23 / 95%	4.2 (3.9- 4.5)	3.5 (3.1- 3.8)	3.6 (3.3- 3.9)	- (- - -)	230
50861-01-01	PHYS 182	21 / 87%	3.9 (3.5- 4.2)	3.8 (3.4- 4.2)	3.6 (3.2- 4.0)	- (- - -)	230
50863-01-01							
[REDACTED]	PHYS 142	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
50809-01-01	PHYS 142	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
50817-01	PHYS 162H						
[REDACTED]	PHYS 241	14 / 73%	3.7 (3.3- 4.2)	3.5 (2.7- 4.3)	3.3 (2.7- 3.8)	- (- - -)	230
50963-02-02	PHYS 241	12 / 85%	3.5 (2.9- 4.1)	3.5 (2.9- 4.1)	3.4 (2.8- 4.1)	- (- - -)	230
50965-02-02							
[REDACTED]	PHYS 141	21 / 91%	4.3 (4.0- 4.6)	3.8 (3.5- 4.2)	3.7 (3.2- 4.1)	- (- - -)	230
50801-02-02	PHYS 141						

Instructor	Course	Responses	Overall Teaching Effectiveness	Overall Rating of Course	Amount Learned in Course	Difficulty Level of Course	TCE Form
51169-01-01	PHYS 331	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

B 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]
2. P. Navrátil, J. P. Vary and B. R. Barrett, "Properties of ^{12}C in the *ab initio* Nuclear Shell Model," Phys. Rev. Lett. **84**, 5728 (2000). [201]
3. P. Navrátil, J. P. Vary and B. R. Barrett, "Large-basis *ab initio* No-Core Shell Model and Its Application to ^{12}C ," Phys. Rev. C **62**, 054311 (2000). [192]
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]
7. P. Navrátil and B. R. Barrett, "Large-Basis Shell-Model Calculations for *p*-shell Nuclei," Phys. Rev. C **57**, 3119 (1998). [130]

Elliott Cheu
University of Arizona
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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 Distinguished 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 Sabbatical 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. Schwingerheuer *et al.*, *Physical Review Letters* **74**, 4376-4379 (1994).
5. “Observation of Direct CP Violation in $K_{S,L} \rightarrow \pi\pi$ Decays”, A. Alavi-Harati *et al.*, *Physical Review Letters* **83**, 22-32 (1999).
6. “Measurement of the Decay $K_L \rightarrow \pi^0\gamma\gamma$ ”, 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 $B_s \rightarrow \mu^+\mu^-$ at D0,” *Phys. Rev. D* **76**, 092001 (2007) [arXiv:0707.3997 [hep-ex]].
9. E. Abouzaid *et al.*, “Measurement of the Decay $K_L \rightarrow \pi^0 e^+ e^- \gamma$,” *Phys. Rev. D* **76**, 052001 (2007) [arXiv:0706.4074 [hep-ex]].

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 See-saw 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: <i>A Theoretical Study of Inclusive Charmonium Production at the Fermilab Tevatron.</i>	
	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	<ol style="list-style-type: none"> 1. <i>Outstanding Junior Investigator Award</i>. Awarded by The Office of Nuclear Physics of the Department of Energy.
Graduate Students Supervised	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. <i>Colloquium committee</i>: Spring 2006 – Spring 2008. 2. <i>Undergrad Service Courses Committee</i>: Fall 2006 – Present. 3. <i>Grad Advisor</i>: Fall 2007 –Present. 4. <i>Examinations Committee</i>: Fall 2008–Present. 5. <i>Physics Phun Night volunteer</i>: Fall 2005, Fall 2006, Fall 2007.
Courses & Taught	<ol style="list-style-type: none"> 1. <i>Mathematical Methods for Physicists</i>: Spring 2006. 2. <i>Graduate Quantum Mechanics</i>: Fall & Spring 2006 – Spring 2009. 3. <i>Introductory Algebra based Physics</i>: Fall 2008. 4. <i>Quantum Field Theory</i>: Spring 2010.
Selected Articles	<ol style="list-style-type: none"> 1. E. Braaten, S. Fleming, <i>Color-Octet Fragmentation and the ψ' Surplus at the Tevatron</i>, Phys. Rev. Lett. 74, 3327 (1995). 2. S. Fleming, T. Mehen, I.W. Stewart, <i>NNLO Corrections to Nucleon-Nucleon Scattering and Perturbative Pions</i>, Nucl. Phys. A677: 313 (2000). 3. C. Bauer, S. Fleming, M. Luke, <i>Summing Sudakov Logarithms in $B \rightarrow X_s \gamma$ in Effective Field Theory</i>, Phys. Rev. D63: 014006 (2001). 4. C. Bauer, S. Fleming, D. Pirjol, I.W. Stewart, <i>An Effective Theory for Collinear and Soft Gluons: Heavy to Light Decays</i>, Phys. Rev. D63: 114020 (2001). 5. S. Fleming, M. Kusunoki, T. Mehen, U. van Kolck, <i>Pion interactions in the $X(3872)$</i>, Phys. Rev. D76: 034006, 2007. 6. Sean Fleming, Andre H. Hoang, Sonny Mantry, Iain W. Stewart, <i>Jets from massive unstable particles: Top-mass determination</i>, Phys. Rev. D77: 074010, 2008.

Curriculum Vitae

Ke Chiang HSIEH

<i>Birth:</i>	Chungking (Chongqing), China, 14 June 1940		
<i>Citizenship:</i>	U.S.A., 22 February 1977		
<i>Education:</i>	B. A., Physics, <i>cum laude</i> , Wabash College, 1963 Ph. D., Physics, University of Chicago, 1969		
<i>Employment:</i>	University of Chicago	Research Associate	1969-1970
	University of Arizona	Assistant Professor	1971-1976
		Associate Professor	1977-1993
		Professor	1994-present
<i>Also:</i>	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 ^3He -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.

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 Heliosphere" (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 ³He and ⁴He from solar flares," *Astrophys. J. Lett.* **162**, L191-L196 (1970).

Associate Professor

Department of Physics
University of Arizona
1118 East Fourth Street
P.O. Box 210081
Tucson, AZ 85721, USA

Phone : +1 520 626 5112
Fax : +1 520 621 4721
Email : pjacquod@physics.arizona.edu
<http://www.physics.arizona.edu/~pjacquod>

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 Heterostructures 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

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

Professional Accomplishments

Head of the Level 1 Calorimeter-Track Trigger Project for the $D\bar{D}$ experiment, 2002 - 2007

Head of the Level 1 Muon Trigger Project for the $D\bar{D}$ experiment, 1995 - 2007

Co-head of the Muon Detector Upgrade Project for the $D\bar{D}$ experiment, 1996 - 1999

Co-convenor of the B Physics Group for the $D\bar{D}$ 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, muon detector development with micromegas, next generation signal processing and readout for high luminosity collider experiments

Selected Publications

“Measurement of the Top Quark-Pair Production Cross Section with ATLAS in pp Collisions at $\sqrt{s} = 7$ TeV”

ATLAS Collaboration, G.Aad *et al.*, submitted to EPJC(2010).

“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 $\sqrt{s} = 1.96$ 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).

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 than 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 Superlattice in Organic Conductor $(\text{Per})_2\text{Pt}(\text{mnt})_2$* 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 SiO₂”
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.

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 for Conjugated Polymers, 1991 (Utah), 1994 (Utah), 1997 (SPIE, San Diego), 2003 (Venice, Italy),

2005 (Bangalore, India), 2007 (Turkii, 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](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](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 separately)
- 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](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](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://cemcourier.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.Rutherford (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.Rutherford (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.Rutherford, "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.Rutherford (with C.N.Brown et al.) "Dimuon Production in 800 GeV Proton-Nucleus Collisions", Phys. Rev. Lett. **63**, 2637 (1989).
- J.Rutherford (with the ATLAS Liquid Argon Group) "ATLAS Liquid Argon Calorimeter Technical Design Report", CERN/LHCC/96-41, December 1996.
- J.Rutherford, "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.Rutherford, "Signal degradation due to charge buildup in noble liquid ionization calorimeters", Nucl. Instrum. and Meth. **A482** (2002) 156.
- J.Rutherford (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
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University of Arizona
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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. D* **81**, 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. D* **58**, 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. D* **63**, 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 (1989); 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 η_{+-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 nanocoherence,” *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.

- 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: *A 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, <i>Progress in Particle and Nuclear Physics</i> (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 Spire]:

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
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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_1 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-10621; 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 Burroughs 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]

- 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]
- 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]
- 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]
- Aspnes, E., Milster, T., & Visscher, K. Optical force model based on ray-tracing. *Applied Optics* 48,1642-1650 (2009). [0]
- 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]
- 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]
- Skinner, G.M., Visscher K., and Mansuripur M. Biocompatible Writing of Data into DNA *J. Bionanosci.* 1, 17-21 (2007)
- 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]
- 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)
- Seol, Y., Walton, D.B, & Visscher, K. "Suppression of noise in a noisy optical trap" *Phys. Rev. Lett.* 93, 160602 (2004). [7]
- Seol, Y., Skinner, G.M. & Visscher K., "Elastic properties of a single-stranded charged homopolymeric ribonucleotide". *Phys. Rev. Lett.* 93, 118102 (2004). [34]
- 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 Groot 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 executive 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 52th 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 S. S. P. Parkin, *Quenching of Magnetoresistance by Hot electrons in Magnetic Tunnel Junctions*, Phys. Rev. Lett. **79**, 3744 (1997).

C Committees

PHYSICS DEPARTMENT

2010-2011 COMMITTEE ASSIGNMENTS

Executive Committee:	<u>Mazumdar</u> , Barrett, Johns, Stafford
CAPE:	<u>Varnes</u> , Su, to be appointed, to be elected
Promotion and Tenure:	<u>Zhang</u> , Lebed, Shupe, van Kolck
Space:	<u>Shupe</u> , Beck, Eklund, Rafelski, Sarcevic
Grad Committees:	
Director of Graduate Studies:	<u>Visscher</u>
Grad Advisors:	<u>Visscher</u> , Fleming, Sandhu, Stafford, Toussaint
Grad Admissions:	<u>Visscher</u> , Fang, Su, LeRoy, Rutherford, Cronin
Grad Recruitment:	<u>Visscher</u> , Cronin, Fang, Johns, Manne, Mazumdar, Rafelski, Su
Curriculum:	<u>Rutherford</u> , Fang, Jacquod, Toussaint
Examinations:	<u>Fang</u> , Fleming, Sandhu, Shupe, van Kolck, Wing
PSM:	<u>Watchman</u> , Rutherford
Undergraduate Committees:	
Director of Undergraduate Studies:	Milsom
Lab courses/Lab equipment/ Lab reform:	<u>Wing</u> , Bickel, Haar, Novodvorsky, Rutherford, Jackson
Curriculum:	<u>Milsom</u> , Bickel, Cheu, Cronin, Garcia, Toussaint
Arts and Science Advisors:	<u>Toussaint</u> , Bickel, Garcia, Manne, Milsom, Rutherford, Stafford
Science Education Advisor:	<u>Novodvorsky</u>
Undergraduate Recruitment:	<u>Cheu</u> , Jackson, Johns, Mazumdar, Milsom
Other Committees:	
Awards and Prizes, Faculty and Staff:	<u>Sarcevic</u> , Arnold, Lebed, Toussaint
Awards and Prizes, Students:	<u>Barrett</u> , Cheu, Cronin, Fleming
Colloquium:	<u>Rafelski</u> , Cronin, Varnes, Zhang
Computing:	<u>Eklund</u> , Jacquod, Toussaint
Library contact:	<u>Jacquod</u>
Public Relations, Outreach, Recruitment:	<u>Manne</u> , Cheu, Garcia, Jackson, Johns, Mazumdar, Novodvorsky, Visscher
Gender Equity and Diversity:	<u>Johns</u> , Mazumdar, Sarcevic, Su
APR:	<u>Johns</u> and to be announced
Study of CAPE procedures/policies:	<u>Melia</u>

D 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 automatically satisfied)

[See the College of Science advising staff (Gould-Simpson 1017) for details]

Tier 1: four courses

Tier2: four courses

Physics requirements

One of the introductory sequences:

I. Physics 151, 152, 251, 252

II. Physics 161H, 162H, 261H, 262H

PHYS 204 (Mathematical Techniques in Physics)

PHYS 305 (Computational physics)

PHYS 321 (Mechanics I)

PHYS 426 (Thermal Physics)

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 472 (Quantum Theory II)

Six units chosen from:

Physics 320 (optics), 405 (digital electronics), 422 (advanced classical mechanics), 431 (biophysics), 450 (nuclear physics), 460 (solid state physics), 473 (spectroscopy), 476 (mathematical methods), 481 & 483 (advanced lab III)

Research requirement:

Three units chosen from Physics 483 (advanced lab project), 492 (directed research), 498 (senior capstone)

Either a regular minor or a thematic minor is required.

Requirements for a regular minor are set by the minor department. The thematic minor consists of 18 units of sciences other than physics or mathematics in a program approved by your advisor. No more than three units of a thematic minor can be mathematics courses normally required as prerequisites for physics courses.

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 103ab, 104ab or 105ab are strongly recommended.

NOTES

Physics 381 and 382 are writing emphasis courses.

E 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 occurring 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.

F 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.