Planning the Future of the Physics and Astronomy Department

Executive Summary

Physics and Astronomy are the bedrock sciences on which all others depend. Stony Brook's early rise to prominence was to a great extent built upon a strong Physics Department. Our aspirations, as outlined in this plan, offer a similar path to reach the President's goal of bringing us to the top 20 research universities. We believe that the continued prominence of the Physics and Astronomy Department (P&A) will be a key element to Stony Brook's future excellence.

The Department, together with the Yang Institute for Theoretical Physics (YITP), consistently ranks among the best in the country. The recent **NRC ranking placed us within the top 10% of 161 peer departments**. While we are pleased with this standing and will strive to enter the top ten nationally, we recognize that such rankings are sometimes inaccurate. What really matters are the measures entering such evaluations of research excellence – **influential publications, prizes and honors, funding levels, high visibility centers, and student quality**. Our goal should be to enhance these measures, while improving our educational programs to better enable our students to gain critical skills in formulating and solving new problems.

The Department conducts research in nearly all areas of physics and astronomy. We have a large in-house research program and we use many off-campus facilities including the Relativistic Heavy Ion Collider (RHIC), the Center for Functional Nanomaterials and the National Synchrotron Light Source at the BNL, the Fermilab Tevatron Collider, the Large Hadron Collider at CERN, the Palomar Observatory 100 inch Hale Telescope, and accelerator and underground neutrino facilities in Japan. Our faculty and students collaborate in interdisciplinary programs such as the New York Center for Computational Science (**NYCCS**), the **Simons Center** for Geometry and Physics, in the Center for Accelerator Research and Education (**CASE**) and in the **Laufer Center** for Physical and Quantitative Biology. The Department intends to play a strong role in the nascent Joint Photon Sciences Institute (**JPSI**).

Responding to the challenges of increasing enrollments the Department introduced **innovative teaching methods** in the classrooms and in the laboratories. We thrive to increase the number of physics and astronomy majors, currently about 220. The research opportunities and the wide selection of advanced undergraduate courses offered by the Department prepare many of our majors to graduate school.

An important focus of this report is the consideration of initiatives in **new areas of research** which extend our engagement across disciplinary boundaries or with colleagues at nearby institutions. Throughout its history, P&A has focused on a rather stable set of research areas. New opportunities for expanding our activities will arise in the coming decade as a significant number of current faculty retire and replacements are hired. We estimate that even with no new resources from the University, we should still be able to start **two or perhaps three initiatives over the next decade.** Additional support from the University would permit such initiatives to flourish on the national scene more rapidly and to develop new interdisciplinary connections on campus. The recent gift to the Department from the Simons Foundation will allow starting the most promising initiatives prior to the expected turnover through faculty retirements.

The criteria for evaluating proposed initiatives include **overall scientific importance, interdisciplinary connections with other departments or institutions and prospects for significant new external funding.** A further important criterion is the existence of a 'champion' within the Department who would drive the development of an initiative.

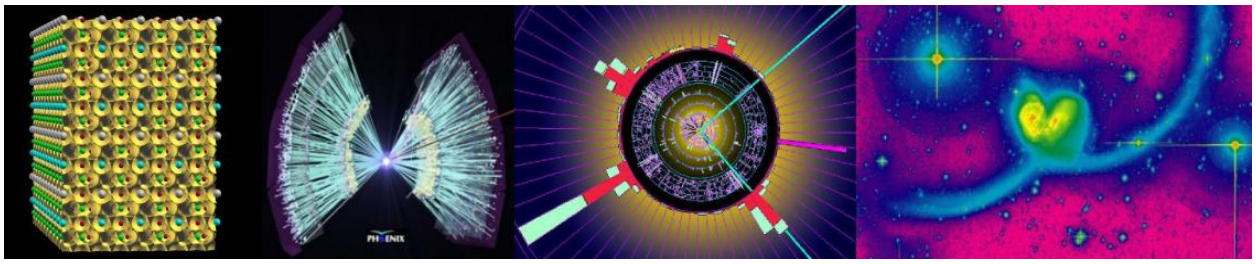
Fourteen specific initiatives are considered for implementation to various extent. Eight of these initiatives were selected for further development using the criteria above. We recognize that in the end, such initiatives will not be identified by a top-down approach, but rather will emerge from the ingenuity and commitment of individual faculty members. While each would extend the Department's reach in important ways, we found that they fall into three broad categories:

1. Those which offer **clear scientific payoff**, and could be accomplished through redirection of faculty lines within our present research programs. They include (a) developing new instrumentation for high contrast imaging studies such as extra-solar planet searches; (b) a collaboration among several branches of physics, chemistry and engineering to explore the role of topological features in quantum systems; and (c) controlling chemical and material science processes at the electron level through adaptive-learning laser systems.

2. Those which offer **very new directions for the Departm**ent and need further development: (a) biological physics using computational or theoretical approaches, grounded in the disciplines of physics; and (b) laser driven high energy density physics, with broad applications to stars and planets, ultra-high energy nuclear collisions, and fusion energy.

3. Those which attack **new and fundamental areas of science through interdisciplinary efforts**, and require some University support to seed them: These include (a) the science of particle accelerators through collaboration of engineers, mathematicians and medical scientists both on campus and at Brookhaven National Lab (BNL); (b) conceptual neuroscience, the study of how biological or synthetic systems organize and communicate information. (c) photon science using the new third-generation synchrotron light source at BNL. A P&A initiative would focus on physics-related topics, and would also provide the coordination of university light source activities, as has been done in the past.

The initiatives in the third category are excellent candidates for consideration in the University's ongoing strategic planning. Each offers exciting scientific advances in **cross-cutting science in new areas for the Department.** Each has the prospect for high visibility recognition on the national scene. Each would require at least one new senior hire to guide the initiative's development and bring in talented younger scientists. **None would require major funding beyond the new faculty hires**, owing either to existing facilities on campus or at BNL, or to the theoretical nature of the initiative.

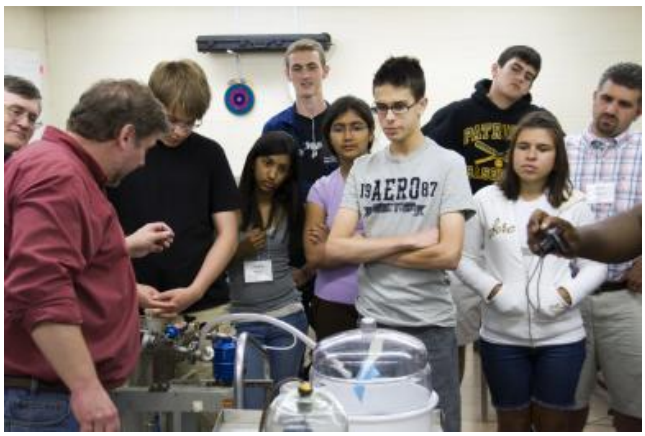


Introduction

Physics and astronomy, as the fundamental quantitative sciences of Nature, have been the bedrock of the major research universities since their inception. With its quantitative experimental methods and wide-ranging theories, modern physics has become connected to most other natural sciences, as those have become more quantitative. Thus a highly ranked physics and astronomy department is a beacon of quality for a research university and an attractor for top faculty in other natural sciences and engineering departments.

We recognize that providing a detailed set of goals and priorities for the next decade and beyond is a very difficult task. We cannot accurately predict the future scientific, economic or political climates in which we will operate, nor can we foresee future departures from the faculty. We know from past experience that unexpected opportunities will arise periodically. And the relative importance of topics in physics and astronomy themselves change on a decade scale as new discoveries, new tools and new societal imperatives arise. Thus, the committee takes its charge mainly as offering general advice on how the department can be revitalized, and to point out those examples for new interactive engagements within the existing research groups and with other SBU departments and external organizations. In so doing, we can also point out ways that either our internal practices, or those of the university, can enhance the productivity and visibility of the department.

Although here we focus on areas of growth and new opportunity for the department's research endeavor, we have kept in mind that as a core discipline in a major university, our educational mission is of utmost importance. Developing new initiatives must be guided both by the opportunities they give for current students to develop, and by their role in bringing better students to Stony Brook. This educational mission extends to all levels from high school to postdoctoral students. Indeed, one of the best indicators of the quality of the department is its ability to attract the best candidate students at all levels. Another measure of our success is the extent to which our students are sought after by other programs who value their physics training and ability to attack new problems innovatively. We are pleased that in past other departments have valued our students, and our future development should enhance this export of talent.



Our planning exercise was conducted by a committee (Strategic Planning Committee, SPC), appointed by the Chair in spring 2010. The charge to the committee is in the Appendix. This document is based on committee discussions and interactions with members of the department in Spring 2010, discussion of an interim report by the full faculty in September 2010, a subsequent revision by the committee. The final version was edited by the Department Chair and the Chair of the SPC.

Where do we want to be in 10 years?

The stature of academic departments is often measured by polls and rankings, and even though these can be flawed they do establish a general sense of our standing relative to other departments of physics/ astronomy. The recent NRC poll put P&A in the top 10% of the 161 peer departments that were ranked. However we recognize that rankings are often out of date, and different polls emphasize different aspects of a department's quality and use different metrics. So a more qualitative goal is that we improve the measures by which departments are judged – publication of influential new work, honors and prizes given to individual faculty members, high visibility grants and centers, leadership in national panels, quality of students, etc. Most generally, we would like to see the department viewed in the university and more widely in the professional community as a center of intellectual innovation and research excellence.

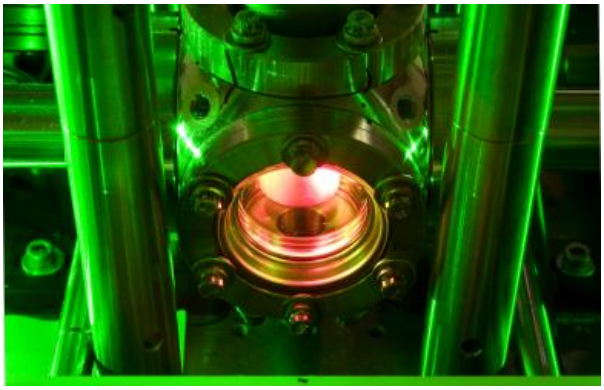
Increasing our stature compared to other physics/astronomy departments where there is more supportive infrastructure in place, and perhaps more financial backing, is challenging. However, with a new administration at the University, the climate within Stony Brook may be changing. There are hopes that the recent crisis will lead to more autonomy to SUNY campuses, placing the University in a better position to compete when more resources will become available. The recent gift by the Simons Foundation to the Department ($500K per year for 10 years) can be leveraged to enable new strategic opportunities even in these difficult times.

An important aspect of planning over the next decade is the demographics of our faculty. Of the 45 faculty currently in P&A, 17 will have passed age 70 within 10 years. (We do not include here the 12 members of the YITP who also have joint appointments in P&A, as the YITP is an independent administrative unit. The YITP age demographics are similar to those of P&A.) This roll-over of faculty, coupled with typical attrition, gives us considerable flexibility to pursue new opportunities.

In our considerations we have assumed that the size of our faculty in 10 years will be somewhere between its current size and 10% larger. Our job is to present opportunities for growth that are sufficiently exciting to make the increase possible.

Assessment of the current status

We have grouped the activities in the department into seven major research areas: Astronomy (AST), Atomic, Molecular and Optical Physics (AMO), Condensed Matter Experiment (CMX), Condensed Matter Theory (CMT), High Energy Experiment (HEX), Nuclear Physics Experiment (NPX) and Nuclear Physics Theory (NPT). There are other research areas brought by adjunct (external to SBU) and affiliated (within SBU) professors. These include accelerator physics, structural biology, medical imaging, materials science, atmospheric science and applied physics. These connections offer opportunities for our students, but are not typically recognized when assessing the quality of the department.



In two of the research areas, AST and AMO, we are at the minimum sustainable size. Astronomy, in particular, is now barely able to cover necessary courses and is noticeably smaller than peer groups or departments elsewhere, and should be increased by about two to four faculty over the coming ten years. Although AMO as a field is in a phase of expanding opportunities, our effort is declining and attention should be paid to building this area back to strength.

The strongest departments in the nation invariably have strong condensed matter groups, so our aspirations for enhanced stature will depend on our excellence in this area. Condensed matter research is central to physics generally, and offers important connections to other areas within the department such as nuclear and atomic physics as well as aspects of theoretical physics. It is also is the natural basis for interdisciplinary initiatives with other departments. Some reseeding of our CMX effort will be necessary in the short term, but there is also the opportunity to retarget some current activities to make room for faculty associated with new initiatives.

The HEX group has strong programs are in place that will continue to be important for years to come. Attention is needed however to maintain the activities with excellent young hires. Some of our research programs are invested in large national or international facilities which have finite lifetimes and thus pose problems of redirection of faculty effort. This is particularly true for HEX and NPX. In these areas particularly the department should take care to diversify our programs so as to guard against losing our relevance when facilities close.

Overall, it appears that six to eight current faculty lines could be devoted to new directions over the coming decade through a combination of some retrenchment in some current areas, and redirection of effort.

Over the five decades of its existence, Physics (and then Physics and Astronomy) has had a remarkably stable focus on the research areas noted above. We have not tended to open new sectors of research, nor have we markedly curtailed existing areas. We sense some perception that we have been insufficiently aggressive in seizing new opportunities and have not capitalized on new interdisciplinary or multi-institutional collaborations to the extent that we might have done. We see other departments both in Stony Brook and elsewhere that have more aggressively started initiatives through Centers or larger collaborations that have substantially increased their impact and standing. It is generally assumed that such initiatives are the most positive way to enhance the department's reputation. In particular, opportunities exist for closer integration of effort between SBU and BNL. A mix of joint appointments and inter-institutional centers with BNL would be a natural way for opening new avenues of research.

Practices of the department

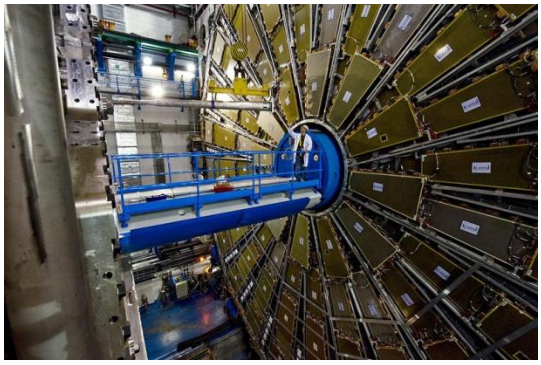
The department has become a leader in physics and astronomy in a remarkably short span of time, so it must be doing many things right. One of the things that many of us prize is the sense of collegiality which enables us to take a common position on ways to move forward. There is room, of course, for improvement and we collect here some suggestions that could enhance our productivity.

The buildings in which we live are large, with quite disconnected spaces organized around research activities. This means that chance encounters are infrequent and leads often to a lack of clear understanding of what others are doing, and their successes or problems. Combating this balkanization requires constant attention, and small steps can be important. The department would be well served by establishing a common room, perhaps adjacent to a new colloquium venue. Some have argued that the current practice of segregating faculty on floors themed by research interests is not ideal; we will always seek out our close colleagues, but chance encounters with others outside our interests require some physical proximity.

The department has traditionally emphasized hiring young faculty over bringing in more established persons. We advocate a more nuanced approach to this hiring strategy, in which refilling lines within established research areas with young scientists is the norm, but in areas where we seek to strike out in new directions, a person with more established credentials may be preferable. In both kinds of hires, we strongly advocate that the criteria be set very high, and that if no person is identified who surpasses the bar, then no offer is made. This insistence on quality is particularly crucial for more senior hires, as there is no subsequent opportunity to rectify a mistake. The new mode of operation in which the department is largely in control of its budget and hiring encourages this insistence on hiring at the highest level – even if we do not find a suitable candidate in one search cycle, we now expect to retain the line.

Some other departments report success with this strategy of conducting searches differently: searches in several areas run simultaneously, with an offer made to the strongest candidate regardless of the field. Such a strategy will not work us in all cases, as there sometimes is a clear need to bolster a particular area rather quickly. However, as we discuss below in connection with initiatives, the success of a new direction will depend so strongly on the quality of the person brought in to start it, that it may be appropriate to seek candidates in several such areas at once and select that area where we can attract the best person.

A long-standing practice of our department is to have faculty teach the recitation sections associated with introductory courses. This is not done in any peer department that we know of. It has the effect of penalizing particularly our junior faculty, for whom teaching is more time consuming, at a time when their energies need to be focused on establishing a research program. Removing this requirement should be a high priority. The flip side of this suggestion is that faculty who are no longer highly research active should take on expanded duties for teaching.

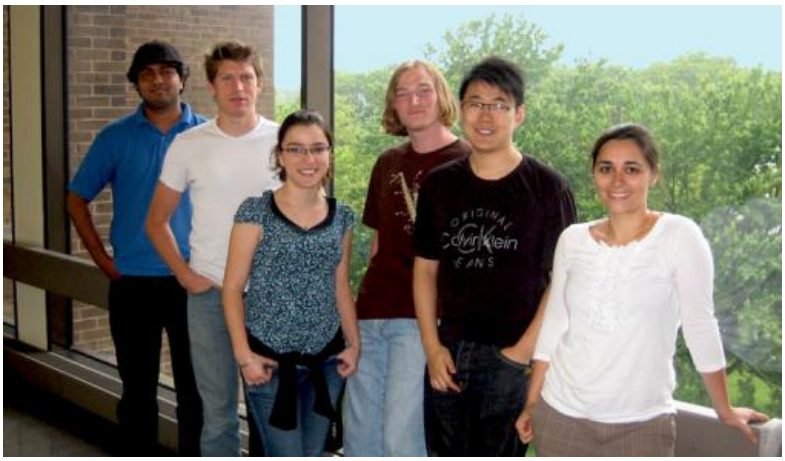


University support

There are several ways in which the university could help this department enhance its stature. While most of these require new funds, we think that they are of sufficient importance to the future of Stony Brook University that they are worth very careful consideration. They address problems that we have encountered in attracting the best candidates for new faculty positions.

The quality of departments at peer universities is well correlated with faculty salaries. Faculty pay at Stony Brook is low when the Long Island cost of living is considered; the NY State 'location adjustment' does not adequately compensate the higher cost. A 2001 North Carolina study (http://www.johnlocke.org/acrobat/pope_articles/) surveys the purchasing power of faculty compensation (salary plus value of major fringe benefits. Stony Brook ranks 118th out of 131 universities considered, and 84th of 90 public universities. We are at a competitive disadvantage in recruiting the best young faculty.

TA support is below the standards of many peer institutions. At present, about 40 TAs are awarded to P&A but are subsidized at the level of 18% by departmental funds to bring them to competitive levels. The number of TAs is low compared to that elsewhere. A 2009 American Institute of Physics compilation of data for 10 public universities[1] reports an average of 75 supported TAs, to be compared with the approximately 40 partially supported lines in P&A. While some care needs to be taken to adjust for program sizes, P&A at Stony Brook is typically of a similar size to these departments. Our Graduate Committee estimates that opportunities for student research could be found if our graduate program were expanded from about 180 to about 225. Increasing the number of TAs, and the overall number of students in our graduate programs, would help in several ways: it would increase revenue for the university; increased TA support would offer the natural solution for teaching introductory recitation sections; and the larger student population would encourage more engagement with research programs in related SBU programs and BNL.



Young physicists and astronomers attracted to our department are often dismayed at the high cost of local housing and tightness of mortgages. Many of our new faculty have recently immigrated to the US and lack substantial financial backing. A program offering low cost mortgages, for a limited period, for qualified new faculty would be a great help in getting these talented individuals to join us.

[1] UCLA, UC Davis, Ohio State, Michigan, U. Washington, Illinois (Champaign Urbana), Maryland (College Park), Connecticut, Texas A&M and Texas (Austin)

Finally, it has long been true, particularly in the sciences, that women are partnered by scientists. Solving the gender imbalance on our faculty would be greatly aided by a more flexible "two body" hiring policy by the university. While it is necessary to insist that each person in the pair be of high quality before hiring both, it would be of great help if there were a few lines in the university set aside for coupled offers.

Possible initiatives

Launching new initiatives will be a key ingredient in raising the stature of the department for several reasons. They can bring new vitality to our research environment, and since all science is interrelated, can create new opportunities even within the fields in which we now work. Physics and astronomy are evolving and increasingly interconnected sciences, and new problems and opportunities are continually emerging. Much of the motivation of the university and the funding agencies for introducing new support focuses on interdisciplinary collaborations, so that our standing will be directly influenced by the degree to which we introduce them. Expanded support for the department will be much more likely on the basis of new initiatives than on extending strong existing programs.

Undertaking a new initiative will require several new hires, and in areas that are new, should begin with the hire of a senior person who will define the program and bring in younger faculty to join it. Any such initiative will require two or three lines, depending on its synergy with other department activities. Given the estimate that we will have around six to eight lines freed through retirements or reprogramming over the next decade, this would mean that the department could undertake two, or possibly three, new ventures in that time frame. In the more favorable case that additional faculty lines are made available from the university, the new initiatives could be pursued more forcefully, thereby increasing their prospects for gaining national prominence. Examples of the Simons Center for Geometry and Physics and the Laufer Center for Computational Biology and Genome Sciences show that a new building or specially refurbished space to house an initiative is the ultimate mark of its impact and visibility.

New initiatives are evaluated according to the following criteria:

(a) What is the overall scientific importance and likely national impact? (b) How unique would this be to Stony Brook? How competitive would we be with other departments? (c) What connections to other Stony Brook units, or to BNL or CSHL, would there be? Does it expand our interdisciplinary engagement? (d) How would this new initiative connect to ongoing activities within the department? (e) What would the cost be (in addition to the new lines)? (f) How likely is this initiative to bring in significant new resources (e.g. Physics Frontier Center or the like)? (g) Are there champions in the department or other units that would drive the development of a new initiative?

The list of possible initiatives is given below, with a very brief description of their character. The order in which they are mentioned is roughly based on a very preliminary opinion formed by the Strategic Planning Committee on their suitability to be initiated in the near-term.

1. **Accelerator science**: Developing new knowledge of the physics and technology of particle beams can illuminate new physical processes and have important applications in physical science, biology and medicine and take advantage of facilities at BNL. In summer 2010, a preproposal to the National Science Foundation for a Physics Frontier Center along these lines

was submitted. Although the proposal was not elected for the second round, the experience will help us to develop a more competitive proposal next time.

2. **Photon science**: The new NSLS II facility now under construction at BNL will explore new phenomena in condensed matter physics, chemical dynamics, materials science, environmental science and structural biology.

3. **Theoretical biological physics**: Computational modeling of biological processes and understanding biological phenomena can be achieved on the basis of underlying physical principles.

4. **Conceptual neuroscience**: In contrast to neurobiology that focuses on biological structure, this field aims to understand the general properties of neural and related structures, either synthetic or biological, and the ways in which information is organized and communicated by such structures.

5. **Enhanced astronomical imaging**: Important problems such as observation of exoplanets, star forming regions and compact objects require new instruments to resolve low contrast objects. Access to frontier facilities can be gained through instrumental contributions.

6. **Coherent quantum control**: Controlling material processes at the electron level and elucidating or controlling the properties of matter that arise from complex correlations offer new applications in chemistry, physics and materials science.

7. **Laser driven high energy density physics**: New national facilities are coming into operation that will allow study of matter in the very high energy density regimes also found in stars, planetary cores, and ultra high energy nuclear collisions. Such studies are an important component of energy research.

8. **Topology in quantum systems**: This initiative would bring together faculty in nuclear, condensed matter and theoretical high energy physics with chemists and electrical engineers. It encompasses studies of such disparate phenomena as hydrodynamics in plasmas, gravity, partonic structure of hadrons and many-body systems such as graphene.

9. **Cosmology**: The discovery that most of the energy density of the universe comes from an unknown and thus far unseen “dark energy” raises fundamental questions about the nature of the universe and its future.

10. **Biological physics experiment**: Studies of simple biological systems or their mechanical counterparts can help guide understanding of complex phenomena such as protein folding, and the interactions among components of living matter.

11. **Device physics**: New physical understanding of nanostructures, superconducting devices and complex semiconductor arrangements can lead to novel devices for broad application.

12. **Astroparticles**: The understanding of fundamental particles and forces from accelerator experiments can be applied to studies of cosmic particle sources both for use in astronomy and for decoding the dark matter puzzle.

13. **Energy science**: Finding and developing new sources of energy is of critical societal need. Many of the problems can be attacked by careful application of physical principles.

14. **Climate science**: The techniques of computer modeling using advanced codes for fluid transport, thermodynamics and hydrodynamics can be brought to bear on understanding our climate.

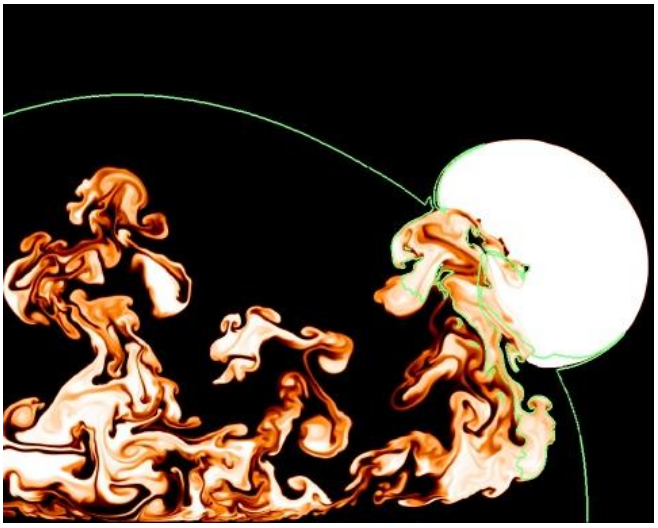
The SPC made a preliminary examination of which of these potential initiatives could be successfully developed within Stony Brook Physics and Astronomy. From that screening, the first eight listed above were identified for a somewhat more in-depth description and evaluation based on the criteria above, and for subsequent discussion.

Some general features of these eight initiatives should be pointed out. First, they range from wholly new activities for the department (high energy density physics, biological physics, conceptual neuroscience) to new thrusts emerging from current or past activities (astronomical instrumentation, coherent quantum control, photon science, topology in quantum systems). The former category may hold good promise for expanding our horizons, but require a great deal more effort to secure the climate within which they could thrive in the department. Although for the latter category it is easier to see how they could evolve, they have less flavor of a bold new direction. The remaining initiative, accelerator science would be new (or at least a restart) at Stony Brook but could be seeded by the strong effort at BNL by physicists who already have a connection to the department.

The eight are also differentiated by the availability of champions within the department on whom we could count to push them along. The accelerator science, enhanced imaging, conceptual neuroscience, topology in quantum systems and coherent quantum control possibilities are examples where this champion could be easily foreseen. Three initiatives – biological physics, photon science and conceptual neuroscience – have connections with biological research in one way or another, and the committee struggled to some extent in differentiating them. Each was judged to be in need of a strong new hire who would forge connections to the Laufer Center for Computational Biology and Genome Sciences, the Center for Computational Neuroscience, the BioImaging Institute, the Joint Photon Sciences Institute (JPSI), or the Departments of Biochemistry, Structural Biology, Chemistry or Computer Science.

The photon science initiative seems particularly natural due to our past involvement in this field and the premier NSLS II facility being built at BNL. Finding ways to engage more productively here is a priority for the department, although the way forward is still somewhat unclear, as the direction would depend strongly on the qualities of a leading faculty person hired to make them happen and to considerable extent on developments outside our department. Thus it could be prudent to proceed by advertising a rather broadly defined new senior hire, with subsequent supplementary junior hires, in more than one of these areas so as to find a superbly qualified candidate in one of them who would then further shape the program.

What is the time scale for these initiatives to start? Those for accelerator science, topology in quantum systems and conceptual neuroscience seem mature enough to launch them now. Theoretical biological physics, photon science and astronomical imaging are reasonably well defined but relationships within P&A and with other departments need further definition. Coherent quantum control has a good basis within the department but needs further definition over the coming two years. The laser driven high energy density physics initiative would be the largest departure from what we are engaged in now and the committee felt that it needed substantial further



definition and exploration of possible collaborations with other departments or BNL, and that it was thus several years away from a start.

Of our list of initiatives, we judged that some (topology in quantum systems, coherent quantum control and astronomical instrumentation), although of very high scientific merit, were achievable through moderate extension of the current activities in the department. The theoretical biological physics initiative would bring a strong new link with new and exciting activities in other departments and the newly formed Laufer Center, but would not likely be an area in which Physics and Astronomy would take the leading role. The high energy density physics initiative would be a major extension of our portfolio, but as noted above we did not feel that it is presently well enough defined to be a candidate now.

In the spirit of seeking bold ideas for new directions that serve university-wide goals, we identified three initiatives for consideration in the university-wide planning process. The criteria for making the choices were: (1) that they give an exceptional scientific opportunity; (2) that they emphasize connections across disciplines and among units inside and outside the university; and (3) that they cannot be viewed as simply extensions of what we do now, but represent new opportunities and challenges.

Accelerator science, photon physics and computational neuroscience (items 1, 2 and 4 in the list above) satisfy the three criteria, as good examples of how the department can lead the university into exciting new areas. Each addresses scientific problems of great interest and urgency on the national scene. Each requires strong collaboration across disciplinary boundaries to make progress. Each is at a stage where the department could capitalize on a near-term investment. Each is in need of some infusion of new resources, primarily a senior person who could provide the necessary leadership and interdisciplinary connections, together perhaps with a few junior hires to make the initiative succeed. For each, the investment needed beyond the cost of the new hires is modest. Finding the appropriate candidates to lead us in these areas will be challenging, and as noted above, it may be necessary to seek the right person in more than one subfield.

The selection of these three initiatives put forward in this plan in no way implies that the other new directions discussed above are of less interest or importance. It simply reflects the fact that those initiatives which evolve from current activities can be started within the context of future retirements and redirections without substantial new external funds.

For each of the three initiatives advocated for university-wide consideration we have assessed their strengths and the areas where more work is needed.

The accelerator science initiative addresses an area of growing national priority as accelerators migrate to new research communities and find expanded use in medicine, industry and government. The geographical proximity of Stony Brook to a major national accelerator laboratory gives us a nearly unique opportunity. Research in this area involves a broad range of core disciplines in physics and connects with applied mathematics and many engineering departments. We expect that this subject will attract many new students both at the PhD and MS level as the demand for graduates is high. The BNL pre-eminence in accelerator science is a strong plus, but we feel that it will be necessary to establish a strong base in P&A both through new hires and creation of joint appointments with BNL. The champions for this initiative exist in our department now.

Conceptual neuroscience addresses one of the most fundamental questions in science today: “How does matter organize itself to think and communicate?” Although this question has a strong basis in neurobiology, it also extends to artificial systems such as those studied in computer science or electrical engineering and widely used in physics and astronomy. These disparate disciplines can be connected and organized by persons trained in physics to create a much broader view than afforded by either pole, allowing the possibility of the transformational advances that arise from collaboration across cultures. We envision connections within the department to prior work in condensed matter physics and extending to the YITP, Simons Center for Geometry and Physics, Center for Computational Neuroscience, and the Laufer Center. This initiative would require a new hire of a senior person to help define the specific program, but several current P&A faculty are interested in this thrust and champions to push it forward exist.

Photon science is a very attractive and timely initiative owing to the NSLS II project at BNL due to turn on in 2014. The proximity of this world class facility to Stony brook provides a unique opportunity for leadership at the university. Photon science includes a variety of physics research topics ranging from correlated electron systems and magnetism, X-ray imaging of biological systems, and nanoscience. In addition it includes many aspects of materials science, environmental science and structural biology of interest to other Stony Brook departments. The structural biology effort could benefit from physicist leadership in developing new methodologies for time-domain studies of proteins or enzymes. In our view, this initiative should provide a nucleus around which the various Stony Brook programs at NSLS II could coalesce. Participation in JPSI, the joint BNL/Stony Brook center for photon science offers the possibility of extended external collaborations. Although P&A has worked at the NSLS in the past, our current program there is diminished, and a new senior hire is needed.

Summary and conclusions

- Our general goal is to raise the ranking of Stony Brook Physics and Astronomy by further strengthening the Department in ways that address the criteria of excellence on which such rankings are intended to be based. We aspire to move from the current status of being in the top 10% to being one of the top 10 departments in the nation.
- In an increasingly interdependent scientific community, the Department should seek to expand its engagement with other departments, both within and without the university, through collaborative interdisciplinary initiatives. Expanded collaboration within the department will also be important.
- New initiatives offer the best way to enhance our standing in comparison with other peer departments. We have identified criteria against which initiatives can be judged. Eight potential initiatives were evaluated in detail, and their readiness to be started was gauged. Three good examples for university-wide consideration were identified. Two or three such initiatives could be undertaken in the next several years.
- The Simons Foundation gift offers a major opportunity to realize new initiatives and we propose that those funds be devoted to making them happen, both through support of new faculty and provision of funds that enable new external funding.
- The Department should eliminate or reduce the reliance on faculty for teaching recitation sections as secondary assignments. This practice, and the assignment of administrative positions, detracts from the research effectiveness particularly of our younger faculty. Increased university support for TAs would help solve the recitation teaching problem, and would itself allow new income and enhanced research performance in the Department. Other changes to current Department and University practice are discussed.
- We are pleased that the new budgeting rules instituted by the Provost have improved the ability of the Department to make long term planning decisions and have enabled us to carry out searches for new faculty in a more deliberate and selective manner.
- We will establish a standing committee (Strategic Planning Committee), charged with reviewing and guiding the new initiatives. Its operation will be similar to the review committees that funding agencies or national laboratories convene to evaluate ongoing projects, where progress and problems can be identified, and recommendations given on an annual or semi-annual basis.

Appendix: Committee and Charge

TO: Strategic Planning Committee Members
FROM: Laszlo Mihaly, Professor and Chair
SUBJECT: Charge to the Strategic Planning Committee
DATE: March 2, 2010
Committee Members:
Boris Altshuler, Professor, Department of Physics, Columbia University
Samuel Aronson, Director, Brookhaven National Laboratory
Paul Grannis, (Committee Chair) Distinguished Research Professor, Department of Physics and Astronomy, SBU
John Hobbs, Professor, Department of Physics and Astronomy, SBU
Barbara Jacak, Distinguished Professor, Department of Physics and Astronomy, SBU
Janos Kirz, Scientific Advisor, Advanced Light Source, Lawrence Berkeley Laboratory and Distinguished Research Professor, Department of Physics and Astronomy, SBU
James Lattimer, Professor, Department of Physics and Astronomy, SBU
Konstantin Likharev, Distinguished Professor, Department of Physics and Astronomy, SBU
Luis Orozco, Professor, Joint Quantum Institute and Department of Physics, University of Maryland
Peter Paul, Distinguished Research Professor, Department of Physics and Astronomy, SBU
Steven O. Smith, Professor and Director of Structural Biology, Department of Biochemistry and Cell Biology, SBU
George Sterman, Distinguished Professor, Department of Physics and Astronomy and Director of YITP, SBU
At our faculty meeting in November, 2009, while accepting the report of the Long Range Planning Committee, we decided that the Department needs a Strategic Plan, looking beyond the 3-5 year time horizon of the typical Long Range Plans. Our decision to start Strategic Planning coincided with the launch of a similar planning process initiated by President Stanley.

At the meeting we discussed several ways of formulating the Strategic Plan, including a Town Hall meeting and other ideas. After consultations with many faculty members I came to the conclusion that the best approach is to appoint this committee. The report of the Committee will be discussed and voted on according to our usual customs.

Maintaining and improving the excellence of the Department is the result of our dedication to research, teaching and service. We have never given up the goal of being among the best 10 Departments in the Nation. You are asked to provide recommendations, relevant at a time scale of 5 years and beyond, to guide the faculty, future Long Range Planning Committees and Department Chairs to achieve this goal.

It is recognized that over the years changing circumstances will likely lead to revisions of the long term goals. All we ask from you is to use your considerable experience and expertise to provide us with the best guidelines possible at this point in time. You will have at your disposal all the data and resources the Department has access to. In particular, you may want to review the reports of past Long Range Planning Committees and the 2006 Self Study Report. Available NRC and other ranking data for the last 25 years from various sources will be provided to you. You can also look at current and past teaching, funding and publications and other data of our faculty. You can choose whatever you think is the best way to consult with Department members. Naturally, seeking contributions from our junior faculty is especially important.

I recommend that you report your first findings to the faculty before the end of this (Spring 2010) semester. Whereas it is possible that that report will be the final report of the Committee, it is also possible that revisions, based on faculty discussion and advice, will be needed and the final report will be put forward for faculty vote early in the Fall 2010 semester.

The specific questions to the committee:

1./ Are there one or two areas of research with the greatest opportunities for us to compete with the top three departments/programs in the US?

2./ What are the areas of research where we are lagging behind and in which do we need to invest in order to maintain a balanced Ph.D. program?

3./ If, to achieve expansion into new areas or meet university constraints, we are forced to

retrench in some area, what would it be?

4./ Do you see research areas where we can work towards removing traditional boundaries within physics/astronomy or between physics/astronomy and other disciplines?

5./ What should be our policy regarding joint research with Brookhaven Lab? What should be our approach towards various interdepartmental Centers and Institutes, the number of which is likely to increase? Are there long term benefits in giving faculty position to high visibility researchers primarily based in these units?

6./ Are there emerging opportunities in graduate education, student recruitment and mentoring that the Department should be pursuing