University of Washington

Department of Physics

Ten Year Review, Autumn 2018

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Executive Summary

Physics is *the* foundational science. The central importance of research and instruction in physics demands that a research-intensive university aspire to lead in this field. The University of Washington is fortunate to have a department of physics that is already one of the most outstanding in the world. The department is keen not just to maintain this position, but to "substantially improve the national and international ranking of the department." The Review Committee (RC) endorses this goal, and agrees wholeheartedly that a renewed investment will be necessary if the department is to achieve it.

In the past decade, like most STEM units at the UW, physics has weathered an increase in the size of its undergraduate service instructional program. The 100-level program serves students across campus, was large at the outset, and grew by 20% during the past decade. But it is the majors' undergraduate program that underwent stunning growth in this decade, *tripling in size from about 60 to 180 bachelor's degrees per year*. There are just a few other physics departments nationally at which annual degree production comes even close to this size. In other words, degree production on this unusually large scale is not normal for a physics department in the U.S.

Most unfortunately, this growth occurred during a period of severe financial austerity, particularly in the College of Arts and Sciences. The larger instructional mission in physics was achieved not only without significant additional resources, but rather with a *reduction* in the tenure track faculty count of the department. Though students express satisfaction with the physics undergraduate education they receive at all course levels, the growth has strained the program. Most introductory coursework is now offered by lecturers, upper division courses are much larger than in the past, TA funding constraints preclude breakout sessions for 200-level majors courses, advanced laboratories are using out of date equipment, and capstone/research experiences vary widely in availability and quality. In response to these challenges, the department is proposing to roll back and cap the size of majors program at about 120 bachelor's degrees per year.

The RC believes the UW administration should collaborate with physics to determine (and provide) a resource base and program modifications that together ensure both quality and accessibility of a physics undergraduate education at this institution. The RC did not attempt to undertake a detailed financial analysis of the department, but heard repeatedly and strongly from all constituencies (faculty, staff, TAs, students) of negative consequences of an inadequate budget.

The physics graduate degree program remains quite strong. Student morale is good. The RC saw evidence of strong mentoring in the early years. The program continues to make efforts to sustain and improve diversity. The professional masters degree program is in good health.

The RC appreciated that the department had seized the opportunity provided by this review to come to consensus on a thoughtful faculty hiring plan. The RC is pleased to strongly endorse this plan, particularly the focus on hiring faculty members in areas of theoretical physics. A relatively

small number of hires could be the difference between sustaining or even improving the already high quality of this department and significant decline.

The department is well governed. The RC congratulates long-serving department chair Professor Blayne Heckel and the three highly capable associate chairs (Professors Marjorie Olmstead, Marcel den Nijs, and Laurence Yaffe) for this. The staff members are highly capable and dedicated; the staffing level of the department seems modest, particularly in light of the greatly expanded undergraduate program.

The culture of this department can be captured in a single word: Excellence. The members of this department wish to be the very best—in the nation or even the world—at what they do, be it teaching or research. It was clear to the RC in all of our meetings that the department feels, and the RC concurs, that their excellence is threatened by their current financial circumstances. There is a mismatch between the size of their task and the budget that supports it. A closing statement in the self-study summarizes the problem:

> "How the [College of Arts and Sciences] (or central administration) chooses to address the current mismatch between the funds needed to support a competitive physics program and the tuition revenue derived from physics SCH is the most serious issue facing the department going forward."

A former Provost of the University of Washington is rumored once to have said that ten year review committees across all fields report that "this department is pretty good, but they need more resources." Under those circumstances it would be hard for an administration *not* to become desensitized to such requests. Two things set this case apart: first, this department, a key science unit, is not just "pretty good"; it is outstanding. The department is responsible for two of the entire institution's seven Nobel Prizes. Second, this department has seen extraordinary growth in its majors program without appreciable financial investment for the obvious reason of financial austerity in the College to which they report. The degree to which the department perceives this as a serious threat to the quality of their programs in the long term is indicated by their proposal to petition to transfer to a better-supported college.

The RC understands that physics is unlikely to be the only department at the University with unmet financial needs. The question we ask is whether the University has done all that it is appropriate to do and can do financially to help physics, given the magnitude of their unmet financial need. We do not see the current situation as stable. We request that this report stimulate an in-depth consideration of that question.

Summary of Recommendations

The Review Committee recommends that all degree programs be continued, and that the program next be reviewed in ten years. We recommend additionally:

Overarching Recommendation

- The university (including representatives from the Provost's office and the College or Arts and Sciences) should partner with the department to make a serious assessment of what is a reasonable resource base to achieve the several missions we expect of the department, and to devise a plan (perhaps multi-year in nature) to provide and deploy that resource base. Such a plan should take into account the workload/resource base of national peer physics departments and on-campus peer science and engineering departments.

Undergraduate Instructional Program

- The department should continue its current laudable practice of endeavoring to meet student demand for introductory level physics coursework with offerings of the very highest quality.
- The department should continue its current laudable practice of endeavoring to meet student demand for majors physics coursework and research/capstone offerings and of the very highest quality.
- To the extent possible, steps should be taken to evaluate the impact on student learning of the large upper division classes, and if the impact is negative to reduce the size of these classes.
- The College should work with the department to ensure the availability of TA resources sufficient to cover all levels of the undergraduate program, including the addition of small break-out sessions ("sections") for sophomore level coursework.
- The Provost and College should participate in making available funds to ensure that upper-division laboratory courses (which have lower enrollment, such that laboratory fees provide inadequate resources) use modern equipment.
- More faculty members should be encouraged to offer capstone/research experiences for majors, perhaps "rationed" in some way by the department to ensure students best able to benefit are served.
- The RC leans against capping the physics degree program, but recognizes the imperative to assure an appropriate quality/quantity balance given available resources. The RC also acknowledges that capping of instructional programs has been a successful strategy in other Colleges for securing new resources. The RC would prefer as a worst case capping only the "comprehensive" track, leaving others open to qualified students. A decision to cap the total program has ramifications for other departments and the budget of the College of Arts and Sciences and thus would need to be approved by the Dean of the College of Arts and Sciences.

Graduate Degree Programs

Ph.D. Program

- As already well understood by the department, attention to increasing the diversity of the graduate program should be continued. Attention to both financial support and "soft skills" are important.
- Continued attention to diversity issues in departmental climate. Careful attention should be paid to recommendations of the APS climate committee review.
- Space issues, particularly the need for graduate student office space, should be addressed.
- As in all departments, there must be continuing efforts to find additional sources of external funding for graduate students. This includes increased attention to fundraising.

PMSP Program

- The department should look into increasing the tuition charged for the PMSP program; this is a program that benefits both the students and the department.
- Marketing should be increased, particularly to local industry where employers find value in the training provided to their employees.
- With increased tuition, financial aid could be offered from the income to select students.
- Look for recent PhD graduates who need teaching experience to act as lecturers for these courses, rather than young faculty.
- Consider partnering with engineering to broaden the potential student base.
- Focus on local students, or abandon the idea of experimental capstone projects for PMSP students (these could be replaced by reading or technology assessment projects).

Research and the Faculty

Quantum Matter (QM)

- The group needs a mix of theory (highest priority) and experiment. The additional faculty lines committed to the retention case should be honored, but it is more important that these searches be done thoughtfully and top asst. profs. hired than that it be done quickly.
- The group needs to work more effectively with the Natural Sciences Development staff to understand how to raise funds for their priorities, which are (correctly) graduate student fellowships, and postdoctoral support. The excitement of their proposed research is more important to likely donors than the naming of the institute after Nobel Laureate Thouless; it is more likely that the donor would want the institute (or the fellowships) named after something important to them.
- The group might explore connecting better to the QIC.

Challenging the Standard Model: Experiments at the Energy and Precision Frontiers

- We recommend the University continue its historically strong support for these efforts. We applaud that the group is alert to developing new areas and in maintaining its leadership position in a number of existing areas. This includes improvements to ADMX, larger scale searches for neutrinoless double beta decay, and possible future very high energy colliders. Consideration will have to be given to impending retirements,

though we note that the group, in its meetings with our committee, supported the department's view that the first priority is hiring in theory.

Theoretical Nuclear Physics, Particle Physics, and Particle Astrophysics

- Hiring, ideally in anticipation of retirements and to offset separation
- Openness in hiring to emerging areas of interest, e.g. synergistic efforts with those in quantum information and quantum computing (overlaps with string theory, nuclear physics, lattice gauge theory).

Quantum Information and Computing

- We believe that Quantum Information and Quantum Computing is an emerging area with great promise, where the University of Washington is positioned to develop a significant presence. A core of excellent faculty across several relevant disciplines is in a position to lead this effort. There is a good positive energy among the faculty. Additional faculty could lie in Engineering or be joint hires, rather than looking for more positions entirely within Physics. We agree that theory is a priority. Fundraising for graduate and postdoctoral fellows can and should be part of departmental development priorities, for this area specifically (as one that is likely to appeal to donors, as well as to federal funding agencies and industrial partners).

Physics Education Research (PER)

- Department should be sure to maintain strength in this area of national impact, but hiring in this area is not the leading priority in the near term (as recognized by all including the PER group).

Biophysics

- Although this is a promising area of research, given limited numbers of hires, searches in other areas should be higher priority.

Governance, Staffing, Diversity, and Culture

- The Dean and Provost are strongly urged to partner with the department to embed a staff person to jump-start their fund raising activities.
- Continue diversity efforts. The efforts are laudable and based on experimentation and learning; this should be continued at all levels.

I. Process

The Review Committee (RC) members were identified during the Winter Quarter of 2018, and formally appointed on May 22, 2018. The latter coincided with a one-hour initial meeting of available members of the RC (all but FH) with representatives of the various UW offices coordinating the review as well as representatives from the Department of Physics ("the department"). At that meeting the charge to the committee (see Appendix A) was reviewed, the dates of the two-day site visit confirmed (November 8 and 9, 2018), and the department Chair, Professor Blayne Heckel, briefly presented to the RC a set of "unit-defined" questions that the RC was invited to answer.

In late September, 2018, the RC received a highly informative Self-Study document and extensive appendices thoughtfully prepared by the department, as well as a proposed agenda for the upcoming site visit. The latter evolved somewhat in the succeeding weeks; the final schedule (see Appendix B) afforded ample opportunity for the RC to pursue candid conversations with representatives from all constituencies, including faculty, staff, and graduate and undergraduate students. An exit discussion at the end of the second day of the site visit afforded an opportunity for the RC to share initial observations with the leadership group from the department and representatives from the UW offices coordinating the review. A final executive session allowed the RC to converse with University administrators to whom the department reports.

In addition to the above, the RC had available to it documents archived by the Graduate School concerning department reviews from 2008-2009 and 1997-1998. Particularly informative was the Review Committee report from the 2008-2009 review, which argued strongly that it was in the University's best interest to invest in the department in order to assure that the stellar international reputation of the department not be lost due to retirements and the departure of several key faculty members to other institutions. Also informative was an interim report prepared in 2013 by the current department Chair in response to the concerns expressed in the 2008-2009 review.

II. Background and Current Issues

We concur with the assessment of the 2008 Ten Year Review Committee of the Department of Physics concerning the central role of the discipline:

> "Physics is the foundation of the sciences. It seeks to understand some of the most profound questions humans can ask. It is fundamental to all of the other sciences, as well as medicine and engineering, which often draw upon its discoveries for subsequent advances in their own fields."

Furthermore, the role of a physics department in a major public research university goes well beyond pursuing the answers to these profound questions, because of the instructional mission. Since the last ten-year review, the department has offered introductory physics instruction to approaching 30,000 undergraduate students! Additionally, as a nationally leading producer of bachelor's degree recipients, the department has awarded roughly 1000 physics baccalaureate degrees. The department is also responsible for the graduate and postdoctoral education for the next generation of physicists.

For all of these reasons, there can be no doubt that any research intensive academic institution that aspires to lead in research and education in the sciences must have an outstanding physics department.

The University of Washington is fortunate to have one of the most outstanding physics departments in the U.S. Of the just seven Nobel Prizes that the UW Office of Research lists on its website as having been awarded to UW faculty, two (Dehmelt and Thouless) were awarded to physics faculty, an astonishing record. As recently as the late 1990s, the department of Physics was clearly the most highly regarded nationally among the "large" UW science units, then ranked 14th by the National Research Council.

The department underwent a ten-year review two decades ago, in 1997, at the time they enjoyed the 14th ranking. The review committee report stated that the department could "realistically aspire to move into the top 10." But the report went on to call the department "fragile" due to the age profile of the faculty, noting "real danger of it seriously slipping in the coming decade."

Indeed, a decade later (in 2008) more than a third of the faculty had turned over, due to both retirements and departures to other prestigious institutions. The U.S. News and World report reputational ranking in 2008 had dropped somewhat, to 20th. The 2008 ten-year review committee characterized the ranking as having "slipped seriously", noting that these rankings are typically very stable across time. The 2008 report characterized the situation (which again included the possibility of further substantial faculty turnover through both retirements and departures to other institutions) as follows:

> "It is not an exaggeration to say that the Department faces a crisis, and valiant efforts will need to be made by the Department and the institution, despite the current fiscal difficulties, to prevent a further loss of stature, morale, and competitiveness."

Today, a decade later, the RC is pleased to concur with the leadership of the department that the potential crisis did not materialize. The current U.S. News and World Report ranking of 22nd indicates the department has maintained, but not rebuilt, its national reputation. At the same time, it has been a challenging decade for the department. The beginning and ends of the past decade have been characterized by declining local budgets, initially due to the financial crisis (a nationwide experience for public higher education), and more recently due to a serious budget deficit in the College of Arts and Sciences (A&S). Like many other A&S units, physics has seen their tenure track faculty count decline during the past decade. The latter is especially troubling, given the growth in undergraduate teaching responsibilities the department has continued to experience.

Given these financial difficulties, on top of the rising instructional demands being placed upon them, the RC believes the department deserves great credit for having held its current national ranking during the past decade. It is hard to imagine, under these financial circumstances, doing better than this.

The department concludes its self study by stating its aspiration to "substantially improve the national and international ranking of the department", noting that an investment to fill existing and future faculty vacancies would be needed. The RC endorses this goal, and agrees that a renewed investment will be necessary if the department is to achieve it.

III. Undergraduate Instructional Program

The department is charged with providing the highest possible quality undergraduate instructional program that includes both service and majors courses. The service program, in particular, has impact on undergraduate students university-wide. The department takes this responsibility very seriously. The scale of these programs is among the largest at the UW. By the measure of baccalaureate degrees in physics annually awarded, the program is among—and in some recent years has been—the largest in the nation.

The ability of the department to offer a high quality undergraduate program is critically dependent upon the availability of a team of faculty (tenure track and lecturers), staff (primarily to coordinate laboratory courses), and teaching assistants that is size-matched to the task they face. During the past decade the department has taken heroic steps to accommodate substantial growth in both the service and majors programs. Through no fault of the department, the demand for and size of the programs have grown at a rate that far outstrips the rate at which new resources have been made available to support these enrollments. This has placed the department under great pressure, and risked the quality of the undergraduate education the department can be expected to provide. Under these challenging circumstances, the department has done an outstanding job.

Undergraduate Service (Introductory) Instructional Program

Strengths

- A very high quality program that directly serves *45% of all incoming UW freshmen*.
- A range of entry options catering to varied levels of student preparation and interests.
- Student enrollment demand that has risen 20% in the past decade.
- A highly capable group of lecturers and a physics education group that provide leadership on "evidence based" curriculum and teaching methods in the introductory level courses.
- A deep commitment on the part of all members of the department to provide the highest possible quality instructional program and to meet student demand for these courses.

Challenges

- The quality of the introductory physics courses is placed at risk by a resource base (supporting faculty, TAs, staff, and operating costs) that not only has not tracked rising student demand, but appears recently to be in decline.

Discussion

About 45% of entering freshman take at least one of the department's introductory level physics courses. Some of these students go on to become physics majors, but the vast majority will earn a degree in a wide range of other disciplines, from anthropology to zoology. It is in the University's broadest interests to assure the high quality of the physics introductory level coursework.

The vast majority of introductory level undergraduate physics enrollments are in two three-quarter sequences (that both include a laboratory component). PHYS 114/5/6 is a sequence

intended for life science students ("algebra based") that initially enrolls about a 1000 per year. PHYS 121/2/3 is a sequence intended for physical science and engineering students ("calculus based") that initially enrolls nearly 2000 per year. About 50-60 of the latter enrollments are in an honors version of the calculus-based sequence that is an important source of physics majors, but that also serves the most capable and ambitious undergraduates across all majors.

Rising enrollments in these two three-quarter sequences have driven a 20% increase in the size (by measure of student credit hours) in the 100-level physics programs during the decade covered by this review (2009-2018). The increase has been accommodated by a combination of a larger number of sections of some courses being offered annually, and an increase in the number of students per section.

The entry level program consumes the lion's share of the department's resources: about 40% of all faculty teaching assignments and about 60% of the TA resources are invested at the 100-level. About 70% of the department's student credit hours are generated by these courses.

About 2/3rds of the instruction in the 100-level program is provided by lecturers, with the balance taught by tenure-track faculty. The physics education group plays a central role in maintaining and advancing the quality of instruction at this level using "evidence based" curricula and methods, providing a national model.

All of the evidence available to the RC, including the self-study and interviews with faculty, staff, teaching assistants, and undergraduate students, suggests that the quality of the introductory program is maintained at a very high level. The concern uniformly expressed by these individuals, and with which the RC concurs, is that the quality of these programs has been placed at risk by a resource base that not only does not track the workload (as driven by meeting student demand for enrollment) but that appears recently to be in decline.

Among the unit-defined questions posed by the department to the RC was, "Are resources being used efficiently in our introductory physics program?" The RC does not purport to have a definitive answer to this question but offers the following observations:

There is no reason to believe that the modest levels of non-faculty staffing (as in laboratory support staff) and TAs are not used quite efficiently. Good arguments can no doubt be made for *more* investment in those areas.

The self study notes that some 40% of faculty teaching assignments are consumed by the 100-level courses, predominantly by PHYS 114/5/6 and PHYS 121/2/3, and that faculty members are in short supply. We note reluctantly the obvious, which the RC believes should be a last resort, which is that fewer faculty would need to be invested in the 100-level program (and thus released to support the exploding majors program) if the average size of the sections were increased from the current ca. 200/section. Facing similar pressures, both Biology and Chemistry have moved at least some of their introductory coursework to much larger scale: BIOL 180 at 576/section, and CHEM 142 presently at about 600/section. On the other hand, facing similar rising enrollment pressures, UW Mathematics has chosen not to exceed 160/section in their lower level coursework. The RC has no sense of what are the national standards in this regard for the field of

physics, or for that matter whether the national standard is "evidence based" for optimal student learning. The physics education group is well equipped to assess whether an increase in section size would have negative consequences for student learning outcomes. The RC agrees with the department that it would be unfortunate for a scale-up of section size to negatively impact the ability of faculty to use lecture demonstrations; there would clearly be a one-time cost of unknown size associated with equipping a larger lecture hall for demonstrations that the university would need to make. We note that large lecture theaters have at times been in short supply at UW, and there is no point to consideration of increasing section size if a larger lecture theater were not available to the department at suitable days/times.

On balance the RC was convinced that the department takes extraordinarily seriously the commitment to provide the highest quality undergraduate service education possible and on a scale that meets student demand. This attitude is highly laudable.

Recommendations

- The department should continue its current laudable practice of endeavoring to meet student demand for introductory level physics coursework with offerings of the very highest quality.
- The university (including representatives from the Provost's office and the College of Arts and Sciences) should partner with the department to make a serious assessment of what is a reasonable resource base to achieve the several missions we expect of the department, and to devise a plan (perhaps multi-year in nature) to provide and deploy that resource base. Such a plan should take into account the workload/resource base of national peer physics departments and on-campus peer science and engineering departments.

Undergraduate Majors Instructional Program

Strengths

- A top-quality program that is in high and rising student demand; tripling of annual baccalaureate degree production in past decade to nearly 180 degrees/year.
- Implementation since last review of three new undergraduate degree tracks that have improved retention and student satisfaction.
- A deep commitment on the part of all members of the department to provide the highest possible quality degree program that has met the demand of qualified students.
- A deep commitment by the faculty to providing capstone experiences to all majors.

Challenges

- A tenure track faculty count that has declined rather than risen in the face of a tripling in scale of the degree program.
- Sophomore level courses that lack break-out sessions due to lack of TA funds.
- Upper division courses with enrollment numbers that preclude a deep interaction with faculty.
- Outdated equipment in advanced laboratories and no funding source to upgrade.

- Their commitment to provide research/capstone experience to all majors is stretching faculty availability as the number of majors has gone up while faculty numbers have declined, leading to consideration of capping the number of majors.

Discussion

The combination of the baby-boom echo, which caused the college-age population of the U.S. to rise dramatically beginning in about 1995, and a contemporaneous long-term trend of students shifting their choice of majors toward (higher cost) STEM majors has placed science, mathematics, and engineering departments at the UW under very significant pressure to meet rising enrollment demand in their degree programs. At the same time, public institutions in particular have faced a prolonged era of fiscal austerity, in which budgets have risen inadequately to cover the rising costs caused by these demographic trends.

How UW units have responded to this pressure has varied. In broad overview, the approach adopted by the College of Arts and Sciences has been to meet student demand, with the result that annual bachelor's degree production in a number of science units sky-rocketed, by factors approaching ten! Again in broad overview, the College of Engineering adopted a policy of limiting enrollments on the basis of resource constraints. The latter approach has arguably been more successful at controlling the resource/workload ratio of the impacted departments, and no doubt plays a role in the quite logical suggestion made in the self-study that the UW physics mission might better be pursued by shifting from membership in the College of Arts and Sciences to the College of Engineering (more on this later).

The precise years during which various degree programs experienced enrollment growth have varied by discipline. This has perhaps contributed to such landmark changes in scale of science and mathematics degree programs at UW having been met with rather limited response in terms of new investment. During the decade presently being reviewed the physics department's annual production of baccalaureate physics degrees has exploded: from about 50-60/year a decade ago to 150-180/year today, a tripling. Paradoxically, the tenure-track faculty of physics was more than 40 FTE a decade ago, and is below 40 FTE today. Tripling the rate of degree production with a declining census of tenure track faculty obviously then required major changes to the program. The additional degree production was achieved by shifting a substantial fraction of the entry level program to lecturers, and increasing the size of upper division (majors) courses, with unknown long term consequences. The department has been challenged to find meaningful research opportunities for so many students seeking a physics degree.

A second dramatic, in this case positive change to the department's undergraduate degree programs was the introduction in 2011 of three new degree "tracks". Added to the traditional "comprehensive" program were tracks for those interested in applied physics, biological physics, and physics teacher preparation. About 90% of students pursue the comprehensive or applied tracks (about evenly divided). About 7% of physics majors opt for the biological physics programs and about 2% for physics teacher preparation. This change, endorsed by the RC from 2008, was in part responsive to the dissatisfaction of students majoring in physics after being rejected from degree programs in the College of Engineering. The department makes a compelling case that the track system has led to high student satisfaction: an annual senior

survey find 80 to 90% of student rate *every* individual physics course they have taken, from 100 through 400 levels, as very valuable, valuable, or somewhat valuable.

The tripling of degree production in an era of fiscal austerity has created a number of problems that the university should help the department to address. The RC believes that the university should work with the department to address as many of the deficiencies identified by the department as is possible, which include:

- Upper division courses have become much larger than in the past. The question of whether this has impacted student learning should be evaluated.
- There are no small-group break out sessions ("sections") for sophomore level coursework. Even at the increased scale of the degree program, the new investment in TAs needed to add these break out sessions would not be large.
- Advanced laboratories are using out-of-date equipment. Lab fees work well for lower division (high enrollment) courses; but in advanced laboratories (low enrollment) lab fees generate insufficient revenue to cover the costs of modern scientific equipment.
- Capstone/research experiences now vary widely in availability, quality, and depth.

Included in the discussion of the unit-defined questions posed by the department to the RC was the statement that the department (through the "direct to division" admission program, now on hold) intends to target a future graduation rate of 120 students per year, or up to about 30% smaller than the largest class previously graduated (of 173), rolling back the clock about three years. This would have the obvious impact of reducing upper division class sizes and improving the availability of capstone/research experiences. This approach is entirely consistent with that adopted by the College of Engineering, which appears to have resulted in new resource investment. Nevertheless, the RC has strong reservations concerning any "capping" of the availability of the opportunity for qualified UW students to pursue a baccalaureate degree in physics.

The RC would strongly prefer to see the department and university collaborate to provide a resources base and program modifications that together assure that students wishing to study physics all receive the best possible physics education *consistent with their level of commitment*. Perhaps a cap could be established only on the "comprehensive track". Or special sections of upper division coursework, with enrollment caps, could be established to focus additional resources on students selected on some basis determined by the department. Similarly, some mechanism of selectively allocating research/capstone experiences to students best able to benefit from these experiences could be coordinated by the department. The RC would prefer to see undergraduate students turned away from the study of physics *only* if it is clear that these students would be better served by studying in some other department.

Capping the physics degree program has consequences not just for the physics department, because it potentially sends students to other departments, and has budgetary consequences for the College of Arts and Sciences. In the end any decision to cap would need to meet with the approval of the Dean of the College of Arts and Sciences.

Recommendations

- The department should continue its current laudable practice of endeavoring to meet student demand for physics coursework and research/capstone offerings of the very highest quality.
- The university (including representatives from the Provost's office and the College or Arts and Sciences) should partner with the department to make a serious assessment of what is a reasonable resource base to achieve the several missions we expect of the department, and to devise a plan (perhaps multi-year in nature) to provide and deploy that resource base. Such a plan should take into account the workload/resource base of national peer physics departments and on-campus peer science and engineering departments.
- To the extent possible steps should be taken to evaluate the impact on student learning of the large upper division classes, and if the impact is negative to reduce the size of these classes.
- The College should work with the department to ensure the availability of TA resources sufficient to cover all levels of the undergraduate program, including the addition of small break-out sessions ("sections") for sophomore level coursework.
- The Provost and College should participate in making available funds to ensure that upper-division (lower enrollment, for which laboratory fees provide inadequate resources) laboratory courses use modern equipment.
- More faculty should be encouraged to offer capstone/research experiences for majors, perhaps "rationed" in some way by the department to ensure students best able to benefit are served.
- The RC leans against capping the physics degree program, but recognizes the imperative to assure an appropriate quality/quantity balance given available resources. The RC also acknowledges that capping of instructional programs has been a successful strategy in other Colleges for securing new resources. The RC would prefer as a worst case capping only the "comprehensive" track, leaving others open to qualified students. A decision to cap the total program has ramifications for other departments and the budget of the College of Arts and Sciences and thus would need to be approved by the Dean of the College of Arts and Sciences.

IV. Graduate Degree Programs

Doctoral Program

Strengths

- Student morale seems good
- Generally effective PhD mentoring; evidence of strong 1st and 2nd year mentoring.
- Qualifying exam revisions made some years ago seem sensible.
- Significant effort with some success to sustain/improve diversity

Challenges

- Diversity: This is a nationally shared problem, in part attributable to the pool of qualified candidates. Two years ago, the department saw a significant decline in the number of female students in its entering class. This has been improved by targeted recruitment strategies and a one-time success in obtaining dedicated funding, but the lack of continuing funding remains a source of concern.
- Balancing need for TAs with RAs.
- Limited RA support in some theoretical areas.
- Challenges in finding space for students, e.g. some students have no actual office space, only space in labs.

Discussion

From our discussions with students and with the graduate program coordinator, we came away with the sense that overall student morale is high and that they are generally happy with the opportunities available to them at UW, and with the level of faculty support. They generally seem happy with the level of individual mentoring. We did hear concerns about space and about external support in some research areas. The department seems happy with the change in the qualifying examination policy (in particular, the department has moved to a coursework-based assessment of early graduate student performance). Retention levels seem appropriate. The average time to degree – 6.2 years – seems somewhat long.

The RC heard mixed reviews of the impact on graduate students and the program concerning the present level of compensation for RAs and TAs. On the one hand, we were told that data suggested that recruitment of new graduate students to the program is not being negatively impacted by current salary levels. On the other hand, and not surprisingly, students reported some difficulty living in the increasingly expensive Seattle area. The RC encourages the department to explore financial sources that would allow physics graduate students to have parity in compensation with graduate students in other UW science units in all years.

The committee was impressed with student peer mentoring and hosting of the regional APS conference for Undergraduate Women in Physics, with which several graduate students are involved.

Recommendations

- As already well understood by the department, attention to increasing the diversity of the graduate program should be continued. Attention to both financial support and "soft skills" are important.
- Continued attention to diversity issues in departmental climate. Careful attention should be paid to recommendations of the APS climate committee review.
- Space issues, particularly the need for graduate student office space, should be addressed.
- As in all departments, there must be continuing efforts to find additional sources of external funding for graduate students. This includes increased attention to fundraising.

Masters program (PMSP)

Strengths

- The Professional MS program is a well-designed and relatively unique program that offers evening classes and online access to these via Zoom, with 6-12 degrees awarded each year.
- Funding brought into the department supports both this educational function and more.

Challenges

- Finding faculty lecturers
- Students who do not live locally

Discussion

We did not meet with any of the PMSP students or faculty who teach in this program, hence relied on written materials and comments from the Chair and Executive Committee.

Recommendations

- The department should look into increasing the tuition charged for the PMSP program; this is a program that benefits both the students and the department.
- Marketing should be increased, particularly to local industry where employers find value in the training provided to their employees.
- With increased tuition, financial aid could be offered from the income to select students
- Look for recent PhD graduates who need teaching experience to act as lecturers for these courses, rather than young faculty.
- Consider partnering with engineering to broaden the potential student base.
- Focus on local students, or abandon the idea of experimental capstone projects for PMSP students (these could be replaced by reading or technology assessment projects).

V. Research and the Faculty

The research effort of the department is organized into several distinct groups. We present our findings for each separately below. A unit-defined question sought the opinion of the RC concerning faculty hiring plans presented in the self-study, that are discussed below. Generally, the RC was extremely impressed with the evidence of careful consideration the department has focused upon faculty hiring plans.

All of the faculty members we met with expressed support for the plans articulated in the self-study. Given the traditional cat-like independence of faculty members, this consensus is itself a very positive sign for the department. The RC is pleased to strongly endorse the department's hiring plan, specifically to focus on hiring theory faculty, likely in QI&C, Nuclear and Ptcl, and QM. The outside members of the RC noted that biophysics also needs a theorist.

Quantum Matter (QM)

Strengths

- A historically strong group, particularly in 2D materials
- Two Nobel Prizes
- A strong and interactive set of faculty, with significant funding and a good range of career stages
- Strong connections to the College of Engineering
- Particular strength in 2D/layered materials, which is one of the most exciting current areas of condensed matter physics
- Commitment by UW to several future hires, from a recent retention case

Challenges

- Imminent departures of nearly the entire theory QM faculty
- Missing a number of experimental areas that would complement and strengthen existing areas

Discussion

This is a historically strong group that should continue to be supported. It is critical that the commitments made as part of the retention case be honored, and these hires, if done well, will provide the additional faculty needed to make this group strong (a balance of theory and experiment is essential); it is more important that this be done well than fast. This group proposes to develop a "Thouless Institute for Quantum Matter"; we were given a brochure outlining this idea. While the importance of Quantum Matter in modern condensed matter physics is enormous, and the Nobel Prize of David Thouless a significant event in the history of the department, this combination unfortunately does not necessarily lead to a successful fundraising model, as described to us by the fundraiser for Natural Sciences and consistent with this committee's experience. Donors wish to support things they are interested in, not what the faculty find important; also Thouless, regrettably, is no longer a presence on the UW campus.

Recommendations

- The group needs a mix of theory (highest priority) and experiment. The additional faculty lines committed to the retention case should be honored, but it is more important that these searches be done thoughtfully and top assistant professors hired than that it be done quickly.
- The group needs to work more effectively with the Natural Sciences Development staff to understand how to raise funds for their priorities, which are (correctly) graduate student fellowships, and postdoctoral support. The excitement of their proposed research is more important to likely donors than the naming of the institute after Nobel Laureate Thouless; it is more likely that the donor would want the institute (or the fellowships) named after something important to them.
- The group might explore connecting better to the QIC.

Challenging the Standard Model: Experiments at the Energy and Precision Frontiers.

The University of Washington has a long tradition of forefront efforts in particle physics and precision atomic physics. The committee is impressed with the way in which the effort at UW has responded to new opportunities, achieving leadership roles in a range of areas.

Strengths

- Organizational structure: CENPA
- The ATLAS experiment - current experimental program
- ATLAS experiment – involvement in future developments
- Strong Nuclear Physics effort
- ADMX
- Project 8
- Planning for future includes existing experimental efforts but also future areas.

Challenges

- No major challenges in the group
- Sustaining faculty excellence in light of likely retirements
- Need to continue to seek opportunities as these fields develop

Discussion

The experimental efforts in these areas are organized under the umbrella of the Center for Experimental Nuclear Physics and Astrophysics. This is a vibrant group, with leadership roles in a number of forefront experiments.

Among these are important roles in the ATLAS experiment at the large Hadron Collider, where the group does important work on particle tracking and analysis, but is also engaged heavily with the upgrades to the detector and with proposed future experiments (including some which are exotic and potentially groundbreaking – MATHUSLA and FASER).

Other important experiments include the ADMX dark matter experiment. The axion is one of the leading candidates for the identity of the mysterious dark matter, and this is the leading experiment in the world presently searching for it. The group has achieved important milestones recently, and continues to work on improvements in experimental reach.

Still other important efforts include engagement with the muon g-2 experiment at FERMILAB, which currently is aiming at an improvement on existing measurements, which will either confirm an earlier possible discrepancy with the Standard Model, a very dramatic development, or demonstrate that the Model correctly predicts the magnetic properties of the muon. It also includes experiments looking for "neutrinoless double beta decay", quite important in establishing the origin of neutrino mass, itself only discovered relatively recently. These masses, in fact, are not known for the various individual neutrino types, and CENPA physicists are engaged in efforts to measure individual masses.

Overall, the CENPA is an extremely valuable resource. Faculty and staff are highly skilled, engaged in the most interesting work going on in this area, and highly opportunistic and entrepreneurial.

Recommendations

- We recommend the University continue its historically strong support for these efforts. We applaud that the group is alert to developing new areas and to maintaining its leadership position in a number of existing areas. This includes improvements to ADMX, larger scale searches for neutrinoless double beta decay, and possible future very high energy colliders. Consideration will have to be given to impending retirements, though we note that the group, in its meetings with our committee, supported the department's view that the first priority is hiring in theory.

Theoretical Nuclear Physics, Particle Physics, and Particle Astrophysics (presented to RC as Frontiers of Nuclear, Particle and Astrophysics and their Intersections)

Strengths

- Broad program in Nuclear Physics, ranging from traditional nuclear physics to QCD, to nuclear astrophysics. Internationally recognized efforts.
- Broad program in Particle Physics – includes particle phenomenology, particle astrophysics, lattice gauge theory, fundamental questions in quantum field theory and string theory. Internationally recognized efforts.
- Dark Universe Science Center (DUSC) in formation – will build on existing theoretical strengths to develop a program in an exciting emerging area.

Challenges

- Sustaining excellence in anticipation of upcoming retirements
- Ideally would replace upcoming separation expeditiously. Goal not necessarily to replicate existing program. The department is alert to the importance of exploring opportunities in new areas.
- Various areas not well covered, such as particle astrophysics.

- Quite generally, it is important to remain nimble in choice of research areas as fields evolve, both for current faculty and future hiring.
- Funding, particularly for graduate students; stresses include a combination of Federal Government cuts in funding and funding for TA's.
- Space, both quantity and quality.

Discussion

Overall, the theoretical physics effort is quite strong. In nuclear theory, the INT provides a setting for a broad program including traditional nuclear physics, nuclear astrophysics, and QCD. There are important synergies with the particle theory effort and with aspects of the nuclear experimental program.

The particle theory effort is at the forefront of several current areas of activity in the field. There is impressive work in lattice QCD, in Physics Beyond the Standard Model, and on aspects of particle astrophysics. The faculty members are all leading, highly visible figures in the field.

In the self study, there is some concern expressed about the ranking of the Nuclear Theory effort. But we view the INT as an impressive resource, and are not sure that the change in ranking is of great significance.

Recommendations

- Hiring, ideally in anticipation of retirements and to offset separation
- Openness in hiring to emerging areas of interest, e.g. synergistic efforts with those in quantum information and quantum computing (overlaps with string theory, nuclear physics, lattice gauge theory).

<u>Quantum Information and Computing</u>

Strengths

- Several strong individual PI's with good funding.
- Support from INT (a workshop in 2017 and a longer term program scheduled for 2020)
- Strong interdepartmental ties, and joint appointments with engineering

Challenges

- Gaps in faculty coverage in important areas
- Lack of dedicated theory faculty

Discussion

This is a program in formation, in an area of great excitement, and to which the Federal Government has committed significant resources, and there is also interest among companies such as Microsoft and Intel. There are several outstanding faculty members who are spearheading this effort, most at relatively early career stages. This includes both theoretical and experimental efforts. The review committee does not feel competent to propose or endorse

specific hiring strategies, but believes this is an area where UW has an opportunity to become an important player.

Recommendation

- We believe that Quantum Information and Quantum Computing is an emerging area with great promise, where the University of Washington is positioned to develop a significant presence. A core of excellent faculty across several relevant disciplines is in a position to lead this effort. There is a good positive energy among the faculty. Additional faculty could lie in Engineering or be joint hires, rather than looking for more positions entirely within Physics. We agree that theory is a priority. Fundraising for graduate and postdoctoral fellows can and should be part of departmental development priorities, for this area specifically (as one that is likely to appeal to donors, as well as to federal funding agencies and industrial partners).

Physics Education Research (PER)

Strengths

- A historical, nationally-recognized, impactful, and nearly unique strength of this department
- A strongly interactive, collaborative group, with strong research funding
- Complements well and supports the teaching mission of the department, leading to strong outcomes for their students, both undergraduates who benefit from the results of the research into effective teaching and the graduate students who as TA's learn modern effective teaching techniques

Challenges

- Department relies on them heavily for teaching, making their service activities heavier than other faculty
- Missing mid-career faculty; only one assistant professor, others all senior

Recommendations

- Department should be sure to maintain strength in this area of national impact, but hiring in this area is not the leading priority in the near term (as recognized by all including the PER group).

Biophysics

Strengths

- A strong research group, with a good balance of junior and senior faculty, and joint appointments that seem to be working well, plus many adjunct faculty

Challenges

- Group believes it is below critical mass with no clear support from department
- Recent spousal hire failed, leading to possible departure of a key Physics faculty member
- Infrastructure for Biophysics within the Physics complex not good

Discussion

This is an exciting and topical area of research, with good overlap with School of Medicine; more overlap with Biology and Engineering would seem to offer potential.

Recommendations

- Although this is a promising area of research, given limited numbers of hires, searches in other areas should be higher priority.

VI. Governance, Staffing, Diversity, and Culture

Strengths

- Collaborative and transparent decision making
- Strong culture that includes faculty (and joint faculty), staff, and students
- Dedicated staff focusing on the quality of the student experience
- Strong efforts in diversity with results
- Excellent (centrally connected) advancement staff

Challenges

- Advancement efforts and staffing at department level are below needed threshold
- Outreach is weak and needs to be strengthened
- Ongoing diversity challenges (not unique to this physics department)
- Tough decisions to be made on student experience (with high number of majors, minimal staff)
- A weak and recently declining University-provided budget

Discussion

The department administration is organized as follows. Three faculty associate chairs (research, undergraduate advisor, graduate advisor) report to the department chair. The department administrator and the assistant to the chair are staff reporting directly to the chair. Additionally, the associate chairs (undergrad and grad) each work with a staff coordinator. There are also 3 lecturers (principal lecturer, lecture demo research scientist, senior lecturer of instructional labs) who report up to the chair, with additional staff support for them (lecture demo science instructor, manager of introductory labs, and scientific instruction tech 2).

The administrator has 5 staff directly reporting up (Building coordinator, Administrative assistant, manager of program ops, instrument shop manager, and computing director). Three fiscal specialists report to the manager of program operations, 4 instrument makers and a shop glassblower to the instrument shop manager, and 3 senior computing specialists and a systems analyst to the computing director.

There are 15 instructional-related department committees (for example, graduate curriculum), and 10 department business-related committees (for example, executive committee).

The physics staff appears to be highly capable and productive. Job satisfaction is indicated by the low rate of staff turnover. Staffing is though quite lean given the scale of the program. It has been observed that the introduction of the university personnel system *WorkDay* has added to staff workload significantly, and there is concern that upcoming university finance system revision will add to the workload further. It is our view that the staff that work in the physics department are incredibly dedicated, hard working, and part of a strong and healthy work culture that includes staff, students, and faculty.

The modest size of the Physics staff no doubt plays some role in the finding of the RC that some very important activities relative to fund raising do not currently have department-level staffing. These include tracking graduates, handling donor relations, preparing a newsletter, and actively soliciting gifts. In this respect the department appears to be somewhat behind many on-campus peers, leaving money on the table. The RC strongly urges the department to ramp up their development (advancement) activities. The RC believes that the department urgently needs an embedded advancement officer to coordinate closely with College-level development staff. The action plan for the department is no secret: they can emulate the successful programs of many on-campus peers. The industrial connections accrued through the professional masters program offer a unique opportunity for fund raising. The Frontiers of Physics evening seminar with an active donor board can also be leveraged in this regard. The RC commends Professor Kaplan for the latter program which appears to be doing well.

The RC very strongly urges the Dean and Provost to partner with the department financially to greatly accelerate their fund raising activities. It would be ideal for the department to receive new funds, even if it meant bridge funding a fraction of the needed new staffing. Consideration should be given to sharing such a staff person with another unit (Astronomy? Chemistry?). Given funding limits in the department, the RC urges the College to help support an embedded person, for a few years; in time the investment will pay for itself.

The overall department culture including interactions between faculty, staff, and students appears to be excellent and collaborative, with a focus on excellence and attention to students. This is highly commendable and valuable to maintain.

Instructional staff are dedicated and focused on high quality experiences for students. With limited staff and potential TA cuts, there is a big challenge of how to maintain scale and quality of these programs.

The joint faculty appointments in Physics have worked very well – the faculty members seem very happy with both the culture of the physics department and with their connections to other departments. This is commendable and productive both from a culture and a vision / growth / strategic perspective.

A unit-defined question asked the RC to assess the department climate. The department has invested a lot of thought and effort into diversity and inclusion. In particular, gender diversity in the Ph.D. program, at 21% is somewhat above the national physics average, although more work remains to be done (the field of physics in general lags in diversity nationally). With STEM fields generally having much remaining work to do in this area, we heard from some who expressed understandable discomfort with the pace of change. On balance, though, the RC found no substantive reason to believe there is any unusual problem with the climate in the department.

The department has a revamped recruitment process that focuses first on identifying excellent women and URM applicants, with personal contact, and department visits. A one-time gift to the department was extremely helpful in increasing the diversity of the entering graduate students who benefitted from this; this should be a high priority with development efforts. UW is also the largest source of physics majors in the country; therefore, diversity programs here will have a

multiplicative effect. The department has developed specific undergraduate focused diversity and inclusion programs. The related challenge of inclusiveness is also being addressed, through an expanded diversity committee, training, hosted seminars, gender workshops, and student organization involvement.

The self-study includes the following unit-defined question,

> "UW's brand of Activity Based Budgeting [ABB], which requires the College of Arts and Sciences to survive on tuition income alone, makes it impossible for the Physics Department to ever "pay its way" (cover its costs) within the College. *Please assess the pros and cons of a possible Physics Department petition to move to the College of Engineering*."

This is a bold proposal on which the RC offers the following thoughts.

First we note that numbers shared by A&S with the RC indicate that the current A&S provided budget of physics does closely match the tuition revenue they are generating. So technically, physics is presently paying its way. *Unfortunately, the problem is that the present budget is inadequate if UW aspires to maintain or improve the current national and international ranking.*

A "pro" of a move to COE from a financial perspective is clear: the core budget provided by the Provost to the College of A&S is nearly completely formulaic and tuition based. For various historical reasons, the College of Engineering (COE) budget includes tuition funds based upon the same formulas, but then this tuition-derived budget is approximately doubled by the addition of a non-formulaic "supplement" provided by the Provost. A move to COE would in principle allow physics to compete with other COE units for these supplement funds. On the other hand, this advantage could change (for better or worse) in an instant, because the Provost has the discretion to change supplement funding levels of the schools and colleges. Thus, the supplement levels of one or both of A&S and COE could change.

Missing from the self study is articulation of an academic motivation for a move to COE. Before such a plan could be considered, an academic justification should be developed.

If the motivation for physics to move to COE is financial, then it would be simpler and more logical for the Provost to award new supplement funds to the College of A&S. A downside of this is that this would leave physics in the long term competing for these funds with a larger number of other departments than in COE, with many of these (A&S) departments relatively poverty stricken.

For all of these reasons, the RC takes no position on the tentative proposal to move physics to the College of Engineering.

We note in closing a problem for all of UW that was mentioned: the high cost of housing in the Seattle area for faculty, staff, and students. This is obviously an institutional problem that merits urgent attention.

Recommendations

- The Dean and Provost are strongly urged to partner with the department to embed a staff person to jump-start their fund raising activities.
- Continue diversity efforts. The efforts are laudable and based on experimentation and learning; this should be continued at all levels.

Appendices

UNIVERSITY OF WASHINGTON

Undergraduate Academic Affairs
&
The Graduate School

May 22, 2018

Department of Physics Review Committee
Paul Hopkins, Professor, UW Department of Chemistry (Committee Chair)
Vikram Jandhyala, Professor, UW Department of Electrical Engineering
Michael Dine, Professor, Department of Physics, University of California, Santa Cruz
Frances Hellman, Professor and Dean, Division of Mathematical and Physical Sciences, University of California, Berkeley

RE: Charge to Review Committee for the 2018 – 2019 Department of Physics Review

Dear Review Committee:

Thank you once again for agreeing to serve on the committee to review the degree programs offered by the Department of Physics at the University of Washington (UW): Bachelor of Science, Master of Science, and Doctor of Philosophy. The Department of Physics is located in the College of Arts and Sciences at the University of Washington.

The review is in accordance with state legislative mandate and under direction of the Office of Academic Affairs and Planning in the Graduate School. It is conducted in coordination with the Office of Undergraduate Academic Affairs, College of Arts and Sciences Dean's Office, and the Office of the Provost.

Committee Charge

In general, the committee's charge in this review is to assess the quality of the undergraduate and graduate degree programs in the Department of Physics and to provide its faculty with constructive suggestions for strengthening those programs. These reviews provide the University with a clearer understanding of each program's academic quality, educational value, and resource requirements. In addition, reviews provide context for the unit's role within the academic discipline, University and community.

As background information, the Department of Physics was last reviewed in 2008-2009. Documents related to the 2008-2009 program review are available on the current program review website: https://sites.google.com/a/uw.edu/2018-2019-department-of-physics-review/

For the 2018 - 2019 review, the possible recommendations range from suspension of student entry into one or more of the department's continuing degree programs to a recommendation for continuing status with a subsequent review in 10 years. Shorter terms can be recommended if the committee deems it appropriate. Equally important to the status recommendation for specific degree programs, the review can offer the unit and the administration an independent assessment of the overall "health" of the unit and advice on how it can be improved.

Self-Study and Site Visit

The Department of Physics will submit a **draft of the site visit agenda and its self-study by September 15, 2018.** Both documents will be made available shortly after receipt by the Graduate School. After reviewing the self-study, the committee may wish to initiate its work before the site visit to ensure a thorough and rigorous review.

Based on our experience, we suggest that the external reviewers be relied upon as content experts who can evaluate the quality of the unit from a national perspective. The external reviewers are also likely to be able to comment on recent developments in the field and their incorporation into the unit. UW reviewers are able to evaluate the unit within the larger context of the institution.

We encourage the committee chair to communicate with the chair of the department so that the department knows your interests and expectations, particularly for the site visit, and to communicate with other key faculty, if time permits. UW committee members may conduct interviews prior to the site visit as they deem appropriate, coordinated by the Office of Academic Affairs and Planning in the Graduate School.

The two-day site visit on **November 8 – 9, 2018,** will culminate with an exit discussion, including:

- Graduate School Associate Dean and representatives
- Dean's Office representation from the College of Arts and Sciences
- Department of Physics representation
- Associate Vice Provost for Academic and Student Affairs
- Associate Dean, Undergraduate Academic Affairs
- Director of UW Academic Program Review
- Representatives from the Graduate School Council

During the exit discussion, you will provide an overview of the committee's emerging report. The first half of the discussion may include other unit representatives, while the second half will include only the review committee and administrators along with the divisional dean. Early in the second half, we will request your formal recommendation regarding the degree programs including your recommended timeline for the next program review.

Review Committee Report, Unit Response, and Final Recommendations

We request that your committee submit its written report approximately a month after the site visit. Specifically, the **written report is due December 14, 2018**.

A written response will then be provided by the unit and is due on **February 1, 2019.**

When the response is available, the report and response will be considered by the Graduate School Council. The Graduate School Dean and Associate Dean for Academic Affairs will then write a letter outlining the review and recommendations to the Dean of the College of Arts and Sciences, with copy to the Provost, for consideration and action.

Please note that upon completion of program reviews, the primary review documents become public documents and are placed on the UW Office of the Provost's web site. These documents include the self-study, the review committee report, the unit's response to the report, and the Graduate School Dean's final recommendation letter.

Specific Considerations for the Review

The most important objective of the review is an assessment of the academic and educational quality of the unit. Important questions include:

1) Are they doing what they should be doing?
2) Are they doing it well?
3) How can they do things better?
4) How should the University assist them?

In addition to the standard (Part A) questions from the academic program review guidelines, the unit should provide context for the issues it has outlined in the unit-defined questions for Part B, attached beginning on page four of this letter. The unit may contact the review committee chair if it has questions about what written documentation would be most useful to the committee as it does its work.

Thank you for your time and effort. Please contact Wesley Henry at weshenry@uw.edu with any questions you may have about the review.

Sincerely,

Rebecca Aanerud
Interim Dean

Kima Cargill, Ph.D.
Kima Cargill
Interim Dean for Academic Affairs

cc: Patricia Moy, Associate Vice Provost for Academic and Student Affairs, Office of the Provost
Michaelann Jundt, Associate Dean, Undergraduate Academic Affairs
Suzanne Hawley, Divisional Dean, Natural Sciences, College of Arts and Sciences
Blayne Heckel, Professor and Chair, Department of Physics
Graduate School Council Representatives
Wesley Henry, Director, Academic Program Review, Graduate School
GPSS President

Department of Physics
Questions for UW Graduate School Review

Question 1. Instructional Program

Our instructional program is one of the largest in the nation for physics departments: 2500 students register for introductory physics instruction each academic quarter, 500 physics majors receive instruction in our majors program, and 190 students receive instruction in our graduate programs. We provide 126 physics courses each academic year to meet our instructional needs. Looking forward, we would like to ensure that we are using our resources efficiently to provide the best instruction we can to prepare our students for their career paths.

Please assess the quality and standards of our instructional programs.

- *Are resources being used efficiently in our introductory physics program?*
- *Do the physics major "tracks" serve the needs of our students?*
- Research experience is a capstone requirement for our majors, yet our research programs cannot accommodate our large student population. The senior seminar course is our alternative to lab experience. *Is the senior seminar an adequate capstone experience? Are there other capstone experiences that we should be considering?*
- *What steps should be taken to minimize the damage to our instructional program from anticipated budget cuts?*

Question 2. Faculty Research

Faculty hiring decisions within the department inevitably force a choice between strengthening existing research groups versus moving into new research directions. In the last 10 years, we have invested heavily in experimental condensed matter physics and when possible have hired into existing research groups. We failed to make strategic hires in cosmology, astrophysics and other areas of theoretical physics.

Please assess the research portfolio of the department.

- *Does the committee have advice about how research fields should be prioritized in the future?*
- *Is the balance between experimental and theory programs healthy or should that balance evolve as we move forward?*
- During the last decade, the university has incentivized the creation of joint positions between the Physics Department and departments within the College of Engineering. *Does the committee assess these investments to have been successful and to have strengthened our research program? Should more or less emphasis be given to such positions in the future?*

Question 3. Department Climate

Please assess the department atmosphere and levels of job satisfaction experienced by students, faculty and staff. Please provide advice on best practices to increase the recruitment, retention and satisfaction of members of underrepresented groups in our department.

Question 4. Department Budget

State support for the department is in decline; TA support is regularly in jeopardy, faculty count has been reduced, the Physics/Astronomy Building is aging and there are no plans for renovation, offices have been lost to the Astronomy Department and the Physics/Astronomy Library was lost to the Computer Science Data Science Studio. Perhaps most importantly, support for new initiatives is shrinking. For example, we have been unable to leverage the astonishing success of a Nobel Prize for David Thouless into any tangible benefit to the department.

- *Are there untapped resources or fund raising activities that we are neglecting?*
- *Can the committee suggest new ways for the department to interact with the administration to avoid further decline?*

- UW's brand of Activity Based Budgeting, which requires the College of Arts and Sciences to survive on tuition income alone, makes it impossible for the Physics Department to ever "pay its way" (cover its costs) within the College. *Please assess the pros and cons of a possible Physics Department petition to move to the College of Engineering.*

Question 5. Department Rank

The department has dropped in rank in the US News and World Report from #20 in 2008 to #22 in 2014.

- *Other than limited resources, can the committee identify further reasons why we are failing to keep parity with departments that were once our peers?*
- *Please provide advice on steps that we should be taking to reverse this trend.*

Appendix B: Site Visit Schedule

University of Washington

Department of Physics Site Visit
Agenda November 8-9, 2018

Day Zero
Night before site visit starts

6:30 pm	**Review Committee working dinner** Mamma Melina, 5101 25th Ave NE

Day One, Thursday
November 8
PAB room B405

9:00 – 9:15 am	**Meeting with Graduate School Academic Affairs & Planning Representative**
9:15 – 10:00 am	**Blayne Heckel, Chair**
10:00 – 10:45 am	**Executive Committee/Associate Chairs** Marjorie Olmstead, Professor Marcel den Nijs, Professor Laurence Yaffe, Professor
10:45 – 11:00 am	**Break**
11:00 – 12:00 pm	**Instructional degree programs** Paula Newcomer, Program Assistant Margot Nims, Academic Counselor Catherine Provost, Counseling Services Coordinator Andreas Karch, Professor Marjorie Olmstead, Professor Marcel den Nijs, Professor Jeff Wilkes, Professor Emeritus
12:00 – 1:30 pm	**Break & Lunch** (boxed lunches delivered to meeting location)
1:30 – 2:00 pm	**Lecturers and Introductory physics** Usama Al-Binni, Lecturer David Smith, Lecturer Kazumi Tolich, Lecturer Nikolai Tolich, Lecturer David Pengra, Senior Lecturer Daryl Pedigo, Principal Lecturer

2:00 – 2:30 pm	**Meet with selected graduate students**
2:30 – 3:00 pm	**Meet with selected undergraduates**
3:00 – 3:15 pm	**Break**
3:15 – 3:45 pm	**Physics education research faculty** Donna Messina, Lecturer Suzanne Brahmia, Assistant Professor Paula Heron, Professor Lillian McDermott, Professor Peter Shaffer, Professor
3:45 – 4:15 pm	**Assistant Professors** Suzanne Brahmia, Assistant Professor Alvaro Chavarria, Assistant Professor Jiun-Haw Chu, Assistant Professor Gray Rybka, Assistant Professor
4:15 – 4:45 pm	**Quantum matter** Anton Andreev, Professor Jiun-Haw Chu, Assistant Professor David Cobden, Professor Subhadeep Gupta, Professor Andreas Karch, Professor Xiaodong Xu
6:30 pm	**Review Committee working dinner** Nell's, 6804 East Green Lake Way N.

Day Two, Friday
November 9
PAB room B405

8:45 – 9:15 am	**Department Staff** Alison Alcoba, Assistant to the Chair Katie Hennessey, Budget Analyst Mike Kummar, Administrator Raines, Administrator (recently retired) Wilson Waldrop, IT Director
9:15 – 9:45 am	**Challenging the standard model** Alvaro Chavarria, Assistant Professor Jason Detwiler, Associate Professor

	David Hertzog, Professor Shih-Chieh Hsu, Associate Professor Henry Lubatti, Professor Gray Rybka, Assistant Professor Gordon Watts, Professor
9:45 – 10:15 am	**Frontiers of Nuclear, particle, and Astrophysics** Silas Beane, Professor Aurel Bulgac, Professor Larry McLerran, Professor Jerry Miller, Professor Ann Nelson, Professor Miguel Morales, Associate Professor Sanjay Reddy, Professor Martin Savage, Professor
10:15 – 10:30 am	**Break**
10:30 – 11:00 am	**Quantum information and quantum computing** Kai-Mei Fu, Associate Professor David Kaplan, Professor Mo Li, Associate Professor Arka Majumdar, Assistant Professor Martin Savage, Professor Xiaodong Xu, Professor
11:00 – 11:30 am	**Faculty with joint appointments** Arka Majumdar, Assistant Professor Kai-Mei Fu, Associate Professor Mo Li, Associate Professor Paul Wiggins, Associate Professor Xiaodong Xu, Professor
11:30 – 12:00 pm	**College Advancement team** Alexandra Haslam, Associate Director of Advancement, Natural Sciences Ric Thomas, Director of Advancement for Natural Sciences
12:00 – 2:15 pm	**Review Committee Executive Session** Boxed lunches catered (Includes meeting with Graduate School Academic Affairs &Planning Rep.)
2:15 – 2:30 pm	**Break**
2:30 – 4:30 pm	**Exit Discussion (in PAB room C520)** Unit Representative (leave at 3:30) **Blayne Heckel**, Chair **Marjorie Olmstead**, **Marcel den Nijs, Laurence Yaffe**, Associate Chairs

University Administrators

Suzanne Hawley, Divisional Dean of Natural Sciences, College of Arts & Sciences

David Canfield-Budde, Assistant Dean for Academic Affairs & Planning, The Graduate School

Patricia Moy, Associate Vice Provost for Academic & Student Affairs

Becky Corriell, Director of Academic Program Review & Strategy, The Graduate School

Chris Partridge, Academic Program Review Specialist, The Graduate School

Michaelann Jundt, Associate Dean for Undergraduate Academic Affairs

Shima Abadi, Assistant Professor, Engineering and Mathematics Division of STEM, UW Bothell; Graduate Council Representative

Dan Turner, Associate Dean, Masters Program/Principal Lecturer, Marketing and International Business, Foster School of Business; Graduate Council Representative