

**External Reviewer Report  
on the Department of Physics and Astronomy,  
University of Hawaii at Hilo**

Sally Seidel  
Professor of Physics  
Department of Physics and Astronomy  
University of New Mexico  
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**Introduction**

An invitation to serve as external reviewer of the Department of Physics and Astronomy, University of Hawaii at Hilo (UHH), was extended on 12 September 2016. This review follows upon a visit to the university during the period March 15-17, 2017. In the course of three full days, I met undergraduate students, tenured and tenure-track faculty, instructors, lecturers, the instructional lab coordinator, and the APT staff member in the Department of Physics and Astronomy (hereafter referred to as P&A). I met the Natural Sciences Division Chair Jim Beets, Geology Chair Steven Lundblad, Dean of Arts and Sciences Susan Brown, Vice Chancellor for Academic Affairs Michael Platz, and the accreditation officer, Prof. Seri Luangphinit. I also spoke with Chair of Mathematics Brian Wissman and the Director of 'Imiloa, Ms. Ka'iu Kimura. By telephone after my visit, I spoke with IfA Director Guenther Hasinger and Chancellor Donald Straney. I toured the Hilo Department of Physics and Astronomy facilities, the campus, and the peak of Mauna Kea. I attended an astronomy class taught by Prof. Kathy Cooksey and observed Prof. Marianne Takamiya working with her laboratory class in the field, at Mauna Kea.

The department provided me with its very helpful and thorough self-study document, related information, and documents produced during the 2005/6 review. As the self-study is extensive and rich in information, I will generally not recapitulate it here. This review will focus on information I collected during my visit to the department and in subsequent email exchanges with Prof. Takamiya.

**Education and Teaching**

***Findings***

Providing the highest possible quality of education to the UHH students was clearly uppermost in the mind of every person I met. Every conversation touched on challenges as well as successes, and yet the students are manifestly the priority that drives decisions at all levels of staffing, instruction, and administration.

State of the art teaching techniques, involving various types of active learning, are being used in this department. Some of the faculty furthermore publish in education research journals.

The course catalog includes physics offerings consistent with what is typically included in a Physics B.A. program. The course catalog includes astronomy offerings and opportunities that are richer than at many other institutions offering Astronomy B.S. degrees.

The lower division physics courses serve physics and astronomy majors as well as degree candidates in other programs including, for example, geology and marine science. The service courses, which are heavily enrolled, included PHYS 106, PHYS 107, ASTR 110, PHYS 170, PHYS 171, and associated laboratories. The upper division physics courses serve physics and astronomy majors.

The numbers of bachelor's degree recipients in physics and astronomy are very similar, respectively anticipated to be 7 and 5 for academic year 2016-17 (see Table 1 on page 7 of the self-study document). These numbers are *both* higher than the national average for number of degree recipients in a (physics or astronomy or both) department at degree-granting institutions whose highest (physics or astronomy, respectively) degree is a bachelor's (see Tables 1 and 5 of Appendix A-1 in the self-study document). Thus: both the Physics B.A. program and the Astronomy B.S. program are above the national average among their peers, in degree recipients produced.

The educational mission of the department benefits from the proximity of IfA scientists, and this has been strengthened by the execution, in May 2016, of a Memorandum of Understanding between IfA, the University of Hawaii at Manoa (UHM), and UHH. IfA scientists now teach in the P&A classrooms one course per semester, and expanded training in observational astronomy techniques is potentially now available for UHH students.

### ***Comments***

The department reports substantial pressure to cancel courses with low enrollment, and a strong perception that this is damaging enrollment and significantly hindering the progress of the majors. Students shared anecdotes about time to degree being extended significantly as the student waited for courses. Faculty reported anecdotes about students giving up in frustration over this and either disenrolling or switching majors. The frequency with which this sort of concern came up in discussion points to a problem. There is an anxiety among the students that may well produce feedback that further suppresses enrollment.

While it is true that the annual number of physics majors graduated by UHH is typically below 10 and thus less than the number of majors in many other fields, this is normal: according to a 2017 AIP report on undergraduate program size, the median annual number of Physics bachelor's degrees awarded per department, averaged over all 744 U.S. departments offering such degrees in 2014, was 7.

Upper division physics courses are frequently taught by astronomers and lecturers in this department. Both faculty and students shared the opinion that, while those teaching the courses are competent to teach this material, it would be preferable for students, especially graduate-school-bound physics students, to learn it from a physicist and ideally from a member of the regular faculty. This is a sound opinion.

A member of the P&A faculty is working (through another department) toward the establishment of a program in Energy Science. This is a visionary contribution to the university's programs.

### ***Recommendations***

The idea has been floated to eliminate the Physics degree program while retaining the Astronomy degree program. I have looked into the question of whether there is a precedent at any U.S. four-year degree-granting institution for offering an astronomy bachelor's degree but not a physics one. No example has been found. It is strongly recommended that UHH not pioneer this idea. The Physics B.A. is a stepping stone to numerous productive and remunerative careers. Furthermore physics is the foundation of astronomy, and that foundation is not captured by the introductory courses alone. A university that eliminates the physics degree program, but attempts to retain only introductory physics service courses for astronomers, will find it impossible to attract first-rate physicists to teach those courses, and will find itself in the position of explaining why *all* of its physics courses are taught by people whose primary training is in another field. Surely the department's reputation, and the university's, would be damaged by this.

It is recommended that the department and administration explore models in which a faculty member might be compensated in some way for offering Directed Study in cases where a student cannot otherwise complete in a timely manner a course that is critical for his/her major.

A committee should be established to study the benefits and costs of creating a master's degree program in this department. The expertise of this faculty is well suited to offer training in several specializations that are potential magnets for contemporary students (and are not duplicated in the UH System) - for example an M.S. in Astrophysical Instrumentation or an M.S. in Observatory Management. It is conceivable (but not essential) that this sort of program could be developed in stages, with a department first offering a certificate, and then, if a market for that is demonstrated, moving forward with the awarding of master's degrees. The establishment of a master's degree will enhance - not detract from - the *undergraduate* teaching mission of UHH. Naturally, research productivity will grow in an environment that includes post-graduates. The faculty are already conducting research, and it clearly energizes and renews their instructional efforts; making that research connection easier, by involving graduate students, should lead to even greater energy and renewal in all of their classrooms. The postgraduate students serve as role models and informal mentors to the undergraduates. M.S. students can serve as teaching assistants, allowing faculty freedom from routine activities,

leading to time they can use to provide more personalized guidance of undergraduates as well as graduate students. Increased research activity translates to increased overhead return to the university on research funding, and this too boosts the undergraduate program. Lastly, a master's program will nurture increasingly robust on-campus research, as faculty can build groups that are then more attractive to postdocs - and in P&A, those research groups naturally include UHH undergraduates.

There was discussion about the problems some students face in transitioning from high school to university, and about the fact that some students do not arrive with adequate foundational training for the introductory courses. The teaching load (see Personnel section below for further remarks on this) makes it difficult for those teaching to give extra attention to students struggling to overcome deficiencies of this sort. Some institutions respond to this sort of problem by implementing a formal "peer tutoring" program.

## **Administration and Internal Communications**

### ***Findings***

Within the department, there is a perception, at times, of a disconnect in communication with the UHH administration, regarding a number of topics. There were no analogous mentions, during discussions with UHH administrators, of any perceived disconnect with the department. Within the administration, however, there is a perception, at times, of a disconnect in communication with administrators of the UH System as well as, perhaps, with the Board of Regents.

There is a sense in the department that recommendations from the previous departmental review were largely not implemented. There is also disappointment that the university's Strategic Plan (which ended in 2015 and has not been renewed or replaced) was not implemented.

Conversations yielded speculation that the WASC regional accreditation agency may be disbanded. Discussions indicate some lack of confidence in the mode of interaction between the agency and the university and in the impact of the periodic accreditation reports. There was concern about how this could affect reception of the departmental review.

Some mismatches between requirements and curricula in P&A and those in related departments were discussed. Some of these include: (1) a desire by P&A that the math curriculum introduce some topics, for example vectors, at an earlier stage so that these can be assumed at a more natural time in the introductory physics sequence, (2) a question from P&A about whether marine science and geology majors would be best served by calculus-based or non-calculus-based introductory physics courses, and (3) encouragement from related departments that the scheduling of P&A courses continues to maintain consistency with the standard time blocks.

### ***Comments***

Esprit de corps was apparent among those who teach in this department. Inspiring and nurturing this spirit is an intangible skill of the Chair. Prof. Takamiya should be commended for accomplishing this.

While the status of implementation of the university's Strategic Plan is an issue that goes beyond the scope of the review of a single department, it is relevant to that department both concretely and in the way that unrealized plans can, if not explained to those affected, lead to faculty and student demoralization.

### ***Recommendations***

It is suggested that recommendations from the previous review be revisited jointly by the department and the upper administration to determine whether they merit continued consideration.

Proposals from the Physics and Astronomy department to the upper administration may be strengthened if they demonstrate, more explicitly, strong support from the Natural Sciences faculty. If the Natural Sciences division is transformed into a college, then the routine path for any proposal would be through the college, and in the course of this channel such support could be indicated. Even in the absence of a College of Natural Sciences, it was recommended that proposals from P&A demonstrate broad support from allied departments.

Typically academic departments handle decisions (e.g., curriculum, hiring priorities, infrastructure, assessment) by forming committees to give focus to issues, set priorities, prepare plans and recommendations, and report to the chair. There was no mention of committee work during the visit, and it seems that the burden may fall mainly upon the chair. It is recommended that a committee structure be implemented and, given the small size of the regular faculty, that it involve if possible instructors as well as professors.

The accreditation officer did not indicate access to, or knowledge of the location of, previous review reports. (Reports were obtained directly from the Physics and Astronomy Department chair, so this presented no immediate problem for this review.) If reports are not routinely archived with the accreditation office, it might nonetheless be useful for the accreditation office to maintain a record of where they are kept, and to ensure that permanent copies are available somewhere.

### **Outreach and External Communications**

#### ***Findings***

Some department members communicated their sense that an additional APT staff member may be needed in order to meet all the responsibilities that are currently assigned to that position. The department website is one of the many diverse responsibilities handled by the APT staff.

The department tries, within budgetary limitations, to offer public talks of scientific interest.

### ***Comments***

The department website is an important tool for recruitment and an indication to the outside world of the vitality of the program. A vibrant website, especially one highlighting research opportunities for students and the attractively high faculty-to-student ratio in the advanced courses, could be very effective as a recruitment and communication tool.

An outreach program of public talks has practical benefit in raising public awareness of the value of science and motivating young people whose families may not have given thought to scientific careers.

### ***Recommendations***

The P&A website should be updated in a way that makes better use of the tabs to particular topics and eliminates the long list of consecutive announcements, many of which are obsolete. Presently a few of those who teach in the department have links to personal websites on the Contacts page. To fully convey the richness of expertise available, it is recommended that all who are teaching add such links, and that these be transferred from the Contacts page to the Faculty and Staff page.

It is recommended to increase the frequency of public science talks as much as possible by taking advantage of access to visitors to the observatories and visitors to UHM. It is noted that the presence of 'Imiloa on campus is an important step in this direction; the recommendation is to build upon interest stimulated by the excellent planetarium shows by adding more live science talks (which could be held at any location on campus), even on topics other than astronomy. The experience of "meeting a scientist" (outside of the classroom) can be transformative for a young person.

## **Personnel**

### ***Findings***

The tenured and tenure-track faculty, and many of the other professionals who teach in this department, maintain active research programs. The faculty, all of whom trained at institutions in the highest tier, are world class scientists.

The hiring of a new faculty member in physics has been identified by the members of this department to be a high priority.

Starting salaries of recently hired tenured or tenure-track faculty members in P&A are consistent with the national average for starting salaries of astronomy professors. However: a recent study by the Economic Policy Institute indicates that the cost of housing in Hilo is among the highest of any US city.

The two most recent faculty searches attracted applicant pools of 71 and 49 individuals, respectively. A recent study by the Committee on the Status of Women in Astronomy published a distribution of the total number of applicants to 35 faculty searches in 2013. The minimum is 40, the maximum 340, and the median is about 115. Thus: recent UHH faculty search candidate pools have been relatively small.

The teaching load per semester is three courses per tenured/tenure-track faculty member (unless relieved for other responsibilities) and potentially four or more per instructor or lecturer. The teaching load at many top tier undergraduate institutions is, for tenured faculty, 4-6 courses per year; and at many of those institutions, it is 4-5 for pre-tenure faculty.

### ***Comments***

Those teaching, and those being taught, are clear-eyed about the costs to the students that come with this size load. Accommodations in instructional style are made to handle the volume of grading. Senior students are used for some recitation sections. Both faculty and students acknowledge that the amount of feedback available to students on individual assignments is restricted by the sheer volume of students and assignments each teacher handles, and that this impacts the learning process.

The fraction of women counted among the UHH P&A faculty (including instructors and lecturers) exceeds the national average for Physics and Astronomy departments. This is an accomplishment.

### ***Recommendations***

There is sentiment in the department that hiring another faculty member to replace recent losses could have a transformative effect on the department's educational and research stature. Cognizant of competing needs and budget limitations, I discussed with several administrators some strategies that could accomplish this. One idea involves a shared position between P&A and 'Imiloa, for a faculty member whose Ph.D. is in Physics and whose research is Physics Education Research (PER). The nature of 'Imiloa, which by making links with Pacific cultures is unique in going beyond what a typical planetarium or science museum offers, could provide unparalleled platforms for PER. One would thus expect an exceptionally strong candidate pool for this position. At the same time the new faculty member would fill the urgent need for another physicist on the regular faculty to teach the advanced physics courses and could further energize the active learning efforts in P&A.

It is recommended that the university review whether the conditions of P&A faculty employment are consistent with continuing to attract outstanding applicant pools that are needed to fully realize the extraordinary potential implicit in this university's location and resources. Conditions that might be compared with those at peer institutions include teaching load prior to tenure; starting salary relative to regional cost of living; and demonstrated commitment by the university to

maintaining the facilities that draw faculty and students in the first place. It is also recommended that the university adopt a policy on spousal hiring and bring the attention of all potential applicants to it.

## **Research**

### ***Findings***

A number of research grants are currently active, including some that were brought by faculty upon joining the department, and others that have been funded subsequently. The faculty seek and obtain funding from a wide range of sources, from internal and county funds to *international* sources and *highly competitive federal programs* at NSF, NASA, and NIH. The faculty also seek and are awarded telescope time equivalent to many tens of thousands of dollars.

The research programs of the personnel in P&A routinely involve undergraduate students, and students' names appear on the author lists of publications. UHH Physics and Astronomy students present posters and talks at conferences. Nine of the eleven astronomy majors who graduated between Fall 2015 and Fall 2016 conducted research. All of the physics degree graduates in the same time period conducted research.

The MoU between IfA, UHM, and UHH enables UHH faculty to supervise graduate students in the UHM graduate program and receive cross appointments in IfA.

### ***Comments***

Given the teaching loads, the amount of research (funded and unfunded) presently underway is in fact astonishing.

The research experiences being provided to UHH students are very important to the education of the students and provide especially critical training for those considering graduate school.

In some cases, involving an undergraduate in a research project may actually *slow down* the research itself; thus these faculty, so committed to the training of their students, should be especially commended - and rewarded - for making those research experiences possible.

### ***Recommendations***

Maintaining a connection to research keeps educators at their best in the classroom. It is recommended that the university explore the possibility of offering periodic "research semesters" (i.e., in addition to sabbaticals) in which teaching load may be reduced based on prior negotiation to conduct active research involving UHH students and/or develop research proposals.

It is recommended that UHH faculty initiate the supervision of UHM graduate students, and the cross appointments in IfA, per the conditions of the MoU, as soon



as is reasonably achievable. One could imagine that this might open new channels of communication that could lead to fruitful research, increased exposure of Hilo students to frontier science, and access to grant opportunities. Routine supervision of such students would be synergistic with a proposal (see above) for a distinct M.S. program at UHH P&A.

## **Infrastructure**

### ***Findings***

Several recent improvements have been made in departmental infrastructure and facilities, and these promise to raise the department's teaching and research profiles even higher. Residence in the new Science and Technology Building is of course one of them, and among the rest are the acquisition of a new small aperture telescope and the flexible design of the departmental space to incorporate a telescope's remote control room.

Several of those involved in P&A teaching and operations spoke with pride about new initiatives in instructional laboratory equipment.

Members of the department expressed strong interest in enhancing the upper division physics laboratory course options. Effort has gone into developing the optics laboratory and this has valuable overlap with astronomy training.

It was reported that capital equipment line items are not routinely included in the university budget and that this leads to uncertainty and strains related to facilities maintenance generally.

Within P&A, it was mentioned that financial strains have put at risk the continued functioning of some essential instructional tools, for example the teaching computers (reported to be 10 years old) and the vehicles required for access to Mauna Kea.

Students and faculty are deeply concerned about the effects of a prolonged shutdown of the Hoku Ke'a telescope.

### ***Comments***

Agencies including NSF have offered infrastructure grants for instructional needs in STEM departments, some of them aimed at undergraduate institutions. As an example, recent offerings included "Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics" (NSF 17-1).

The replacement for the instrument on Mauna Kea has been purchased - it is a PlaneWave Instruments CDK700 telescope, 28", with corrected Dall-Kirkham optical design, designed to allow switching between different instruments on a timescale of seconds and operable in three modes: classically, remotely, and robotically. It is being tested and prepared for operation, to the fullest extent possible, on campus

now. Devices of this type are *active research instruments* as nodes in small-aperture telescope networks (see for example <https://lco.global/>, <https://hatnet.org/>, and <http://exoplanets.psu.edu/falcon-telescope-network/>). *This one is also an outstanding educational instrument.* The opportunity to commission a new telescope in an observatory - not just to use an existing one to take data - would be an extraordinary experience for UHH students.

### ***Recommendations***

Contact with program officers at federal and state funding agencies is recommended as a possible route to funding for instructional infrastructure, in addition to what may be available through the university. Some release time for a faculty member taking on the preparation of such proposals might assure their highest competitiveness.

An upper division physics laboratory course with a broader selection of experiments that demonstrate 20th century discoveries is important for the education of both Physics B.A. and Astronomy B.S. majors. It is recommended that the university explore whether support for this is possible.

The commissioning of the new Hoku Ke'a telescope at the best possible site for its combined educational and research missions should proceed as soon as possible with full support from the University. The Hoku Ke'a instrument has great potential to attract outstanding students to the campus and to train them for roles in astronomical research on an international stage - and of course, those students are the future of science. In conversations with the P&A students, I heard numerous times that they had come to Hilo because of the opportunities that it provides for undergraduate research. Hoku Ke'a is a big part of what brings them to UHH. The university as a whole benefits from this.