

**Department of Astronomy Program Review
Report of the Committee**

February 8, 2011

Committee:

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1 Introduction and Principal Recommendations

We greatly enjoyed the opportunity to learn more about the University of Washington's Department of Astronomy, all the more because we found the department to be doing an excellent job in its research, educational, and outreach missions. We do have some concerns, which are described in this document in the hope of helping the department as it plans for the coming decade, but our overall impression is highly favorable. The department is doing outstanding research; has appropriate plans for extending its reach in survey science, computational astrophysics, and astrobiology; has a strong and growing graduate program with satisfied graduate students; has as well a growing undergraduate program with enthusiastic majors; is making important contributions to service teaching at the lower level; has developed a national model for attracting minority students into STEM fields through Pre-MAP; and is reaching beyond the university through activities such as those at the Jacobsen Observatory and the planetarium. Although not yet in the top five of US astronomy departments, this program is certainly in the peer group of the top ten departments. With investment by the administration and continued wise planning and decision making by the faculty, we would fully expect it to be in the middle of the top ten within the next decade.

Our principal recommendations are listed below. More details are provided in what follows.

Undergraduate Major

1. The department should have discussions about Physics 227-228 with the chair of the Department of Physics in order to better understand how the course is being taught and, to the extent reasonable, to provide input, given how significant this entry course is for timely completion of the upper division physics courses needed to perform well on the GRE.
2. The department should assist Astronomy majors in their preparation for the Physics GRE by helping them set up study groups, perhaps with the aid of a graduate student.
3. The department should take steps to raise the graduate school ambitions of Astronomy majors, for example through opportunities to meet as a group with faculty who visit from other universities with highly ranked programs.

Graduate Program

4. The department should upgrade its TA training for graduate students, including a more focused, full day of TA preparation in their initial orientation program paired with follow up evaluation and mentoring during subsequent quarters of service as TAs.

Diversity and Outreach

5. The department should work with advancement officers, the Dean's Office, the Provost's Office, and the Office of Minority Affairs and Diversity to establish a more secure long-term funding base for the department's innovative and successful Pre-MAP.

Advancement

6. The department should establish funding priorities at a range of price points, from \$10,000 to \$10,000,000, in coordination with college and university advancement officers, in preparation for the university's capital campaign.
7. The department should work with the Dean's Office and University Advancement to identify opportunities for effective faculty engagement in outreach and advancement activities.

Research

8. The faculty should decide which key scientific issues addressable by LSST and CCO are of highest interest and then use this to drive the planning for both new faculty positions and research resources. The necessary planning process, perhaps best done in a one-to-two day retreat, should also take into account the future use of the 3.5 meter telescope, including any instrumentation needs or changes in its mode of operations. Additional outcomes of the process might be a list of needs that can be addressed through advancement efforts and an indication of which departments are likely to be critical to the strategy, Physics and Computer Science and Engineering for example.
9. The department should identify the fields of theoretical astrophysics most relevant to their science goals, then work with the Physics chair (and the INT Director) to discuss common goals that would strengthen all parties. The points of common interest for theoretical astrophysics efforts across such a department boundary have historically been in cosmology, supernovae/transient science, and compact objects/gravitational waves. Independent of cooperation with Physics, the department needs to make progress on this.
10. The department must take a leadership role within the Astrophysical Research Consortium to identify a vision for the broad future of Apache Point Observatory that is both consistent and integrated with the department's research goals.

Faculty

11. The department should establish a focused plan for the next decade of faculty hiring that aligns with its strategic goals, so that it can manage the renewal of its faculty, an especially critical task given the likelihood of four significant retirements during this period.

12. The college and university should enable such a planning process, allowing the department (jointly with Physics) to build a core of at least 15 regular faculty in astronomy and astrophysics over the next decade so that it can not just maintain its current status, but achieve more.
13. The department needs to adopt and clearly communicate a policy on hiring research faculty, an initial step being to normalize the discussion through a survey of other institutions that have incorporated large research projects into a department culture.
14. The department should provide mentoring to the mid-career faculty who are emerging as departmental leaders in order to prepare them to guide the department during the next decade and beyond, so that it is positioned to take best advantage of the opportunities that will arise.

Formalities

15. The graduate and undergraduate degree programs should be continued.
16. The next program review of the Department of Astronomy should be in ten years.

2 The Review Process

We met at the Graduate School (and by phone) on April 7, 2010, with Associate Dean James Antony of the Graduate School, Associate Dean John Sahr of the Office of Undergraduate Education, Divisional Dean Werner Stuetzle of the College of Arts and Sciences, Tom Lee of the Graduate School Council, David Canfield-Budde of the Graduate School and Suzanne Hawley, Scott Anderson, and Sarah Garner of the Department of Astronomy. At the meeting, the procedure for the upcoming review was discussed and we received our charge. Also, Professor Hawley introduced additional questions that the department wished to address during the review. A final charge letter was provided on April 19, 2010.

The department's self-study was made available to us on December 7, 2010. In the first week of January 2011, we sent a letter to Astronomy department faculty, staff, and students inviting them to contact us before the site visit, if they wished, and encouraging them to attend the site visit meetings. In response, we received an email from a research scientist laying out some concerns and expressing hope that there would be ample time to discuss them.

The site visit took place January 23-25, 2011. In addition to the meetings scheduled ahead of time, we took advantage of open appointment times to meet again with some of the faculty, with the department chair, with the chair of the Physics department, with some graduate students, and to meet with the College of Arts and Sciences' chief science advancement officer.

Following the site visit, we exchanged several drafts of the written report, agreeing on this final version on February 8, 2011.

3 Service Education

The department is doing an excellent job of providing lower-level astronomy courses to undergraduates. Its introductory astronomy course and solar systems course are at capacity each quarter with 250 students each. These are supplemented by newer courses on the moon and on public outreach in astronomy. The department values this component of their mission, with both tenured faculty and lecturers engaged in teaching. Unfortunately, cuts to the TA budget have reduced the number of weekly section meetings in each course from two to one.

The three lecturers appear to be a superb group, devoted to their students and to continued improvement of instructional methods. However, they cannot handle the service courses alone. As senior faculty retire, the department will need to ensure that tenure-line faculty continue to play an essential role in teaching these courses.

The department is in the early stages of exploring on-line course offerings, in collaboration with UW Educational Outreach. A proposal is currently under consideration by UWEO for a modest experiment next year, to be handled by the hiring of an additional part-time lecturer. The department is understandably uncertain where this may lead, or how well it fits into the departmental mission. But they are showing welcome foresight in proposing their experiment and should be encouraged in their efforts.

4 Undergraduate Major

The department has undergone significant growth in its number of majors, with 27 graduating last year compared to an average of 15. More impressive than numbers is how obviously happy the majors are to be part of the program and the department. There is genuine esprit de corps and a deep sense of community, with wide appreciation of the supportive role played by the department's academic counselor.

What most impressed us was how actively engaged the majors are in research projects. This surely has much to do with their sense of involvement with department life and their high level of satisfaction with the degree program. Particularly striking is how members of the department at every level – graduate students, postdocs, research scientists, and faculty – take part in overseeing undergraduate research. In turn, the undergraduates themselves help to mentor Pre-MAP students on research.

It appears that about half of the majors go on to graduate school, and of these, about a third go to peer graduate programs in astronomy. Those majors anticipating careers in astronomy should set as their goal admission into the top graduate programs. We believe that such ambitions are not as widely shared as they should be. The largest cause of the students' more modest ambitions appears to be low scores on the Physics GRE.

To do well on the Physics GRE, students must have taken the key upper-level Physics courses in quantum mechanics, electromagnetism, and thermodynamics ahead of time. Too many

students are taking these courses in their senior year. If they take the GRE in the fall of senior year, they won't be properly prepared. The alternative, which several students choose, is to delay graduation for a quarter or longer, extending research projects or other activities into the next fall. This is one reason that the median time to degree, 5 years, is long on the national scale.

Digging a little deeper, we found that one source of delay in the timely taking of Physics courses is Physics 227-228, a course in mathematical physics. Ideally, students would take this sophomore year, the upper-level Physics courses junior year, and be ready for the GRE. However, many students struggle with this course, some having to take it more than once, and many finding it frustrating regardless of how they perform.

Ultimately, the responsibility for course scheduling, course performance, and GRE preparation lies with the students. But we do recommend that the department provide what help it can in addressing these issues.

Recommendations:

- The department should have discussions about Physics 227-228 with the chair of the Department of Physics in order to better understand how the course is being taught and, to the extent reasonable, to provide input, given how significant this entry course is for timely completion of the upper division physics courses needed to perform well on the GRE.
- The department should assist Astronomy majors in their preparation for the Physics GRE by helping them set up study groups, perhaps with the aid of a graduate student.
- The department should take steps to raise the graduate school ambitions of Astronomy majors, for example through opportunities to meet as a group with faculty who visit from other universities with highly ranked programs.

5 Graduate Program

The Astronomy graduate students are performing well in a collegial environment and appear to be happy with the program. They become engaged in research quickly, often in their first year with faculty who may ultimately not be their advisors, so that they get to work with a variety of faculty. They have a good range of options for research areas and are fully supported. Indeed, there is enough funding for RA appointments that the department sometimes has difficulty finding sufficiently many students to serve as TAs. The students also are happy with the range of course offerings, the qualifying exam system, and funding for travel. The placement of graduates from the program appears to be appropriate, given the strength of the department, with several in recent years receiving prestigious postdoctoral awards.

Some students made it a point to bring to our attention the ease with which students can

get observing time on the 3.5 meter telescope at Apache Point Observatory (APO), and the ease as well of operating it remotely. They described APO access as “fabulous.”

One concern expressed was that several faculty members are not taking students, so that an already small faculty is smaller still from the perspective of choosing advisors. Nonetheless, the department’s rate of production of new PhDs is at the national average of two every five years per FTE (as measured by Professor Bildsten).

Another issue that emerged in our meeting with graduate students was a lack of emphasis in the department on TA training. TA training is included in the new student orientation before the school year starts, but some students seem to have forgotten or somehow missed it. They perceive that they receive little or no feedback on their success as educators.

Recommendation:

- The department should upgrade its TA training for graduate students, including a more focused, full day of TA preparation in their initial orientation program paired with follow up evaluation and mentoring during subsequent quarters of service as TAs.

6 Diversity and Outreach

The department has done well at all levels, from undergraduate to faculty, in making women welcome. It also has created an innovative program, The Pre-Major in Astronomy Program (Pre-MAP), that is effective in attracting traditionally under-represented students into Astronomy and STEM fields. The program was created by graduate students in the department who have since moved elsewhere, giving the department a national reputation in its diversity efforts. This reputation can be helpful in attracting students to the department and should not be allowed to dissipate. The university needs to assist in giving Pre-MAP stable support, whether from internal funds or through fundraising with the assistance of the advancement staff.

The department runs a wide variety of successful outreach activities, such as its annual open house and its public programs at the Theodor Jacobsen Observatory and the UW Planetarium.

Recommendation:

- The department should work with advancement officers, the Dean’s Office, the Provost’s Office, and the Office of Minority Affairs and Diversity to establish a more secure long-term funding base for the department’s innovative and successful Pre-MAP.

7 Advancement

The department, in its self study and in discussions with us, expressed hope on several occasions that some of its goals might be achieved by taking advantage of suitable fundraising opportunities. Some members of the department are actively engaged in talking to both groups and individuals outside the university. However, we are not confident that the department will succeed in its hopes without a larger and more systematic effort.

The large base of local contacts generated by the departments outreach efforts give it a head-start on fundraising efforts. Our meeting with Jeff Walker, the college's director of development for natural sciences, made it clear that he was aware of the potential for raising funds for the department, but there needs to be an increase in the frequency of contact between the department and advancement. It appears that a few of the faculty are ready to carry the load of a fund-raising effort, so all that is needed is a clear list of priorities and sustained cooperative effort between the faculty and advancement. A few items looked ripe to us for fundraising, such as the \$50,000/year needed to keep the Pre-MAP program alive.

Recommendations:

- The department should establish funding priorities at a range of price points, from \$10,000 to \$10,000,000, in coordination with college and university advancement officers, in preparation for the university's capital campaign.
- The department should work with the Dean's Office and University Advancement to identify opportunities for effective faculty engagement in outreach and advancement activities.

8 Space and Infrastructure

The department's educational and research infrastructure is impressive. In a national context, the space is modern and the machine shop is superb. The APO software interface developed in-house by the APO staff is highly praised and effective as a student research resource. These are significant departmental strengths, ones in which the university has made an investment that continues to add value, allowing faculty and students to do research and learn.

Apache Point Observatory is in great shape and well managed. The closing some time soon of the neighboring National Solar Observatory facilities on Sacramento Peak is cause for concern, since NSO provides water and additional support for APO operations. This is being taken into consideration in APO planning.

9 Research

The department is one of the founding partners of the 8.4 meter Large Synoptic Survey Telescope (LSST), which was recently ranked in the National Research Council’s 2010 Astronomy and Astrophysics Decadal Survey as the first priority for large-scale, ground-based research initiatives. The local infrastructure, engagement in LSST, and excellent faculty with a record of achievement in growing astronomical sub-disciplines such as computation have placed the UW Astronomy department in an excellent position for this decade. The strategy is strong. UW’s engagement in LSST builds on its success as a major participant in the Sloan Digital Sky Survey, giving UW faculty opportunities for national leadership. UW could be well positioned to perform research of an international stature once LSST begins taking data in 2017 or 2018. Likewise, the vision for the proposed Center for Computational Origins (CCO) is excellent, successfully (and sensibly) incorporating distinct departmental strengths in computation (both large data sets and computational astrophysics) while also triggering meaningful engagements with other units on campus. The 3.5 meter telescope at Apache Point remains an active research tool, especially for the graduate students. These investments place UW in a competitive position for this coming decade, especially since many of their self-identified peer competitors lack such advantages.

However, we identified shortcomings in the explicit planning needed to achieve this vision. Our strong sense from the faculty was that the current budget climate has inhibited them from “thinking big.” This is potentially tragic, given the nascent opportunities in this field and the excellent alignment of the departmental strengths with national goals, which should allow them to fare better than average on the national funding scene. This absence of scientific planning was evident in both the faculty hiring plan laid out in the self study and the self study’s explication of the relation between infrastructure priorities and science plans in the upcoming years, prior to LSST.

The first instance of an absence of planning lay in the department’s failure to describe which piece of LSST-enabled science the faculty intend to “dominate,” thereby attracting the best graduate students, postdocs, and faculty to UW in this decade and the next. Selecting such a piece would trigger some immediate scientific activities that would position UW to be a dominant player in specific domains of LSST science. Since LSST is an open project, the presence of the Data Group at UW may not, in itself, prove to be an adequate draw for international talent. It is a competitive market and many of the best universities are working to position their science programs to take full advantage. The faculty mentioned a number of fields that they were interested in working on, including transient science, which is undergoing a revival with the Palomar Transient Factory and Pan-STARRS, but there is no current involvement in these projects.

The second instance of an absence lay in the description of the goal of the CCO (though perhaps this can be remedied with additional explication from the department):

This Center will serve as a focal point for our research efforts; we envision that it would support workshops on scientific and computational challenges, develop

courses that address science in the era of massive datasets, fund graduate student fellowships and prize postdoctoral fellowships in the area of computational astronomy and provide support for faculty.

UW is absolutely a leader in the development and incorporation of large-scale computation for astrophysics, so that the plan for the CCO is well matched to the department's goals and an effective way for the department to engage with other units on campus. However, what is missing is an explicit connection between the department's vision for the CCO and a specific suite of science goals. One laudable goal is certainly discovery via large data-sets, but others are likely to be more subtle and would require the engagement of allied theoretical or observational efforts. It is in these latter instances where preparatory work is required to make an internationally competitive program.

Another committee finding is that the department's historic connection to the Physics department has faded due to the loss of senior faculty. There have been common interests across the two departments in theoretical astrophysics and cosmology, areas recognized in the self study as ones the department wishes to build. Given the losses of senior theoretical faculty and migration of some of the faculty away from theory, this is a critical need. Theoretical astrophysicists often provide the intellectual drivers for large scientific efforts, always provide a key element of graduate student education, and are an essential element to a top ten astrophysics effort. Thus, hiring in theoretical astrophysics is an 'obvious' answer to the immediate hiring need, but more importantly, it is also a potential opportunity to rebuild the historically strong connections to the Physics department.

As already noted, Apache Point Observatory is well used by graduate students, who love its availability and ease of use, and it is extremely well run. APO's role in future faculty research was less clear. We failed to see a vision for the broad future of APO and how it will be used.

Recommendations:

- The faculty should decide which key scientific issues addressable by LSST and CCO are of highest interest and then use this to drive the planning for both new faculty positions and research resources. The necessary planning process, perhaps best done in a one-to-two day retreat, should also take into account the future use of the 3.5 meter telescope, including any instrumentation needs or changes in its mode of operations. Additional outcomes of the process might be a list of needs that can be addressed through advancement efforts and an indication of which departments are likely to be critical to the strategy, Physics and Computer Science and Engineering for example.
- The department should identify the fields of theoretical astrophysics most relevant to their science goals, then work with the Physics chair (and the INT Director) to discuss common goals that would strengthen all parties. The points of common interest for theoretical astrophysics efforts across such a department boundary have historically been in cosmology, supernovae/transient science, and compact objects/gravitational waves.

Independent of cooperation with Physics, the department needs to make progress on this.

- The department must take a leadership role within the Astrophysical Research Consortium to identify a vision for the broad future of Apache Point Observatory that is both consistent and integrated with the department's research goals.

10 Faculty

The department gives due attention in the self study to key research and educational opportunities in the coming decade, but lays out a hiring plan that we found inadequate. Subsequent discussions with the faculty served to reinforce the sense that there is not a sufficiently focused plan within the department for continued hiring, especially given the likelihood of four significant retirements in the next decade. We suspect once again that the department may be inhibited in its ability to plan because of the current budget climate and a resulting assumption that it will not be able to make tenure-line appointments. The college and university need to provide assurances, whatever form this may take, that there is a more promising future for which the department must prepare.

The universities in the US with top ten astrophysics efforts typically have 15 to 25 faculty between their Astronomy and Physics departments. UW's Astronomy department is already within the top ten, despite having fewer than the optimal number of faculty. It can move well inside the top ten over the next decade and take its place among the nation's elite programs with sufficient college and university support and with a focused hiring plan that includes allied departments such as Physics and Computer Science and Engineering. Everything is in place to reach this level of prominence, from track record to infrastructure.

The department appears stuck in developing a policy on the hiring of research faculty. In our conversations with tenured faculty, research faculty, and research scientists, uncertainty about how the department should proceed came up repeatedly. This may be connected to the faculty's parallel uncertainty about how many tenure-line faculty it will be able to hire over the next decade and the resulting worry about how to prepare for large research projects such as LSST. We have no recommendation regarding what policy should emerge for the appointment of research faculty, but we do urge the department to come up with a policy and to communicate it clearly within the department. As a first step, which can serve as the basis for rational discussion independent of the people currently here and of past departmental history, we recommend that the department normalize the discussion by surveying other institutions that have incorporated large research projects into a department culture.

A larger theme may be lurking in some of the issues we have identified. While the department has clearly succeeded in creating the necessary components to achieve excellence in a variety of its endeavors, it has, in many instances, not followed through to assemble those components to achieve its goals. Examples include its faculty hiring plan, its LSST science planning, its use of the 3.5 meter Apache Point telescope, and its fund-raising efforts. This

pattern of near-greatness suggests a need for additional mentoring of mid-career faculty now emerging as departmental leaders in order to guide them toward the perspective needed to bring the department to the level it can achieve.

We observed that the lecturers appear to be playing a critical role in the undergraduate program, from service courses through preparation of majors, and are fully integrated into the department. The lecturers mentioned that they have been free to develop their own courses, a huge advantage to their career growth.

There has been a large increase recently in the number of postdoctoral fellows in the department, which combined with limited office space has resulted in some office crowding. Nonetheless, the postdocs seem to be happy with the research environment and are aware of their career options. Some noted complexities with respect to larger UW bureaucratic issues, such as getting clear and timely information on health insurance. However, they agreed that the department is very helpful with these issues as they arise. They participate in all department activities, including (as noted earlier) the mentoring of undergraduates, and appear to have high esprit de corps.

Several research scientists expressed a desire for a career ladder that would lead to a senior position in which they could have on-going PI status. They were concerned as well with other restrictions on research scientist opportunities, such as serving on graduate committees or signing up undergraduates for credit who are doing research with them. Related to these concerns was the aforementioned issue of lack of clarity about the department's research faculty hiring policy.

One last observation is that despite the historic and continuing collegiality of the department, communication among the faculty appears not to be as good as it could be, especially between the more senior members and the younger members of the tenured faculty.

Recommendations:

- The department should establish a focused plan for the next decade of faculty hiring that aligns with its strategic goals, so that it can manage the renewal of its faculty, an especially critical task given the likelihood of four significant retirements during this period.
- The college and university should enable such a planning process, allowing the department (jointly with Physics) to build a core of at least 15 regular faculty in astronomy and astrophysics over the next decade so that it can not just maintain its current status, but achieve more.
- The department needs to adopt and clearly communicate a policy on hiring research faculty, an initial step being to normalize the discussion through a survey of other institutions that have incorporated large research projects into a department culture.
- The department should provide mentoring to the mid-career faculty who are emerging as departmental leaders in order to prepare them to guide the department during

the next decade and beyond, so that it is positioned to take best advantage of the opportunities that will arise.

11 Staff

The core department staff – those providing operations and advising support – appeared to have the resources needed for their jobs, to be highly skilled, and to feel a part of the department. They are funded from a mix of state funds and research cost recovery funds. With additional cuts in state funds anticipated, the burden on the department’s RCR budget to support core staff will increase. This is hardly news; it is happening in science departments throughout the college. But it is worrisome.

The UW Telescope Engineering Group also appeared to be highly skilled, productive, and satisfied with their working conditions, though inevitably any uncertainty about the future of operations at APO or with the Sloan Digital Sky Survey will affect them. It appears that the staff has very little to do with LSST engineering, or even software. Perhaps the department should look for opportunities over time to take advantage of LSST’s increasing importance to its future by shifting some staff effort in that direction.

12 Conclusion

We wish to express our thanks to the Graduate School and the Department of Astronomy for their superb job in setting up such an informative and well organized site visit. We conclude, as we began, by noting our overall highly favorable impression of the department and offering our encouragement to the college and university, in these difficult economic times, to find the means to continue to invest in it. The combination of such investment and good planning by the department (in collaboration with Physics and perhaps others) will propel the department into the elite of the nation.