Physics & Astronomy -- University Plan III October 13, 2008

Mission and Aspirations

The Department of Physics and Astronomy aspires to the highest standards of excellence in all aspects of teaching and research in addition to service to the University and State of Wyoming. Undergraduate and graduate courses will be taught in effective ways that enable our students to pursue productive professional lives that meet tomorrow's scientific and technical challenges. World-class research will be conducted that is not only relevant beyond academia, but is also synergistic with the needs of our students.

We propose the third phase of the reconstruction of our undergraduate and graduate programs. The Department has established expertise in astrophysics and materials science/condensed matter physics. Although the faculty are exceptionally productive, we would like both our programs in physics and astrophysics to mature to the point of achieving international recognition. In addition, the department would like to create synergistic links with the School of Energy Resources, and to provide leadership in high performance computing in both areas with the new NCAR facility. Computational physics and materials research both match Moving Forward areas of distinction.

Previous Planning Accomplishments

Since the introduction of The Academic Plan in 1999, Physics and Astronomy has made a number of substantial achievements:

- Increased the undergraduate major enrollment from 17 in 1997 to over 60 at present, thanks to increased recruiting and the introduction of more flexible degree programs.
- Reestablished the graduate program for both astronomy- and physics-track students, with our first Ph.D.s to be awarded in 2009.
- Achieved one of the highest extramural funding levels per faculty at UW. We currently have about $9 million in open grants among eight tenured/tenure-track faculty. Both physicists and astronomers contribute substantially to this figure.
- Our tenured and tenure track-faculty published 41 refereed journal articles in 2007, many featuring students as co-authors.
- Research productivity is ranked #2 at UW by the 2004 Faculty Scholarly Productivity Index (by Academic Analytics, LLC; Animal Science is ranked #1).

Relevant Institutional Issues

We are still in the process of rebuilding our graduate program, a process that is consistent with UW's goal of boosting the production of M.S. and Ph.D. recipients. Increasing our faculty and the number of state-funded GAs will help us achieve this goal. There are two immediate impacts to having a relatively low number of GAs. One impact is that we are

insufficiently staffed for our teaching labs and discussions. To address this shortage we have faculty, undergraduates, and non-GA graduate students teach many of our labs. Our shortage of GAs also impacts the research side of our program. We fund several GAs via extramural funding, and on top of our normal graduate admissions we admit a few additional students each year without any funding support. We will always fund several GAs via grants, as that is natural for programs with significant grant funding, but as our faculty ranks increase we need to continue increasing our GA lines.

Action Items

PHYS01: Complete the 2004 Academic Plan

To complete the minimum critical mass for supporting two independent Ph.D. areas of emphasis and successfully recruit quality Ph.D. students it is necessary for us to have a minimum of five active researchers in each of the two areas of research emphasis: astrophysics and materials physics, as planned for in our 2004 academic plan. This means hiring an additional two research physicists and one additional astronomer. One or two of those three positions could be a computational physicist/astronomer. This will allow us to complete building an academic (Ph.D.) program in materials science. Other remaining tasks are to provide additional operational support for WIRO, and increasing the number of GAs to provide the necessary support for the department (to at least 10).

PHYS02: Develop Advanced Undergraduate and Graduate Teaching Laboratories

Our graduate program currently offers no laboratory course, and our undergraduate laboratory facilities are largely limited to freshman laboratories. An upper division modern physics lab course for undergraduates has been an unmet goal of our department for decades. One of our important goals is to provide undergraduate and graduate students practical training in science and technology.

The laboratories which accompany the sophomore level classes Physics 2310 and 2320 will be replaced by a reinstated PHYS 3650 lab course. A student will receive a 'running card' at the beginning of his/her junior year in which a number of advanced laboratory experiments are listed. Students can attend labs in either regular time slots or by appointment, throughout the ensuing calendar year(s). The typical lab sequence for a student will consist of a core assignment and a set number of elective labs. In total, each student has to complete 20 labs, 10 of which are core assignments.

In the near term we plan to offer a graduate physics lab under the guise of PHYS 5870 Special Topics: Experimental Methods. This course will incorporate cutting-edge techniques that are being utilized in Professor Jinke Tang's and Asssistant Professor Wenyong Wang's research labs. These techniques include: nuclear magnetic resonance spectroscopy, X-ray diffraction, characterization of the transport properties of materials, and materials fabrication.

PHYS03: Develop an Interdisciplinary Materials Science Graduate Program

Materials science and engineering (MSE) has figured prominently in the development of science, technology, engineering and mathematics at UW, and has been a prominent focus of UW's academic planning since 2004. A primary emphasis of the MSE graduate program is on research and teaching that is directly energy-related. Creation of an energy-related MSE program allows natural and powerful linkages to be made to the newly created School of Energy Resources (SER). Research involving sophisticated computational approaches to exploring new materials is also appropriate given UW's new partnership with NCAR. Synergistic relationships between existing and new programs allow the most efficient use of research infrastructure and resources at UW, as it does at many small universities.

The MSE Graduate program will be multidisciplinary in nature with Ph.D. or M.S. candidates receiving their degrees from the program. The curriculum will be structured such that the core will be composed of fundamental and materials-oriented courses already in place in individual departments. A requirement will be that each student must take at least one course in each of the three MSE specializations: materials preparation, materials characterization, and material properties, and a fourth specifically on an energy-related topic. Largely these will be drawn from new courses to be developed by the MSE faculty, which is composed of about 20 faculty members currently in the Departments of Physics & Astronomy, Chemistry, Chemical Engineering, Geology and Geophysics, Mechanical Engineering, and Electrical Engineering.

Graduates of the MSE program will be at the forefront of energy-related materials science and engineering R&D and education, add to the international competitiveness of the country in energy production, storage and transmission, and contribute to the nation's needs for energy security and independence.

PHYS04: Develop Expertise in Computational Science

Much of the 20th century theoretical work in physics and astrophysics could be achieved by pencil-and-paper "analytical" approaches, but many of the theoretical breakthroughs of the 21st century are likely to be accomplished via large-scale, computationally-intensive numerical methods. In addition, progress in experimental and theoretical physics/astrophysics go hand-in-hand, with data from experiments helping to constrain new theories, and theory helping to explain new data. Finally, the large new databases being generated today in physics and astrophysics are best "mined" using intelligent computational techniques. Our goal over the next several years is to build up expertise in computational physics and astrophysics. Our computational group will actively participate in UW initiatives such as NCAR, SER, and the Materials Science & Engineering program.

PHYS05: Pursue a Partnership in a Major Telescope Initiative

Upon construction in 1977, WIRO was the 11th largest telescope in the world; now it is ranked 54th. When completed WIRO had ¼ the light gathering capacity of the largest telescope. Telescopes are currently under construction that will have more than 100 times WIRO's sensitivity. Although still heavily used by the department in its role in graduate education as well as selected projects appropriate for its aperture, it is important to the competitiveness of UW astrophysics to obtain the access to large telescopes that other institutions have; all the US institutions that competed with UW astronomy in 1977 now have access to 8-meter class facilities. UW's participation in a large telescope consortium would greatly enhance our opportunities for collaborative research and allow us to attract the best graduate students. Participation in a new project could result in a significant return on this investment via construction contracts for the state's industrial base. In addition, our participation in a major research facility would create opportunities for adding to the research and technical base in Wyoming though the design and development of NSF and privately funded state-of-the-art instrumentation. Each of these instruments would bring in $3-5 million and involve a substantial number of technical staff and students. Our participation in a large-telescope consortium would ensure the competitiveness of UW astrophysics for decades to come.

Implementation

PHYS01 The hiring of additional faculty falls under the annual CPM process.

PHYS02 APL Rudy Michalak has spearheaded several efforts for obtaining funding for developing new advanced lab courses. He has obtained two WY NASA Spacegrant grants, arranged for additional A&S Instructional Excellence funds, and is pursuing NSF grants. These monies are being used to purchase several sophisticated apparati for fields spanning optics, magneto-resistance, semi-conductors, nuclear physics, thermodynamics, quantum mechanics, and materials science. The inaugural editions of the graduate and advanced undergraduate lab courses will be taught in Spring 2009 and Fall 2009, respectively.

PHYS03 The long-term viability and sustainability of the materials science program will be achieved through effective interdisciplinary collaborations that will support both the graduate students and the major equipment facilities by attracting competitive external funding. A modest amount of support is currently being provided by NASA EPSCoR. Grants are currently being pursued through NSF EPSCoR program in synergy with the School of Energy Resources and the University of Wyoming administrative priorities. The program will seek major interdisciplinary grants such as the NSF MRSEC (Materials Research Science and Engineering Centers) and NSF IGERT (Integrative Graduate Education and Research Traineeship Program) programs. Professor Jinke Tang is helping lead this effort.

PHYS04 This year we will hire a computational physicist. Our program is likely to request additional computational expertise in upcoming CPM cycles.

PHYS05 We are working with the A&S Development office to find funding for a large telescope buy-in.

	2009	2010	2011	2012	2013
PHYS01					✓
PHYS02	✓				
PHYS03					✓
PHYS04					✓
PHYS05					?