Action Plan Memorandum of Understanding  
Department of Physics and Astronomy  
Georgia State University  

STATUS FROM THE LAST ACTION PLAN –

The last external review of Physics and Astronomy (P&A) that yielded an Action Plan (AP) was initiated more than a decade ago and approved by the Provost in 2003. That AP focused on increased funding for laboratory instruction, the addition of four new tenure-track faculty and one lecturer, and increased Graduate Assistant (GA) support. Those priorities were largely fulfilled by FY2008.

MAJOR FINDINGS OF THE MOST RECENT REVIEW –

The Department completed its most recent self-study in December 2007 followed by an external review whose results were reported the following spring. The review committee recommends that P&A formulate a well-reasoned strategic plan with the following un-prioritized action items:

- Enhance undergraduate teaching by
  - Improving classrooms both in size and facilities;
  - Improving and incorporating better demonstration/laboratory equipment into lectures;
  - Considering a curricular path for majors not wishing to continue with graduate studies;
  - Planning how to meet lab teaching demand in the event of insufficient graduate teaching assistants.

- Respond to the following issues related to the graduate program by
  - Developing a consensus on the appropriate size of the graduate program;
  - Increasing GA stipends by 20-30% to be comparable to actual and aspirational peers.

- Enhance graduate and undergraduate curricula through appropriate and minor adjustments.

- Grow through new resources for faculty and staff expansion by
  - The allocation of new lines to increase the small size of the faculty in comparison with its teaching load;
  - The addition of two staff positions for IT and for activities at Hard Labor Creek Observatory.

While the fulfillment of all of these action items is important to the future of P&A, we consider a number of them to be tactical rather than the strategic. Furthermore, the review is now somewhat stale due partly to the length of time since it occurred, the current challenging economic times, but mainly to the advent of new institutional leadership with a vision for a University that significantly transcends the context of the 2007/08 P&A review. This Action Plan MoU has been written primarily in the spirit of responding to the 2008 review committee’s charge that P&A develop a “well-reasoned strategic plan.”

INSTRUCTIONAL GOALS –

The department seeks academic excellence with pedagogically sound and accepted methods of teaching using modern instructional technology, teaching materials, and equipment, and by involving its experienced and distinguished faculty at all levels of instruction. P&A’s major instructional goals are:

**Increase the number of undergraduate physics majors** – Our goal is to increase the number of physics undergraduate majors beyond the current level of 5-10 graduating students per year. A new course has been developed for all freshman physics majors with the dual goals of providing an overview of modern physics while giving students the chance to discuss topics of particular interest to them. This allows prospective majors to connect with the department early in their academic careers and be involved in meaningful scientific experiences. We plan to exploit existing astronomy research activities in order to recruit and retain majors in the astronomy concentration. Significant effort has also been put into the development of advanced physics labs to prepare our students to be highly competitive in the job market. In addition, short summer activities (e.g. FUN PHYSICS) will be carried out for local high school students, exposing them to our programs.

**Train qualified physics teachers** – In partnership with the College of Education, P&A has a new BS/MAT program option wherein students simultaneously enroll in a BS program in physics and an MAT program in CoE. This is an attractive fast track to teacher certification while also expanding our number of majors. We will also work with CoE to
continue to support the TEEMS program for students who have BS degrees in science and engineering and are returning to school to become certified physics teachers. In many cases, these students will need additional courses in physics in order to satisfy the certification requirements.

Enhance Introductory Courses – New teaching techniques have been explored for more effectively conveying key concepts. A Studio Physics classroom now facilitates active student learning. P&A will build on the successes of the physics innovative instructional efforts and will apply them to the introductory astronomy courses. P&A, in collaboration with the College of Education, will aggressively seek significant new federal funding to support efforts in this area.

Position our graduate programs to attract better quality students – The success of our graduate programs in physics and in astronomy is demonstrated by the success of recent PhD students in winning nationally competitive NSF, NRC and NASA pre- and post-doctoral fellowships in both physics and astronomy. These students contribute to our research productivity as well as to the increasing instructional effort. Our goal, however, will be to support our graduate students to allow them more research time. We also need to find external research grant support to provide competitive graduate stipends and student workloads. The department will carefully evaluate the criteria used in the recent National Research Council assessment of doctoral students in an effort to bring the department in line with peers and aspirational peers. In order to maintain a well-balanced PhD program, instructional responsibilities will also be considered when faculty replacements are made.

RESEARCH GOALS –

The Physics PhD program will build upon the considerable reputation of the Condensed Matter Group (CMG) in new multifunctional materials, sensors, nanolascomics, and nanophotonics. CMG activities are now directed towards understanding, engineering, and applying nano-structured materials in emerging new devices, successfully leading to novel nanosensor concepts that are well supported by funding agencies. Nanotechnology is very promising for making high-density, low power consumption, radiation hardened, and efficient radiation detection elements that are in high demand in medical physics, space studies, and in earth-bound gigantic nuclear and particle detectors. These are core interests of the experimental high energy nuclear and particle group who will benefit from the nanoscience emphasis. The intersection of nanosensor development with the diagnostic component of the Center for Diagnostics and Therapeutics (CDT) is a core area of interest for the biophysics group, providing opportunities for future development. The behavior of confined atoms is a prime interest of P&A’s theoretical atomic physics group whose computations can guide experimental efforts to produce useful nanodevices. NIH, NSF, and DOE all have itemized funds in the 2011 National Nanotechnology Initiative and will be targeted to fulfill the following goals:

Build upon existing expertise to foster a broad, but focused, program of research and instruction in Nanoscience and Nanotechnology. Our goal is to identify a niche enabling CMG to attract substantial new funding consistent with the institutional goals to increase national and international prominence.

Expand the nanoscience focus to develop next-generation smart sensors, nanophotonic & plasmonic devices, and communications systems as a focal point within P&A where CMG can collaborate with the other P&A disciplines on initiatives aligned with GSU’s strategic goals.

Broaden the nanoscale sensor-emitter area to augment the strengths in Biology and Chemistry at GSU in biosensing and diagnostics as envisioned by CDT.

To accomplish these goals and attain international prominence, it is necessary to add expertise and infrastructure in growth, fabrication, and materials characterization at the nano-scale. Thus, the physics strategic focus over the next seven years is on expanding targeted nanoscience activities through recruitment of outstanding new faculty (via initiatives and/or replacements) experienced in the complex areas of growth, fabrication and manipulation of nanostructured materials and device elements, and in nanostructure characterization techniques. The goal is to select persons who will collaborate not only with the P&A faculty but also with faculty in other disciplines.

The Astronomy PhD program will undertake a new Origins initiative emphasizing fundamental probes into the birth and evolution of planets, stars, and galaxies. This focus responds to a major emphasis in the new “Astro2010” astronomy and astrophysics decadal review released in August 2010 by the National Research Council laying out a detailed plan for U.S. astronomy in the 2011-2020 decade that will be followed closely by NASA and NSF. Origins goes to the heart of the most basic human questions of our Universe: where did we come from, and how did we get here? We propose a
strengthening of our program in the following three areas, building upon our current areas of expertise to achieve critical mass for major new funding.

**Stars that Host Planets** — Assessing the potential for life to exist and possibly thrive on planets orbiting our nearest stellar neighbors is a primary thrust of Astro2010 and a key component of *Origins*. Since these 'exoplanets' are, in most cases not directly observable, assessing their habitability relies critically upon comparisons with the host stars' properties. Our program is poised to dramatically improve our understanding of stars that host planets and thereby take advantage of the new funding opportunities and resources. Current faculty members have on-going programs to find nearby stars, measure their fundamental properties and search for planets orbiting them. The work is enabled by our extensive access to telescopes in both hemispheres as well as by our own unique facility — the CHARA Array, which has high-resolution capabilities unrivaled world-wide.

**The Oncoming Era of Surveys** — New facilities coming this decade will create enormous information databases for billions of stars in our Milky Way Galaxy, as well as galaxies beyond. Finesse in using these databases will lead to breakthroughs as once rare objects are discovered by the thousands, and even rarer objects are revealed for the first time. Our CHARA Array will bring its unique resolving power to bear on many of these objects. GSU’s RECONS program already has expertise in mining an existing megadatabase including 1.9 billion sources, revealing previously hidden gems, such as new very nearby stars and stars at the extrema of expected stellar ages. Yet, we have only scratched the surface. By 2020, vast new megadatabases will have changed our understanding of astronomy in fundamental ways. We wish to ensure that our *Origins* theme has the people and resources to aggressively exploit this impending flood of astrophysical data.

**The Birth and Growth of Galaxies and their Supermassive Black Holes** — Galaxies have central black holes with masses a million to a billion times that of our Sun. When these black holes feed on gas from their host galaxies, they enter an active phase that plays a critical role in galaxy evolution through “feedback” of radiation and ionized gas. Active galaxies have been extensively studied by GSU astronomers who measure the masses of the black holes and their galaxies and study the feedback processes. Consistent with our *Origins* theme, we will build on existing strengths by expanding into the area of active galaxies in the early Universe; exploiting new funding that will come from observations with the James Webb Space Telescope, NASA’s successor to the Hubble Space Telescope. In addition, new ground-based survey telescopes will provide targets for these studies, and expansion of our group will give us the expertise needed to lead large-scale projects with these new facilities.

**Summary** —

The Department of Physics and Astronomy occupies a central instructional position within GSU while serving the university through scholarship and research in the most fundamental areas of science. We embrace our roles in teaching and research to prepare our students to become scientifically literate citizens and the next generation of leading scientists. Our immediate plans for future development are directly related to the nation’s goals as emphasized in the *President’s Plan for Science and Innovation*, which calls for a doubling of the budgets of the NSF and DOE Office of Science.. The nanotechnology focus in Physics is one of the areas designated for increased support according to the AAAS’s review of 2011 federal budgets while our *Origins* theme in astronomy research will focus on many of the areas designated for support in the Astro2010 decadal survey of the NRC. Nanotechnology has broad implications for fundamental research and for technological advancement, and, through its relation to sensor development, will impact many of the researchers in P&A and in Biology and Chemistry with research focus in Diagnostics and Therapeutics. We regard the CHARA Array as a seminal, national resource for high angular resolution astronomy, and we look forward to directing national efforts in developing the technology and methods needed in this field. We will seek talented new faculty in both Physics and Astronomy, who will collaborate with the P&A faculty and faculty in other disciplines such as Biology, Chemistry, Computer Science, Geosciences and the College of Education by responding to initiatives (such as 2CI) and other means as necessary. We see the broad areas of nanosensing, imaging algorithms and database mining as emerging specialties in P&A and GSU as a whole. We regard these plans as ambitious but realistic, and we will make every consideration in faculty recruitment to maintain a well balanced PhD program that meets our instructional responsibilities. We see ample evidence of new funding opportunities to support new faculty, but we will need to meet the challenges of providing adequate equipment, facilities and space.