# Assessment Findings and Curricular Improvements
# Department of Physics

## Graduate Programs:
### Master of Science in Physics
### Doctor of Philosophy in Physics

### Assessment Measures

The Department of Physics uses the following measures to assess student learning outcomes:

**Direct Measures**

Pass rate on Comprehensive Examinations
Progress toward the degree

**Indirect Measures**

Grades and course evaluations for required courses
Job placement
Alumni surveys

### Assessment Findings

**Comprehensive Examinations**

The number of students passing the Comprehensive Examinations between 2008 and 2012 is summarized on Attachment 1. The number per year passing the M.S. exam varied between 0 and 2, and the number passing the Ph.D. exam varied between 1 and 9. Nearly all students taking either the M.S. And the majority of those taking the Ph.D. exam passed on the first attempt (two attempts are permitted).

The Ph.D. comprehensive examination consists of a two-day written examination with two problems each in the areas of classical mechanics and statistical mechanics and three each in the areas of electricity & magnetism and quantum mechanics, followed by a two-hour oral examination administered by a committee of three faculty members. Each written problem is graded by two faculty members, and the full grade report is submitted to the entire physics faculty, who then vote to pass or fail. The discussion of examination results by the faculty provides a forum for assessing the effectiveness of the coursework and advising offered by the department.

While we offer the option for students to enroll in an M.S. Program, which would require a written exam similar in format to the PhD comps, all of the Physics M.S. degrees in this period were awarded to PhD students. PhD students are awarded an M.S. Degree based on their performance on the PhD comps exam. They are required to show command of a subset of the

questions, typically those based on upper-level undergraduate classes. And, there is no oral component for the M.S. exam. Furthermore, all students who pass the PhD exam are automatically awarded M.S. degrees. Note, M.S. students enrolled in the Nuclear Engineering Protection (NEP) program are considered graduate students in the Dept. of Physics. There is no comps exam for NEP students.

Attachment 2 gives the pass/fail statistics and a graphical description of the number of years taken from matriculation to passing the Ph.D. and M.S. comprehensive examinations. The reasons for some of the large variations are explained in the section on Student Progress below.

**Student Progress**

Attachment 3 shows the progress toward graduation of students admitted in each year between 2008 and 2012. During these years, the number of students entering the Ph.D. program varied between 3 and 10 with total of 30 and an average of 6, and the number entering the M.S. program varied between 0 and 3 (total = 10, average = 2). Attachments 4/01 and 4/02 show graphs of the time taken from matriculation to completion of the M.S. or Ph.D. degree for students who graduated between 2008 and 2012.

The large variations in time taken to pass comprehensive exams and complete the degree are partly due to the very large variation in student careers. On the one hand, some students have entered CUA with previous graduate study or Master's degrees, and have been able to complete their Ph.D. degree in as little as four years. Also, several former undergraduate students at CUA have entered the graduate program directly after graduation, and have completed the M.S. degree within 2 or 3 semesters. Previous to 2009, some students have been admitted to the graduate program from liberal arts colleges with excellent undergraduate records but minimal preparation in physics, requiring them to take some undergraduate-level (UG) physics courses at CUA before entering the more advanced courses normally expected of entering graduate students. More recently, while this practice has been discontinued, we occasionally accept students who have not had the full range of UG physics, hence they may take up to several upper-level UG classes before attempting our core sequence. Some of the extreme cases on the graphs (more than 5 years to pass the comprehensive exam, more than 10 years to complete the Ph.D. degree) represent part-time students, fully employed off campus, who have succeeded in fitting graduate study into their evenings and weekends. For normal "full-time" students, arriving with a bachelor's degree and employed part-time as teaching or research assistants, the typical time to pass the Ph.D. comprehensive exam is 2 to 4 years, and the typical time to the Ph.D. degree is 5 to 8 years. Note, while the average time to graduation in this sample is 6.9 years, the *median* time to graduation is 6 years. We expect as we continue the move to more traditional PhD students, we will achieve our goal of an average time to graduation of 5 years. As described in the Curricular Improvements section below, we are working on ways to reduce this time.

The relatively long period needed to complete the M.S. Degree (see attachment 4/02) is somewhat misleading. Excepting the two NEP students, each of whom completed their degrees in 2 years, the students tracked were all PhD students who received their M.S. degrees after comps.

An important aspect of a successful Ph.D. program is retaining the students who enter it. Only 6 of the 30 students admitted to the Ph.D. program between 2008 and 2012 have left the program either with no degree or after obtaining only a Masters degree. This is a clear improvement on the 50% retention-rate from the previous reporting period and reflects both a more selective admissions process and some streamlining of the curriculum.

**Course Discussion**

There is no single course that acts as a gateway for the graduate programs in physics. All graduate students must master the material presented in the following graduate-level courses:

| | |
|---|---|
| 611-612 | Mathematical Methods of Theoretical Physics I and II |
| 615 | Advanced Mechanics I |
| 621 | Statistical Mechanics I |
| 623-624 | Advanced Electromagnetic Theory I and II |
| 659-660 | Advanced Quantum Theory I and II |

We had previously required students to take PHYS 622, Statistical Mechanics II, but after reveiwing the core curricula of other departments, including the University of Maryland, College Park and Baltimore County, the department voted to make 622 an elective (see below).

Although students entering with a Master's degree from another institution may be able to transfer credit for some of these courses, the majority will take most or all of them in preparation for the Comprehensive Examination.

As a sampling of these courses, we include as Attachments 5 and 6 data on student grades and course evaluations for two of these: Physics 623 (Advanced Electromagnetic Theory I) and 659 (Advanced Quantum Theory I). The fairly negative course evaluation results for Physics 659 in Fall 2009 were due to the fact that this was the first class taught by a new faculty member; the evaluation was discussed thoroughly with the instructor, who showed marked improvement.

**Employment of Graduates**

We list below the current employment of a selection of our graduates by academic year.

***Ph.D. graduates***
***2012***
Physical Scientist, Space Weather Facility, NASA/Goddard Space Flight Center
Staff Scientist, Vitreous State Laboratory, Dept. of Physics, CUA
Patent Examiner, U.S. Patent Office
***2011***
Patent Examiner, U.S. Patent Office
Software Specialist, Google Corporation

***2010***
Senior Research Associate, Dept. of Physics, Virginia Tech
Postdoctoral Researcher, Smithsonian Astrophysical Observatory/Harvard Univerity
Teaching on-line (physics and astronomy)
***2009***
Engineer, Raytheon/ITSS/NASA/Goddard
Assistant Professor, Dept. of Natural Sciences, NOVA Southeastern University
Physicist, Computational Physics Inc.
Staff Scientist, U.S. Naval Observatory
Staff Scientist, U.S. Naval Research Laboratory

***M.S. graduates (non-continuing)***
***2012***
PhD student, Astronomy Georgia State University
PhD student, Electrical Engineering, CUA
PhD student, Electrical Engineering, CUA
Staff, Vitreous State Lab, CUA
Senior Associate, PwC

***2010***
PhD student, GeoPhysics, Johns Hopkins University

***2009***
Staff Scientist, Atmospheric and Environmental Research, Amherst, MA

**Perceptions of Outcomes by Graduate Students**

We intend to implement a system of surveys and questionnaires for outgoing and recent graduate students, asking for their opinions about the effectiveness of the graduate curriculum, teaching and advising in preparing them for the completion of the degree.

## Curricular Improvements

The graduate curriculum of the Physics Department has been unchanged for many years, but is currently being re-evaluated by the faculty. Using data compiled by the American Institute of Physics, we found that, in comparison with most other comparable Ph.D.-granting departments, we have many more required courses and a much more rigorous and time-consuming Comprehensive Examination. While we are proud of our traditions, we were concerned that this difference is harming our ability to recruit capable graduate students, and that it is causing our students to take an unacceptably long time to complete the Ph.D. Degree. Based on this, the faculty eliminated the second semester of Statistical Mechanics as a required course. We continuing to assess the overall program to allow more coursework in the student's field of

specialization such as astrophysics, condensed matter or nuclear physics. Another issue was the large amount of material tested in the Comprehensive Examination, with the consequent long preparation time before most students feel they are ready. In order to address the problem, we have developed a comps preparation course (now formally listed as, PHYS777). Since its inception in Fall 2012, we have seen an improvement in the students' performances on Comps.

Attachments:

1. Comprehensive exam statistics (from CPIT)
2. Comprehensive exam graphs and statistics
3. Student progress (from CPIT)
4. Graphs of time from matriculation to degree
5. Course summary data for Physics 623
6. Course summary data for Physics 659

Attachment 1

**GRADUATE COMPREHENSIVE EXAMINATION RESULTS**
**SCHOOL OF ARTS AND SCIENCES**
**DEPARTMENT OF PHYSICS**
**AY2008-2009 to AY2012-2013**

Master's Comprehensive Exam

| | Fail | | Pass | | High Pass | | Pass w/Honors | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % | |
| AY2008-2009 | 1 | 20.00% | 4 | 80.00% | | 0.00% | | 0.00% | **5** |
| AY2009-2010 | 0 | 0.00% | 1 | 100.00% | | 0.00% | | 0.00% | **1** |
| AY2010-2011 | | 0.00% | | 0.00% | | 0.00% | | 0.00% | **0** |
| AY2011-2012 | | 0.00% | 3 | 100.00% | | 0.00% | | 0.00% | **3** |
| AY2012-2013 | | 0.00% | 0 | 0.00% | | 0.00% | | 0.00% | **0** |
| **TOTAL** | **1** | **11.11%** | **8** | **88.89%** | **0** | **0.00%** | **0** | **0.00%** | **9** |

Doctoral Comprehensive Exam

| | Fail | | Pass | | High Pass | | Pass w/Honors | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % | |
| AY2008-2009 | | 0.00% | 1 | 100.00% | | 0.00% | | 0.00% | **1** |
| AY2009-2010 | 1 | 20.00% | 4 | 80.00% | | 0.00% | | 0.00% | **5** |
| AY2010-2011 | 2 | 40.00% | 3 | 60.00% | 0 | 0.00% | | 0.00% | **5** |
| AY2011-2012 | 3 | 60.00% | 2 | 40.00% | | 0.00% | | 0.00% | **5** |
| AY2012-2013 | 5 | 36.00% | 9 | 64.00% | 0 | 0.00% | | 0.00% | **14** |
| **TOTAL** | **11** | **36.67%** | **19** | **63.33%** | **0** | **0.00%** | **0** | **0.00%** | **30** |

Note:

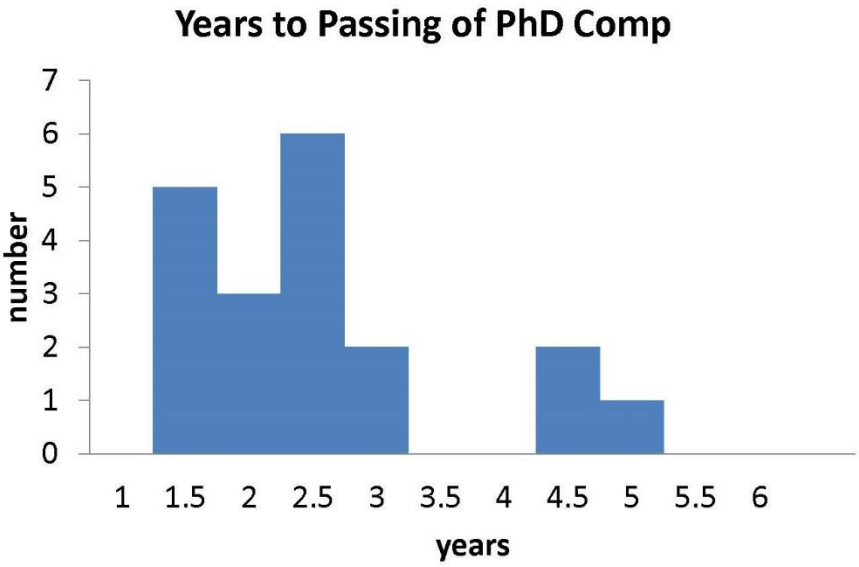
1) Milestone outcomes were included in the categories High Pass and Pass with Honors if these designations were explicitly indicated in the students' milestone record.

2) Category "High Pass" includes both "High Pass" and "Pass with distinction".

3) The count in this table is based on the exam outcomes of all attempts in an academic year.

4) Level of the comps, i.e. Master's and doctoral, is based on the milestone activities; if there is no specification of the level in the record, students' degree level is used to determine the level.

Attachment 2



THE CATHOLIC UNIVERSITY OF AMERICA
Planning, Institutional Research, Student Learning Outcomes Assessment
**GRADUATE PROGRESSION AND GRADUATION**
**SCHOOL OF ARTS AND SCIENCES**
**DEPARTMENT OF PHYSICS**
**Graduate Cohort Fall 2008 through 2012**
**Master Program**

| | Graduate Cohort Size | Returned To CUA in **Fall 2009** No. | Pct. | Returned To CUA in **Fall 2010** No. | Pct. | Returned To CUA in **Fall 2011** No. | Pct. | Returned To CUA in **Fall 2012** No. | Pct. | Returned To CUA in **Fall 2013** No. | Pct. | Graduated in **One Year** No. | Pct. | Graduated in **Two Years*** No. | Pct. | Graduated in **Three Years*** No. | Pct. | Graduated in **Four Years*** No. | Pct. | Graduated in **Five Years*** No. | Pct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fall 2008 | 3 | 1 | *33.3%* | 1 | *33.3%* | 1 | *33.3%* | 0 | *0.0%* | 0 | *0.0%* | 1 | *33.3%* | 1 | *33.0%* | 2 | *67.0%* | 3 | *100.0%* | 3 | *100.0%* |
| Fall 2009 | 0 | | | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | | |
| Fall 2010 | 2 | | | | | 2 | *100.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 1 | *50.0%* | 2 | *100.0%* | | | | |
| Fall 2011 | 3 | | | | | | | 2 | *66.7%* | 2 | *66.7%* | 0 | *0.0%* | 0 | *0.0%* | | | | | | |
| Fall 2012 | 2 | | | | | | | | | 1 | *50.0%* | 0 | *0.0%* | | | | | | | | |

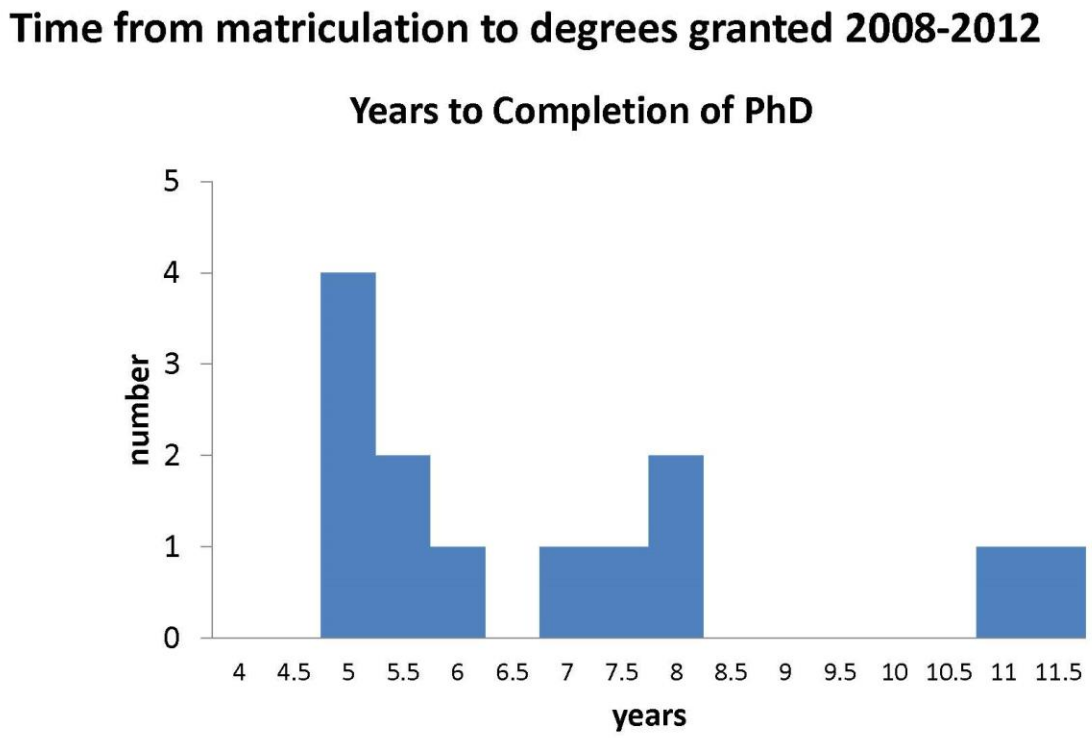
*Two to five years of graduation rates are cumulative. Note 1 M.S. Student from F2012 switched to PhD program in F2013.
Note: A particular cohort is defined as the combination of the students first enrolled in consecutive sessions of one year: the summer session or the fall semester. For example, cohort 2008 consists of students first enrolled in summer 2008 or fall 2008.

**GRADUATE PROGRESSION AND GRADUATION**
**SCHOOL OF ARTS AND SCIENCES**
**DEPARTMENT OF PHYSICS**
**Graduate Cohort Fall 2008 through 2012**
**Doctoral Program**

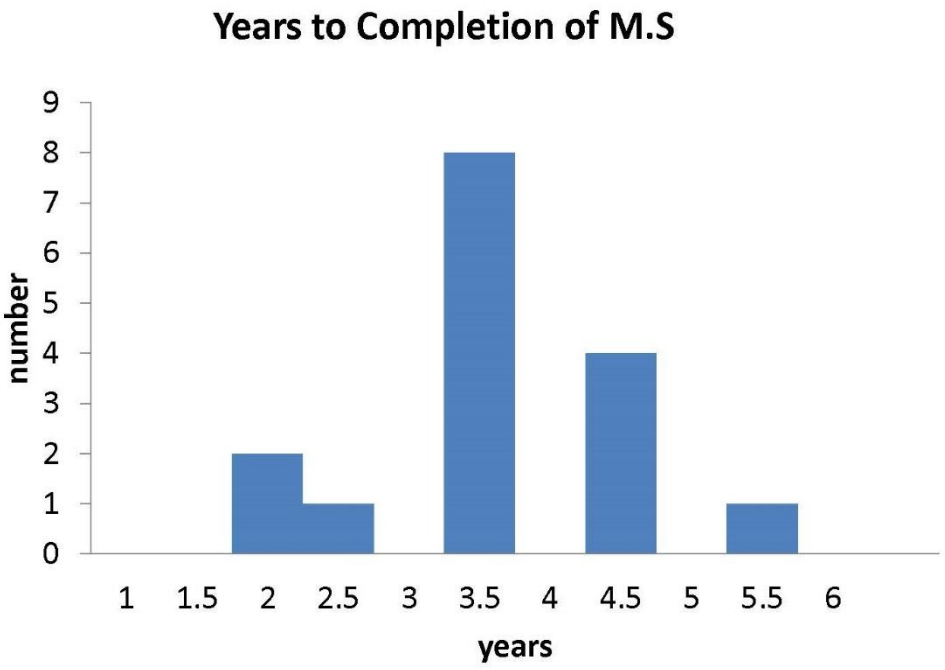
| | Graduate Cohort Size | Returned To CUA in **Fall 2009** No. | Pct. | Returned To CUA in **Fall 2010** No. | Pct. | Returned To CUA in **Fall 2011** No. | Pct. | Returned To CUA in **Fall 2012** No. | Pct. | Returned To CUA in **Fall 2013** No. | Pct. | Graduated in **One Year** No. | Pct. | Graduated in **Two Years*** No. | Pct. | Graduated in **Three Years*** No. | Pct. | Graduated in **Four Years*** No. | Pct. | Graduated in **Five Years*** No. | Pct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fall 2008 | 3 | 2 | *66.7%* | 2 | *66.7%* | 2 | *66.7%* | 2 | *66.7%* | 2 | *66.7%* | 1 | *33.3%* | 1 | *33.3%* | 1 | *33.3%* | 1 | *33.3%* | 1 | *33.3%* |
| Fall 2009 | 6 | | | 4 | *66.7%* | 4 | *66.7%* | 3 | *50.0%* | 2 | *33.3%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | | |
| Fall 2010 | 10 | | | | | 9 | *90.0%* | 9 | *90.0%* | 9 | *90.0%* | 0 | *0.0%* | 0 | *0.0%* | 0 | *0.0%* | | | | |
| Fall 2011 | 5 | | | | | | | 5 | *100.0%* | 5 | *100.0%* | 0 | *0.0%* | 0 | *0.0%* | | | | | | |
| Fall 2012 | 6 | | | | | | | | | 6 | *100.0%* | 0 | *0.0%* | | | | | | | | |

*Two to five years of graduation rates are cumulative. Note: 1 PhD student from F2008 and 1 from F2009 left with M.S. Degrees.
Note: A particular cohort is defined as the combination of the students first enrolled in consecutive sessions of one year: the summer session or the fall semester. For example, cohort 2008 consists of students first enrolled in summer 2008 or fall 2008.

Attachment 4 - 01



Attachment 4 – 02



Attachment 5

**Grade and Course Evaluation Statistics -- Physics 623 (Advanced Electromagnetic Theory)**

**Grades**

| Semester | | | Number of students | Mean grade |
|---|---|---|---|---|
| | | | | |
| Fall | 2008 | | 13 | 3.43 |
| Fall | 2010 | | 13 | 3.46 |
| Fall | 2011 | | 2 | 3.40 |
| Fall | 2012 | | 4 | 3.50 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Course evaluations**

| Semester | | | Number of evaluations | Teacher average (of 10) | Course average (of 10) |
|---|---|---|---|---|---|
| | | | | | |
| Fall | 2008 | | 12 | 8.8 | 8.3 |
| Fall | 2010 | | 10 | 6.8 | 6.5 |
| Fall | 2011 | | 2 | 8.5 | 8.5 |
| Fall | 2012 | | 4 | 9.0 | 8.3 |
| | | | | | |
| | | | | | |

Attachment 6

**Grade and Course Evaluation Statistics -- Physics 659 (Advanced Quantum Theory I)**

**Grades**

| Semester | | | Number of students | Mean grade |
|---|---|---|---|---|
| | | | | |
| Fall | 2009 | | 8 | 3.20 |
| Fall | 2011 | | 13 | 3.75 |
| Fall | 2012 | | 4 | 3.57 |
| | | | | |
| | | | | |
| | | | | |

**Course evaluations**

| Semester | | | Number of evaluations | Teacher average (of 10) | Course average (of 10) |
|---|---|---|---|---|---|
| | | | | | |
| Fall | 2009 | | | 5.0 | 5.8 |
| Fall | 2011 | | | 8.2 | 8.0 |
| Fall | 2012 | | | 9.3 | 8.0 |
| | | | | | |