Academic Program
Plan for Assessment of The PhD Program in Physics and Astronomy
College of Arts and Sciences
The University of New Mexico

A. College, Department and Date

1. College: *Arts & Sciences, University of New Mexico, Main Campus*
2. Department: *Physics and Astronomy*
3. Date: *4/20/18*

B. Academic Program of Study
PhD, Physics

C. Contact Person(s) for the Assessment Plan
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D. Broad Program Goals & Measurable Outcomes
1. Broad Program Learning Goals for this Degree/Certificate Program

A. Students acquire a solid foundation of advanced knowledge in broad areas of physics and/or astronomy

B. Students are able to design, conduct, and report on independent, high quality research

C. This program will successfully recruit a highly talented and diverse pool of graduate students every year.

2. List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1. Students will have a thorough grasp of undergraduate physics.

Physics and Astronomy are hierarchical, with each level building on understanding at lower levels. On entry to graduate school, most students have seen, but not yet mastered, all of the extensive foundational material in the discipline. An important step in their graduate education is to solidify their understanding at this level.

UNM Goals (_X_ Knowledge _X_ Skills   ___ Responsibility)

A.2. Students will have an understanding of core areas of physics and/or astronomy at the graduate level.

Core areas include Quantum Mechanics, Electrodynamics, Statistical Mechanics, Mathematical Tools of Physics, and/or Astrophysics.

UNM Goals (_X_ Knowledge _X_ Skills   ___ Responsibility)

B.1. Students achieve expertise in their chosen research field.

Expertise in a research field means awareness and understanding of the "state of the art" in that field. The student should be aware of the current issues and unanswered questions.

UNM Goals (_X_ Knowledge _X_ Skills _X_ Responsibility)

B.2. Students are able to make professional-quality written and oral presentations of research results.
UNM Goals (_X_ Knowledge _X_ Skills _X_ Responsibility)

B.3. Students can conduct independent and original scientific research that meets disciplinary standards for peer-reviewed publication.
UNM Goals (_X_ Knowledge _X_ Skills _X_ Responsibility)

C.1. The department will recruit a freshman graduate class with geographic and gender diversity, whose members demonstrate exceptional aptitude for study in physics and/or astronomy.

Successful recruitment is both a program goal and metric for program success. Graduate students learn from each other, perhaps as much as they learn from their research advisors. A strong graduate class provides increased opportunities for our students to learn and a healthy environment for their maturation into successful researchers. Moreover, the ability of our program to attract top talent demonstrates that the quality of our program is widely acknowledged.

UNM Goals (_X_ Knowledge _X_ Skills _X_ Responsibility)

E. **Assessment of Student Learning Three-Year Plan**
All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

1. **Timeline for Assessment**

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year 1	**A.2 & B.2 assessed for the previous 3 years and discussed in Spring**
Year 2	**A.1 & B.1 assessed for the previous 3 years and discussed in Spring**
Year 3	**B.3 & C.1 assessed for the previous 3 years and discussed in Spring**

2. **How will learning outcomes be assessed?**
SLO A.1. Undergraduate physics mastery is assessed using our preliminary examinations (**direct measure)** and/or exceptional scores on the Physics GRE (>800; **direct measure**). There are five preliminary exams (3 hours each) covering broad areas of physics: classical mechanics, statistical mechanics, electromagnetism, quantum mechanics, and astrophysics. Students must

pass 4 of these exams to qualify for a PhD. They have 1.5 years (up to 4 attempts) to pass all 4 exams.

Average passing scores on these exams will be reported for all students, as well as the average time to pass, and the average number of attempts actually used.

Lastly, the number of students unable to overcome this hurdle will be reported, and compared to the number of successful PhD candidates.

Criteria: Successful students will achieve scores of 60% or higher on 4 exams.
The average number of attempts per exam will not exceed 2.
Over 90% of students admitted to the program will succeed.

An **indirect measure** of undergraduate physics mastery will be a survey of the graduate students themselves. The results from this electronically administered survey will include all respondants, not less than 20% of the graduate student population.

Criterion: On a 100 point scale, students will report their mastery of undergraduate material to be > 70.

SLO A.2. Understanding of core areas of physics and/or astronomy is assessed using class grades in "core" classes:

- 466 Methods of Theoretical Physics I
- 505 Statistical Mechanics and Thermodynamics
- 511 Electrodynamics I
- 521 Quantum Mechanics I
- 522 Quantum Mechanics II **or** 537 Advanced Astrophysics II

This is a **direct measure.**
Criterion: The average student GPA in these classes will exceed 3.0.

An **indirect measure** of understanding core areas of physics will be a survey of the graduate students themselves. The results from this electronically administered survey will include all respondants, not less than 20% of the graduate student population.
Criterion: On a 100 point scale, students will report that upper division coursework improved their understanding of core areas of physics at a level > 60.

SLO B.1. Students demonstrate expertise in their chosen field via the PhD candidacy examination, consisting of an oral presentation to their dissertation committee followed by a question period. The committee members evaluate the student's presentation and score a number of categories. For this SLO, the relevant evaluations are:

Analysis of previous and related work
Student's knowledge of the field
Ability to answer questions

These are scored on a 5-point scale. This is a **direct measure.**

Criteria: Students advancing to candidacy will score ≥ 3 (good) in all 3 categories. In addition, average scores for all students will exceed 4.

An **indirect measure** of students' ability to become experts in their chosen research field will be a survey of the graduate students themselves. The results from this electronically administered survey will include all respondants, not less than 20% of the graduate student population. **Criterion:** On a 100 point scale, PhD candidates will report their average level of expertise > 60.

SLO B.2. The ability of students to make professional-quality written and oral presentations of research results will be assessed by

1. Relevant evaluations of the candidacy exam. (**Direct**.) These are:
Definition of the problem
Quality of the presentation
Criteria: Students advancing to candidacy will score ≥ 3 (good) in both categories. In addition, average scores for all students will exceed 4.

2. Relevant evaluations of the PhD dissertation defense. (**Direct.**) The PhD dissertation defense has separate ratings for the thesis/dissertation and for the oral presentation (see supplemental material.) The oral presentation is rated in the following categories:
a) Clarity
b) Completeness
c) Pedagogical quality and style
d) Response to questions
e) Evaluation of the talk as a whole
These are evaluated by the thesis committee on a 5 point scale.
Criteria: Every student will have an average score ≥ 3.2 on these evaluations, with no score below 2 (Fair.) The average for all students will exceed 4.

3. Annual research talk. After passing their candidacy exam, all PhD candidates are required to give an annual talk on their research progress. The talk will be scored by the committee on a 5-point scale, and constructive feedback offered to the student. (**Direct.**)
Criterion: Students will score ≥ 3 on their annual talks.*

4. External Presentations. (**Indirect.**) Students will present their research at regional, national, and international conferences appropriate to their discipline.
Criterion: Each year, the number of external presentations by students will exceed 10% of the number of doctoral candidates.

SLO B.3. Students can conduct independent and original scientific research that meets disciplinary standards for peer-reviewed publication. Publication requires not merely that the research be of high quality, but also that the reports of the work be well written. Metrics:

1. PhD dissertation defense. (**Direct.**) The committee evaluates the student's thesis on
a) Substance

b) Methodology
c) Originality
d) Style
e) Evaluation as a whole
 Criteria: Every student will have an average score ≥ 3.2 on these evaluations, with no score
 below 2 (Fair.) The average for all students will exceed 4.

2. Peer-reviewed publications. (**Indirect.**)
Criteria: Every graduating student will be the first author on at least one manuscript accepted for
publication. On average, graduating students will author or co-author more than 2 peer-reviewed
manuscripts.

SLO C.1. The department will recruit a freshman graduate class with geographic and gender
diversity, whose members demonstrate exceptional aptitude for study in physics and/or
astronomy.. The assessment of this outcome will be based on the composition and competencies
of each year's freshman (graduate) class. (**Direct.**)
Criteria:

C.1.1 Every class will be gender diverse and will include both domestic and international students.
C.1.2 The average undergraduate GPA for the class will > 3.5.
C.1.3 The admissions committee also evaluates and scores each applicant using an internal
  evaluation form, which includes consideration of their prior research experience.
  The average score of the freshman class will >10 on the P&A scoring form.
C.1.4 At least 30% of the applicants who attend our departmental open house will matriculate.

3. **Process to analyze/interpret assessment data and use results to improve student learning.**
  1a. Gathering of data.
    i. Preliminary examinations are scored by faculty with recent teaching experience in each of he
       five subject areas, and scores are curated by the Academic Program Coordinator (APC;
       currently Alisa Gibson) in the department.

       The APC will determine:
        the average <u>passing</u> score on each of 5 exams for the past three-year period;
        the average <u>time to pass</u> (i.e. average sitting at which the exam was passed;
        the average <u>number of attempts</u> prior to passing
        the total number of students passed in the past 3 year period
        the total number of students who failed in the past 3 year period

       The information and the (deidentified) spreadsheet will be provided to the Associate Chair
       for Graduate Studies for inclusion in the assessment report.

    ii. A number of indirect measures require surveying graduate students. This will be carried out
        by the Associate Chair for Graduate Studies on an annual basis.

iii. Class grades in core classes are curated by the APC. The APC will determine the average GPA in the core courses over the past 3-year period, and provide that information and a de-identified spreadsheet to the Associate Chair.

iv. PhD candidacy exam results are curated by the APC. The APC will provide the average scores in the categories required, as well as the number of students who fail to meet the criterion stated herein (typically, scores < 3.) The spreadsheet of de-identified scores will be provided to the Associate Chair.

v. Dissertation results are curated by the APC. The APC will report on the average scores, as well as the number of students whose individual average is below 3.2, and the number with any score < 2. These results, and a de-identified spreadsheet, will be provided to the Associate Chair.

vi. Annual research talk forms are curated by the APC. The APC will report the number of students failing to earn a 3 or better on their annual research talk, as well as the total number of talks, over a three-year period. The talk forms will include a listing of student publications and external (conference) presentations.* On graduation, the APC will determine the total number of publications and conference presentations for each student.

*These forms are new. For current year assessments, financial information will be used to track conference presentations.

vii. The APC will determine the average GPA and GRE scores for the freshman graduate class, and report gender makeup and domestic/international student numbers to the Associate Chair.

1b. The Associate Chair will assemble a report following the guidelines elucidated herein, which will be presented to the Graduate Committee prior to March 31 of each year.

2. The graduate committee will consider the implications of the assessment results, including whether to add additional metrics/ mechanisms; whether to offer additional coursework, for example in public speaking or in preliminary exam preparation; and possible mechanisms to improve graduate recruitment, for example through visits to "feeder" institutions.

3. The conclusions and recommendations of the graduate committee will be presented to the faculty at large prior to the end of the Spring semester.