

# HANDBOOK

# FOR

# GRADUATE STUDENTS

Department of Physics and Astronomy

MICHIGAN STATE UNIVERSITY

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**This handbook contains a description of the policies concerning graduate study and programs which are available in the Department of Physics and Astronomy**

# HANDBOOK FOR GRADUATE STUDENTS

## Department of Physics and Astronomy

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Version changes since last major update

- 9/30/2020: Original update
- 1/13/2021: Updated reference [10]; removed inaccuracy about research credits that can be used for a Physics M.S. degree; updated section on outside work for pay; updated physics committee forms (with links)

# 1. POLICIES AND GUIDELINES GOVERNING GRADUATE STUDIES

In the hierarchy of policies and requirements that govern graduate studies in the MSU Physics and Astronomy, there are:

1. The MSU Graduate School policies
2. The policies of the Physics and Astronomy (PA) Department
3. The requirements set down by the student's Guidance Committee (in the case of a M.S. with thesis candidate or a Ph.D. candidate).

University policies included in the following documents override all inconsistent provisions of the particular departmental handbooks. Details can be found in Ref [1]. Other important resources are:

- Academic Programs [2]
- Graduate Students Rights and Responsibilities (GSRR) [3]
- MSU/GEU Contract [4]
- Guidelines for Graduate Student Advising and Mentoring Relationships [5]
- Guidelines for Integrity in Research and Creative Activities [6]
- Policy on Relationship Violence and Sexual Misconduct [7]
- Anti-Discrimination Policy (ADP) [8]
- Consensual Amorous or Sexual Relationships with Students [9]
- Conflict of interest in Employment [10]

The MSU Graduate School has developed guidelines for fostering faculty-graduate student relationships that are characterized by honesty, courtesy, and professionalism and that provide students with intellectual support and guidance. The Department of Physics and Astronomy forms a community of scholars responsible for cultivating a stimulating intellectual environment and, through the joint efforts of all faculty members of the unit, for mentoring of graduate students. The foundational values and shared rights and responsibilities central to the guidelines and the graduate student handbook of the Department of Physics and Astronomy are summarized below. The full guidelines can be found in ref [5].

## Foundational Values

Effective mentoring relationships are formed and sustained through principles of reciprocity and mutual responsibility. Mentors and mentees should respect one another both as researchers/scholars/creative practitioners and as individuals. That respect is formed through a shared commitment to scientific, creative and professional excellence, and a recognition of these common values:

- Commitment to respect and care
- Commitment to professionalism, ethics, and integrity
- Commitment to professional and personal growth and independence of the student

## Shared Rights

Based on the underlying foundational values, members of the Department of Physics and Astronomy share the following rights:

- The right to a safe, supportive environment in which individuals can flourish and grow in their pursuit of knowledge
- The right to an environment that emphasizes tolerance, encourages respect for diverse viewpoints, and promotes civility toward others [11]
- The right to a diverse, equitable and inclusive learning environment
- The right to collegiality in scholarly interactions and sharing of resources

- The right to an environment that actively promotes research and creative excellence

#### Shared Responsibilities

Based on the underlying foundational values, members of the Department of Physics and Astronomy share the following responsibilities:

- The responsibility to hold one's self and one another accountable for integrity in educational and research practices, and for reporting behaviors and practices that violate policies
- The responsibility to know and adhere to federal, University and academic unit rules, procedures and policies applicable to teaching, graduate study, research, and creative activities (including those in FERPA, The Code of Teaching Responsibilities, Academic Programs, Graduate Student Rights and Responsibilities, Medical Student Rights and Responsibilities, Academic Freedom for Students at Michigan State University) and to ensure that they are followed at all levels of the university
- The responsibility to respect confidentiality

## 2. GRADUATE PROGRAMS IN PHYSICS/ASTRONOMY

The following degree programs are offered by the Physics and Astronomy Department at Michigan State University

- The M.S. and Ph.D. in Physics
- Interdisciplinary Ph.D. in Physics
- The M.S. and Ph.D. in Astrophysics and Astronomy
- Dual Ph.D. Degree in Physics and Mathematics
- Dual Ph.D. Degrees with Computational Mathematics Science and Engineering
- Dual Ph.D. Degree in Astrophysics and Computational Mathematics Science and Engineering
- Dual Ph.D. Degree in Physics and Quantitative Biology
- Dual Ph.D. Degree in Physics and Electrical and Computer Engineering
- Graduate Certificate in Accelerator Science and Engineering

In addition, the course requirements for interdisciplinary Ph.D. research in Physics and Biochemistry are slightly different than that of the regular Physics Ph.D., and should be discussed with the Director of Graduate Studies. Physics students may have joint advisors in other departments at MSU or at laboratories outside MSU, as negotiated with the Director of Graduate Studies.

The departmental graduate program also has the following Graduate Certificate:

- Graduate Certificate in Accelerator Science and Engineering

### **Full-time status, tuition waivers, and AST/PHY999 credits**

In order to be considered full-time for academic purposes, students must carry a minimum number of credits per semester or summer session. Details can be found in Ref. [12]. Please note that additional requirements may apply, depending on whether a student is on a visa or has a fellowship. For enrollment questions, please contact the Graduate Program Secretary or Graduate Program Director.

Teaching assistantships come with tuition waivers of 9 credits for fall and spring semesters and 5 credits for summer. Research assistantships come with tuition waivers of 9 credits for fall and spring semesters. For students pursuing research in the summer, the appointment type varies:

- Students who are pursuing research with a faculty member at BPS and who have not completed their comprehensive exams are supported hourly. The student does not enroll for any classes in summer.
- Student who are pursuing research with a faculty member in BPS and who have completed their comprehensive exam (and showing that to be the case in GradPlan) enroll in 1 Non-Fringe credit research assistantship.
- Students who are pursuing research with a faculty member at FRIB/NSCL and who have not completed their comprehensive exams are regular research assistants in the summer
- Students who are pursuing research with a faculty member at FRIB/NSCL and who have completed their comprehensive exams (and showing that to be the case in GradPlan) enroll in 1 Non-Fringe credit research assistantship.

Once a Ph.D. student passes their comprehensive exams, a 1-credit enrollment is required for full-time status, but it is important to plan the uses of waiver credits for AST/PHY999 to achieve the minimum for graduation (24 credits) and to not exceed the maximum prior to graduation (36 credits). In general, once students start enrolling for AST/PHY999, they enroll for 3-6 credits in AST/PHY999 in early semesters, and reduce to 1 credit in AST/PHY999 when they approach the 24 credit limit. Of course, credits can also be used for other course work.



### 3. ACADEMIC ADVISING

All incoming graduate students may seek advice from any faculty member. The Director of Graduate Studies is available for advice, consultation, and discussion.

#### Initial Academic Advising

When students enter the Ph.D. program of the Department of Physics and Astronomy, they have not yet formed a guidance committee and, in many cases, not found a faculty member to work with. To provide incoming students with good advice for the initial stages of their studies, they meet with the Director of Graduate Studies and at least one member of the Graduate Advising Committee from the research area in the Department that the student has expressed interest working in. This meeting takes place during the Orientation week.

In a conversation with the student, they will provide advice on which courses to take initially, taking into consideration the full resume of the student. Important considerations are courses taken, course grades, research and other scholarly experiences that the student has experienced. For example, students can be advised to take an advanced undergraduate course because the student was not able to take more than one advanced course in a certain topic at their institution. Or, students attempt to test out of the Classical Mechanics Subject Exam and can consider alternative courses to take instead.

When students start their coursework, it is important to communicate early with the Director of Graduate Studies if academic progress is not satisfactory so that strategies to improve the progress can be developed.

#### Advising after the formation of a Guidance Committee

Once a student has selected a Major Professor, that faculty member becomes the primary advisor for the student. Once the student has formed their Ph.D. Guidance Committee (see Section 7) the Guidance Committee members and serve as additional sources of advice. Guidelines for graduate student mentoring and advising can be found in the *MSU Guidelines for Graduate Student Mentoring and Advising* (See Section 1).

Students are strongly encouraged to communicate at an early stage with their advisor, guidance committee members, and/or Director of Graduate Studies if there are any barriers to their performance and success, or if they have any concerns about the graduate program.

#### GradPlan

All doctoral students must use GradPlan [13] to plan for and keep track of their academic progress. Details can be found in Ref. [14]



## 4. DEGREE REQUIREMENTS

In this section the degree requirements for the degree programs in Physics and Astronomy at Michigan State University are provided. These include specific dual degree programs for which specific sets of rules exist. However, dual degree programs with other departments than listed here are also possible following the rules of the graduate school [15]. In addition, there is a general interdisciplinary Ph.D. in physics.

### IV. A. Ph.D. in Physics

To receive the Ph.D. in Physics a student must:

1. Complete a program of basic coursework. Graduate students must maintain at least a 3.0 GPA in their coursework and satisfy the other Graduate school requirements concerning grades. The following courses must be completed for the Ph.D. in physics, provided they have not been completed at another accredited graduate school. Further, students must earn a minimum of a 3.0 grade in each of the following core courses:

- Methods of Theoretical Physics, PHY 810 (Fall)
- Classical Mechanics, PHY 820 (Fall)
- Statistical Mechanics, PHY 831 (Fall)
- Quantum Mechanics I, PHY 851 (Fall)
- Quantum Mechanics II, PHY 852 (Spring)
- Electrodynamics I, PHY 841 (Spring)
- Electrodynamics II, PHY 842 (Fall)

The requirement for Electrodynamics II (PHY 842) may be waived with approval from the student's guidance committee.

Newly enrolled students can choose to take the Classical Mechanics Subject Exam in August, just after their orientation. If the students pass the exam with a score of 3.5 or 4.0, the requirement to take the course is waived. If the students score a 3.0, they are advised to take the course.

The course Methods of Theoretical Physics can be waived by the Director of Graduate Studies if the student has taken a similar or more advanced coursework as an undergraduate.

2. DF-Deferred grades: The required work must be completed and a grade reported within 6 months (190 calendar days) from the last class day of the term of instruction with the option of a single six-month (190 calendar days) extension. If the required work is not completed within the time limit, the DF will become a U-Unfinished and will be changed to DF/U under the numerical and Pass-No Grade (P-N) grading systems, and to DF/NC under the Credit-No Credit system. This rule does not apply to graduate thesis or dissertation work.
3. Satisfy the Ph.D. Comprehensive Exam Requirement which in PA is fulfilled through a series of Subject Exams and an oral exam (see Section 5). A student will be given two attempts at each of the parts of this requirement.
4. In addition to the basic courses listed above, the student in consultation with the Ph.D. Guidance Committee chooses a set of advanced courses in the student's area of research specialty, which could include courses administered by other units on campus or courses administered by another university. The student is

encouraged to also select courses outside of the area of research specialty, especially if such courses are otherwise beneficial to the professional development of the student.

5. Form a Ph.D. Guidance Committee (see Section 7) by the beginning of the third year if the Subject Exam requirement is fulfilled by the end of the second Fall semester. If the Subject Exam requirement is fulfilled later than fall of the second year, the Guidance Committee should be formed no later than six months after that happens. The Guidance Committee must meet with the student at least once every year. Prior to the formation of their Guidance Committee the students are mentored by the Director of Graduate Studies and by the Graduate Advising Committee.
6. For a Ph.D. in Physics, the committee consists of five members with at least four being regular and/or jointly-appointed faculty members of the Physics and Astronomy department. Additional members from in and outside the department may be selected, but following the graduate school guidelines [16]. The normal makeup of the committee is three members from the same research area as the student and two from outside of the student's research area. A sixth member may be added with the approval of the Director of Graduate Studies.
7. Write a dissertation on original research, followed by an oral examination based on the dissertation and related material. A student's research program is determined in consultation with the student's research advisor and guided by the student's Ph.D. Guidance Committee.
8. Register for a minimum of 24 credits of doctoral dissertation research (PHY 999) but no more than 36 credits or you must graduate within the semester that you have 36 credits worth of PHY999. Requests for overrides to exceed the maximum of 36 credits of PHY999 must be requested through the Graduate Program Secretary's office and require approval from the Graduate School.
9. The Department of Physics and Astronomy has no foreign language requirement.
10. Unless it is prohibited by the terms of an external fellowship that funds the student for the entirety of their Ph.D., the student must serve as a Teaching Assistant for at least one semester. The student should serve as a Teaching Assistant for at least one semester. This requirement may be satisfied by prior TA work at other universities. In order to be a TA, international students who are not native English speakers must meet certain requirements (see Section 13).
11. Students in the Virtual University VUBeam Ph.D. program are exempt from enrolling in the core courses mentioned in Requirement 1 at MSU and acquire the corresponding knowledge through equivalent studies and courses at local universities. They also do not have to satisfy the Requirement 10. All other requirements, in particular concerning the subject exams covering the core courses, hold unchanged. Written exams can be administered by mutually agreeable local proctors upon prior arrangements with the Director of Graduate Studies. The final student thesis defense must be at MSU.
12. For the Doctor of Philosophy degree, all of the comprehensive examinations (subject exams+oral exam) must be passed within five years after beginning the Ph.D. program. All remaining requirements for the degree must be completed within eight years from the time when a student begins the first class at Michigan State University that appears on their doctoral program of study. Application for extensions of the eight year period of time toward degree must be submitted by the department/school for approval by the dean of the college and the Dean of the Graduate School. Upon approval of the extension, doctoral comprehensive examinations must be passed again.

#### IV. B. M.S. in Physics

To receive the M.S. in Physics, a student must:

1. Earn 30 credits with a grade point average of at least 3.0 and satisfy the other graduate school requirements concerning grades. The 30 credits are subject to the following requirements:
  - A minimum of 16 credits must be at the graduate level (800- and 900-level courses).
  - Up to 14 credits of undergraduate senior level courses may be counted in the total of 30 credits needed for the M.S., provided these courses have not been used previously in the credit total toward another degree. Senior level courses include all of the Physics and Astronomy courses with course numbers in the 400-499 interval.
  - In addition to Physics and Astronomy courses, with specific approval by the Director of Graduate Studies or their designated representative, mathematics courses at the 400-level and above, some Engineering, Biophysics and Geology courses may be included in the 30-credit total.
  - A maximum of 9 semester credits may be transferred from other accredited graduate schools.
  - Five research credits with satisfactory grades are required. These credits may be comprised of any combination of PHY 800 or PHY 899.
2. If the student chooses Plan A (with thesis), they must complete 5 to 10 credits of thesis research (PHY 800, PHY 899) with the thesis supervisor. Students choosing Plan A must form a Guidance Committee of three regular or jointly appointed faculty members, including the student's Master's thesis advisor. This committee will meet with the student yearly and will act as examiners of the student's thesis and oral defense (see form in Appendix E).
3. In Plan B (without thesis) the student must have at least five credits of research coursework (PHY 800, PHY 899) completed satisfactorily.
4. Research credits (PHY 800) may contribute toward the degree. 3 credits per semester up to a total of 6 credits can be counted towards the 30 credits necessary for the M.S. degree in physics.
5. The Department of Physics and Astronomy has no foreign language requirement.
6. Students in the Virtual University VU Beam M.S. program have to satisfy the same requirements as other M.S. students. Usually the bulk of the credit requirements are satisfied via the VU Beam on-line courses PHY 861 and PHY 961 through PHY 964.
7. Unless otherwise specified, the time limit for the completion of the requirements for the master's degree is six calendar years from the date of enrollment in the first course included for degree certification.

#### IV. C. Ph.D. in Astrophysics and Astronomy

The Astrophysics Ph.D. program is structured (1) to provide students with a thorough grounding in the tools of astronomy and the underlying physics used in astronomy, through a sequence of graduate level courses; but also (2) to stress an early entry of the student into research. The evaluation of students for advancement to candidacy for the Ph.D. will place significant weight on their potential as research scientists.

To receive the Ph.D. in Astrophysics and Astronomy a student must:

1. Pass the core physics courses or their subject exams, the core astronomy courses, and two elective courses, with a grade averaged over all of these courses of 3.375. The core and elective courses are described below.
2. Complete the two-semester AST 805 research project satisfactorily at the Ph.D. level. The research project is graded by a committee consisting of two faculty members of the astronomy group and one faculty member from outside the astronomy group, who examine the student on the research and on general knowledge pertinent to the research project. This oral examination will serve as the student's comprehensive examination. A Record of Completion Form (Appendix F) must be signed by the committee at the end of the oral examination. A proposal for this research project must be approved by the astronomy graduate advisor and the student's research advisor by the end of the first year of graduate study.
3. All Astrophysics Ph.D. students must complete the following courses. This normally will take two years.

Two of the following physics courses:

- PHY 820 Classical Mechanics
- PHY 831 Statistical Mechanics
- PHY 841 Classical Electrodynamics
- PHY 851 Quantum mechanics

All of the following astronomy courses:

- AST 810 Radiation Astrophysics
- AST 825 Galactic Astronomy
- AST 835 Extragalactic Astronomy
- AST 840 Stellar Astrophysics

In addition to the six core physics and astronomy courses, students must also take 6 additional credits of elective courses at the 800-level or above in physics, astrophysics, computation, or related areas. These courses must be chosen in consultation with the astronomy graduate advisor.

5. Form a Ph.D. Guidance Committee (see Section 7) no later than six months after fulfilling the Comprehensive Exam Requirement. The Guidance Committee must meet with the student at least once every year. Prior to the formation of their Guidance Committee the students are mentored by the astronomy graduate advisor. The associate chair for graduate students and the graduate advising committee will provide additional advising as needed.
6. For a Ph.D. in Astrophysics and Astronomy, the committee consists of five members with at least four being regular and/or jointly-appointed faculty members of the Physics and Astronomy department. Additional members from in and outside the department may be selected, but following the graduate school guidelines [16]. The normal makeup of the committee is three members from the same research area as the student and two from outside of the student's research area. A sixth member may be added with the approval of the Director of Graduate Studies.

7. Write a dissertation on original research, followed by an oral examination based on the dissertation and related material. A student's research program is determined in consultation with the student's research advisor and guided by the student's Ph.D. Guidance Committee.
8. Register for a minimum of 24 credits and a maximum of 36 credits of doctoral dissertation research (AST 999). Requests for overrides to exceed the maximum of 36 credits of PHY999 must be requested through the Graduate Program Secretary's office and require approval from the Graduate School.
9. The Department of Physics and Astronomy has no foreign language requirement.
10. Unless it is prohibited by the terms of an external fellowship that funds the student for the entirety of their Ph.D., the student must serve as a Teaching Assistant for at least one semester. International students who are not native English speakers must meet certain requirements (see Section 13) in order to be a TA.
11. For the Doctor of Philosophy degree, all of the comprehensive examinations must be passed within five years and all remaining requirement for the degree must be completed within eight year from the time when a student begins the first class at Michigan State University that appears on their doctoral program of study. Application for extensions of the eight-year period of time toward degree must be submitted by the department/school for approval by the dean of the college and the Dean of the Graduate School. Upon approval of the extension, doctoral comprehensive examinations must be passed again.

#### IV. D. M.S. in Astrophysics and Astronomy

Many of our Ph.D. students obtain a M.S. degree during the course of their studies. However, students will not normally be accepted into the Astrophysics graduate program unless their ultimate goal is to obtain a Ph.D. degree. To obtain a M.S. degree, students must take the same courses as for the Astrophysics Ph.D. degree. This includes taking the two-semester research course described for the Ph.D. program.

The requirements for the M.S. degree are:

1. Complete a total of 30 credits that satisfy either Plan A (with thesis) or Plan B (without thesis) of the general university requirements for a Master's degree.
2. Pass the core physics and astronomy courses (AST810, AST825, AST835, AST840, and two of PHY820, PHY831, PHY841, PHY851) with an average grade of 3.0 or better.
3. Under Plan A: complete 4 - 10 credits of AST 899 Master's Thesis Research, and pass a final oral examination in defense of the thesis; or, under Plan B: complete 6 credits in AST 805 Research Project and pass the examination on the research course at least at the M.S. level. Students choosing Plan A must form a Guidance Committee of three regular faculty members, including the student's Master's thesis advisor, one additional faculty member in the astronomy group, and one faculty member from outside the astronomy group. This committee will meet with the student yearly and will act as examiners of the student's thesis and oral defense (see form needed – Appendix E).
4. The Department of Physics and Astronomy has no foreign language requirement.
5. Unless otherwise specified, the time limit for the completion of the requirements for the master's degree is six calendar years from the date of enrollment in the first course included for degree certification.

#### IV. E. Interdisciplinary Ph.D. in Physics

Many topical research areas lie at the boundary between physics and another discipline. Examples include biological physics, quantum optics electrical and computer engineering (ECE), materials science and nuclear chemistry. Students working in these areas may request to have their Ph.D. subject exam and course requirements modified in order to accommodate an increased course load in other disciplines. However this can be overly burdensome, so that the PA department has the option of an Interdisciplinary Ph.D. in which the student completes at most 120% of the normal required course load (including courses outside physics). The requirements for the Interdisciplinary Ph.D. are:

1. Complete a program of basic coursework. Graduate students must maintain at least a 3.0 GPA in coursework. The required courses for the physics component are (provided they have not been completed at another accredited graduate school):

- Methods of Theoretical Physics, PHY 810 (Fall)

And 3 of the 4 following courses (and corresponding subject exams, see item 3).

- Classical Mechanics, PHY 820 (Fall)
- Statistical Mechanics, PHY 831 (Fall)
- Quantum Mechanics I, PHY 851 (Fall)
- Electrodynamics I, PHY 841 (Spring)

Newly enrolled students can choose to take the Classical Mechanics Subject Exam in August, just after their orientation. If the students pass the exam with a score of 3.5 or 4.0, the requirement to take the course is waived.

The course Methods of Theoretical Physics can be waived by the Director of Graduate Studies if the student has taken a similar or more advanced coursework as an undergraduate.

2. Interdisciplinary Ph.D. students must complete at least 9 credits of graduate coursework outside of physics, in areas relevant to their research project.
3. A student will be given two attempts at each of the parts of this requirement. For the interdisciplinary programs, the student should pass three exams in Physics, with an average grade of at least 3.33. In addition to this, the student should satisfy the comprehensive exam requirements of the other department, as well. In the case where the primary department is not physics, then the student should pass two exams in physics instead of three, with an average grade of at least 3.25.
4. In addition to these basic courses, the student's Ph.D. Guidance Committee may prescribe advanced courses, in a consultation with the student and the student's research advisor.
5. Form a Ph.D. Guidance Committee (see Section 7) by the beginning of the third year if the Subject Exam Requirement is fulfilled by the end of the second Fall semester. If the Subject Exam requirement is fulfilled later than fall of the second year, the Guidance Committee should be formed no later than six months after that happens. The Guidance Committee must meet with the student at least once every year. In the case of the Interdisciplinary degree in Physics, at least three members of the Ph. D. Guidance Committee will be regular or jointly-appointed PA faculty and two faculty members from the non-physics departments participating in the program.
6. Write a dissertation on original research, followed by an oral examination based on the dissertation and related material. A student's research program is determined in consultation with the student's research advisor and guided by the student's Ph.D. Guidance Committee.
7. Register for a minimum of 24 credits of doctoral dissertation research (PHY 999).

8. The Department of Physics and Astronomy has no foreign language requirement.
9. Unless it is prohibited by the terms of an external fellowship that funds the student for the entirety of their Ph.D., the student must serve as a Teaching Assistant for at least one semester. In order to be a TA, an International Student must meet certain requirements (see Section 13).
10. For the Doctor of Philosophy degree, all of the comprehensive examinations must be passed within five years and all remaining requirements for the degree must be completed within eight years from the time when a student begins the first class at Michigan State University that appears on their doctoral program of study. Application for extensions of the eight-year period of time toward degree must be submitted by the department for approval by the dean of the college and the Dean of the Graduate School. Upon approval of the extension, doctoral comprehensive examinations must be passed again.



#### IV. F. Dual Ph.D. Degree in Physics and Mathematics

It is possible to pursue a dual degree in Physics and Mathematics. In order to do so, the student's dissertation must include significant research contributions in both disciplines (see the MSU guidelines on dual major doctoral thesis [17]). In case of a dual degree, the student should identify which of the degrees are the primary and secondary affiliations. This section contains the requirements for students who choose Physics as the primary affiliation. Students who choose Mathematics as the primary affiliation must refer to the Mathematics requirements [18]. Mathematics also sets requirements if it is the secondary affiliation – these requirements are included in the requirements stated below. Where this section is quiet, the requirements of Section IV. A. Ph.D. in Physics apply.

##### **Coursework requirements**

- 3 of the 4 PHY subject exam courses PHY 820, 831, 851, 852 (see Section 4), with a GPA of 3.33 for the subject exams, as well as an oral subject exam with a score of 3.5 or better
- Two mathematics qualifying exams (see [18]) within the first three years of the student's enrollment at Michigan State University. The mathematical content of the two qualifying exams must be substantially different from the mathematical content of any exam taken to satisfy requirements in the Physics and Astronomy Department. The candidate will be allowed two attempts to pass each exam.
- The mathematics comprehensive exam should be fulfilled as specified for PhD candidates in mathematics with two possible exceptions: (1) The exam can be taken any time after the qualifying exam requirements have been met and before the end of the fourth year of the student's enrollment at Michigan State University. (2) The syllabus and questions prepared for the comprehensive exam by the student's guidance committee can include topics and questions from the dual program to allow the comprehensive exam to satisfy the requirements of the dual program. At least half the topics and questions should be in mathematics. The topics covered by the comprehensive exam must be approved by the mathematics graduate director and graduate studies committee.
- The remainder of their course requirements can be from any reasonable combination of courses from the two departments, ensuring that the students take a minimum of 15 credits of 800-900 level mathematics courses, excluding dissertation credits (Math 999) and mathematics qualifying exam course sequences. These courses must be approved by the student's guidance committee.

##### **Guidance Committee membership**

- A minimum of five faculty, at least three of whom must have non-0% appointments in Physics and Astronomy
- At least two tenure stream faculty who have a 50% or more appointment in mathematics.
- At least one of the three Physics and Astronomy faculty must be outside of the Department of Physics and Astronomy research area of the student. Individual people can serve in more than one role (e.g. be in Physics and Astronomy and in Mathematics) but students must have a minimum of five faculty on their committees.

#### IV. G. Dual Ph.D. Degree in Physics and Computational Mathematics Science and Engineering

It is possible to pursue a dual degree in Physics and Computational Mathematics Science and Engineering (CMSE). In order to do so, the student's dissertation must include significant research contributions in both disciplines (see the MSU guidelines on dual major doctoral thesis [17]). In case of a dual degree, the student should identify which of the degrees are the primary and secondary affiliations. This section contains the requirements for students who choose Physics as the primary affiliation. Students who choose CMSE as the primary affiliation must refer to the CMSE requirements [19]. CMSE also sets requirements if it is the secondary affiliation – these requirements are included in the requirements stated below. Where this section is quiet, the requirements of Section IV. A. Ph.D. in Physics apply.

##### **Coursework requirements**

- 3 of the 4 PHY subject exam courses PHY 820, 831, 851, 852 (see Section 4), with a GPA of 3.33 for the subject exams, as well as an oral subject exam with a score of 3.5 or better
- 2 of the 4 core CMSE courses (See ref. [20]), and pass the corresponding subject exams with an average grade of 3.25
- The remainder of their course requirements can be from any reasonable combination of courses, ensuring that the students take a minimum of 12 credits of computationally-focused coursework to fulfill their CMSE cognate requirement with the maximum number of required credits being 120% of the credit requirement in the primary graduate program, excluding research credits.

##### **Guidance Committee membership**

- A minimum of five faculty, at least three of whom must have non-0% appointments in Physics and Astronomy
- At least one of the three Physics and Astronomy faculty must be outside of the Department of Physics and Astronomy research area in which the student performs research
- Of the minimum of two CMSE faculty, at least one must have their tenure home in CMSE.

Individual people can serve in more than one role (e.g. be in Physics and Astronomy and in CMSE) but students must have a minimum of five faculty on their committees.

#### IV. H. Dual Ph.D. Degree in Astrophysics and Computational Mathematics Science and Engineering

It is possible to pursue a dual degree in Astrophysics and Computational Mathematics Science and Engineering (CMSE). In order to do so, the student's dissertation must include significant research contributions in both disciplines (see the MSU guidelines on dual major doctoral thesis [17]). In case of a dual degree, the student should identify which of the degrees are the primary and secondary affiliations. This section contains the basic requirements for students who choose Astrophysics as the primary affiliation. Students who choose CMSE as the primary affiliation must refer to the CMSE requirements [19]. CMSE also sets requirements if it is the secondary affiliation – these requirements are included in the requirements stated below. Where this section is quiet, the requirements of Section IV. A. Ph.D. in Physics apply.

##### **Coursework requirements**

- 3 of the 4 core AST courses (see Section 4)
- 2 of the 4 core CMSE courses (See Ref. [20]), and pass the corresponding subject exams with an average grade of 3.25
- One of the core PHY graduate courses, excluding PHY 810 (so 820, 831, 841, 851)
- A GPA of 3.375 in the core AST/PHY courses, for which the higher grade of the course or subject exam is chosen for PHY courses
- The remainder of their course requirements can be from any reasonable combination of courses, ensuring that the students take a minimum of 12 credits of computationally-focused coursework to fulfill their CMSE cognate requirement with the maximum number of required credits being 120% of the credit requirement in the primary graduate program, excluding research credits.
- A minimum of 30 total credits of coursework, including 6 credits of AST 805

##### **Guidance Committee membership**

- A minimum of five faculty, at least three of whom must have non-0% appointments in Physics and Astronomy
- At least one of the three Physics and Astronomy faculty must be outside of astrophysics
- Of the minimum of two CMSE faculty, at least one must have their tenure home in CMSE.

Individual people can serve in more than one role (e.g. be in Physics and Astronomy, and in CMSE, and be Astrophysics Faculty) but students must have a minimum of five faculty on their committees.

#### IV. I. Dual Ph.D. Degree in Physics and Quantitative Biology

It is possible to pursue a dual degree in Physics and Quantitative Biology (QB). In order to do so, the student's dissertation must include significant research contributions in both disciplines (see the MSU guidelines on dual major doctoral thesis [17]). In case of a dual degree with QB, physics is the primary affiliation. Most students pursuing a dual degree in Physics and QB choose the Molecular Biology research concentration in QB. Details can be found in [21]. Where this section is quiet, the requirements of Section IV. A. Ph.D. in Physics apply.

##### **Coursework requirements**

- 3 of the 4 PHY subject exam courses PHY 820, 831, 851, 852 (see Section 4), with a GPA of 3.33 for the subject exams as well as an oral subject exam with a score of 3.5 or better
- The courses listed in [21] with an average grade of 3.33
- The remainder of their course requirements can be from any reasonable combination of courses, with the maximum number of required credits being 120% of the credit requirement in the primary graduate program, excluding research credits.

##### **Guidance Committee membership**

- A minimum of five faculty, at least three of whom must have non-0% appointments in Physics and Astronomy
- At least one of the three Physics and Astronomy faculty must be outside of the Department of Physics and Astronomy research area in which the student performs research
- At least two faculty from outside Physics and Astronomy, including a secondary advisor on the student's research

Individual people can serve in more than one role (e.g. be in Physics and Astronomy and in another Department) but students must have a minimum of five faculty on their committees.

#### IV. J. Dual Ph.D. Degree in Physics and Electrical and Computer Engineering

It is possible to pursue a dual degree in Physics and Electrical and Computer Engineering (ECE). In order to do so, the student's dissertation must include significant research contributions in both disciplines (see the MSU guidelines on dual major doctoral thesis [17]). In case of a dual degree, the student should identify which of the degrees are the primary and secondary affiliations. This section contains the requirements for students who choose Physics as the primary affiliation. Students who choose ECE as the primary affiliation must refer to the ECE requirements [22]. ECE also sets requirements if it is the secondary affiliation – these requirements are included in the requirements stated below. Where this section is quiet, the requirements of Section IV. A. Ph.D. in Physics apply.

##### **Coursework requirements**

- 3 of the 4 PHY subject exam courses PHY 820, 831, 851, 852 (see Section 4), with a GPA of 3.33 for the subject exams, as well as an oral subject exam with a score of 3.5 or better
- The advisor can be a faculty member of either the primary or secondary department; a co-advisor must be selected from the other department.
- Show proficiency in three of the four undergraduate courses ECE302, ECE305, ECE313, ECE366
- Four graduate level courses must be taken in Electrical and Computer Engineering and one must be a core course
- The Graduate Studies Committee in consultation with the Ph.D. Guidance Committee may require an Electrical and Computer Engineering Ph.D. qualifying exam and its format.
- Comprehensive examinations must be passed to the satisfaction of both departments.
- The remainder of their course requirements can be from any reasonable combination of courses with the maximum number of required credits being 120% of the credit requirement in the primary graduate program, excluding research credits.
- The academic program must be developed in consultation with the student. The guidance committee must be satisfied that the dissertation represents a contribution meeting the usual standards in both areas

##### **Guidance Committee membership**

- A minimum of five faculty, at least three of whom must have non-0% appointments in Physics and Astronomy
- At least one of the three Physics and Astronomy faculty must be outside of the Department of Physics and Astronomy research area in which the student performs research
- Two faculty must be from ECE

Individual people can serve in more than one role (e.g. be in Physics and Astronomy and in ECE but students must have a minimum of five faculty on their committees.

#### IV. K. Graduate Certificate in Accelerator Science and Engineering

The Graduate Certificate in Accelerator Science and Engineering provides graduate students the opportunity to further their understanding of accelerator science and technology. Graduates will be certified, well trained, and ready for productive careers in Accelerator Science and Engineering. Research is supported by the Accelerator Science and Engineering Traineeship (ASET) Program. The certificate is available to masters or doctoral students at Michigan State University. Students can apply for the certificate at any time prior to receiving their graduate degree. Students who wish to complete the certificate must consult with the Graduate Program Director prior to beginning course work in the program.

The requirements for the Graduate Certificate in Accelerator Science and Engineering are:

Complete a minimum of 9 credits from the following with a grade-point average of 3.0:

1. The following course (3 credits):  
PHY 862 Accelerator Systems
2. At least two courses from the following or any other 800 or 900-level accelerator science-focused courses as approved by the Physics and Astronomy Graduate Program Director (6 credits):
  - ECE 837 Computational Methods in Electromagnetics
  - ECE 850 Electrodynamics of Plasmas
  - ECE 989 Advanced Topics in Plasmas
  - PHY 861 Beam Physics
  - PHY 905 Special Problems
  - PHY 961 Nonlinear Beam Dynamics
  - PHY 962 Particle Accelerators
  - PHY 963 U.S. Particle Accelerator School
  - PHY 964 Seminar in Beam Physics Research

Students who enroll in PHY 905 must obtain approval of the Physics and Astronomy Graduate Program Director to ensure appropriate content. PHY 905 may be taken more than once as long as the topic taken is different.

## 5. COMPREHENSIVE EXAM REQUIREMENT (SUBJECT & ORAL EXAMS)

Michigan State University requires all students pursuing a Ph.D. program to pass a Comprehensive Examination. For the Physics Ph.D. Programs, the comprehensive examination requirement is satisfied by satisfactory completion of a set of subject exams and an oral exam.

### Subject exams

For the Physics Ph.D. program, students are examined at the end of the following courses:

1. Classical Mechanics PHY820
2. Statistical Mechanics PHY831
3. Electrodynamics I PHY841
4. Quantum Mechanics sequence PHY 851 and PHY 852

The Final Examinations for these courses act as both the final exam for the course as well as one of the Subject Examinations that contribute to the Comprehensive Examination.

Students in the Physics Ph.D. program must complete these four examinations with an **average** final examination grade of 3.375 or better with no grade lower than a 3.0 in order to satisfy the Physics Ph.D. Comprehensive Exam requirement. The physics subject exam average is taken over the best score in each of the subject exams which a student takes.

Students pursuing Interdisciplinary and Dual PhDs are not required to take all of the Physics subject exams. The subject exams required for those programs are described in relevant subsections of Section 4.

The subject exam in each course is set and then graded anonymously by a committee of three faculty members, including the instructor of the associated graduate course.

A student will be given two attempts at each of the subject examinations. The subject exams are offered at the beginning and end of the associated graduate courses. The subject exam given at the beginning of a graduate course may be cancelled if there are not enough students signed up for taking the exam. The exam sequence is as follows:

- Classical Mechanics (PHY 820): August and December
- Quantum Mechanics (PHY 851, PHY 852): August and May
- Electricity and Magnetism (PHY 841): January and May
- Statistical Mechanics (PHY 831): August and December

Newly enrolled students can choose to take the Classical Mechanics Subject Exam in August, just after their orientation. Taking this exam does not count against the two regular attempts for Classical Mechanics.

### Oral exam

In addition, students are required to pass an oral examination, which is administered as part of their first guidance committee meeting. A presentation should be given about the student's research project, a project that the student worked on not directly related their research project or a literature study about a topic related to the students' research. The presentation is open and will be advertised within the department. It should last approximately 25 minutes and with an additional period for questions by the audience. The presentation is followed by a private session with members from the guidance committee, who can ask further questions and determine the grade. A grade of 3.5 or higher is required to pass the exam. The grade is based on the content of the presentation, the quality of the presentation and the mastery of the material presented.

## 6. SELECTION OF THESIS/DISSERTATION ADVISOR

Graduate students are assigned a Temporary Advisor (Graduate Program Director or one of the members of the Graduate Program Committee) when they are accepted into our program. The graduate student should choose their Major Professor before the end of their second academic year in the program; this requires mutual consent between the professor and the student, and many factors go into this important decision. It is the collective responsibility of our faculty to advise graduate students in their research and professional development following the MSU Guidelines for Graduate Student Mentoring and Advising [5]). If the student has trouble in finding a willing faculty member to serve as the Major Professor, they should consult the departmental Graduate Director and/or the Departmental Chair to help find a suitable match.

Graduate Program Brochures are available to highlight the research performed by faculty in the Department of Physics and Astronomy: [23]. In addition, students are strongly encouraged to talk to members of the Department (Director for Graduate Studies, faculty members, other students, and postdocs) about potential research opportunities that align with the student's interests. Participating in colloquia, seminars, and other activities are also excellent ways to get an overview of exciting research opportunities.

The Major Professor will be the chair of the student's Ph.D. guidance committee (Section 7) and with the help of this committee advise and mentor the student in their research and professional development.

The Major Professor will be a regular or jointly-appointed faculty member of the Department of Physics and Astronomy at Michigan State University. The Departmental Chairperson may approve a regular MSU faculty member from a different department who is an adjunct to the Department of Physics and Astronomy to serve as the Major Professor. Exceptions to these rules follow the Academic Programs Catalog [16] and require approval by the Dean of the Graduate School.

If the Major Professor leaves Michigan State University before the student completes their degree program the student should consult the Graduate Director and the Departmental Chairperson to identify a suitable Major Professor. It is the joint responsibility of the student and the Departmental Chairperson to make arrangements for the completion of the degree, and it requires mutual consent between the student and a Major Professor.

The Major Professor and the members of the student's Ph.D. Guidance Committee are officially required by the University to submit the *Report of the Guidance Committee*, which has to be approved by the Departmental Chairperson. The timeline for submission of this report is discussed in Section 7.

After submitting the *Report of the Guidance Committee*, if the student desires to change his Major Professor for any reason, the change should be requested as early as possible in the graduate training program. Any plans for changing to a different Major Professor should be discussed with the Graduate Program Director, the Department Chairperson, the current Major Professor and the student's prospective Major Professor (not necessarily together) prior to the initiation of any change. Before relations with the Major Professor are severed, the student should make sure that another faculty member (regular, jointly appointed or approved adjunct faculty) will serve in that capacity. Research Assistantships are normally associated with specific research programs and are not automatically transferable from one faculty member to another.



## 7. PH.D. GUIDANCE COMMITTEE

The student's Ph.D. Guidance committee serves as the examination committee for the student's Ph.D. dissertation and must be chaired by the Major Professor, selected following the guidelines in Section 6. Usually the Major Professor and chair of the committee is the student's Ph.D. thesis advisor. The Guidance Committee has to be approved by the Chair of the Physics and Astronomy Department and must adhere to the graduate school guidelines [16] as well as the requirements listed in Section 4 for the different types of degrees. Guidance committee members who are not regular or jointly-appointed faculty members at MSU must be approved by the Dean of the Graduate School.

The guidance committee membership must prevent conflicts of interest in the context of the students' committees, for example if a member of the committee is connected, in some fashion, with the source of funding for the student's project. Committee members will reveal such potential conflicts of interest to the Graduate Program Director and/or Departmental Chair when they arise so that appropriate steps to mitigate the conflict of interest can be taken.

To ensure fairness in the examination procedure and maintenance of academic standards, the dean of the college or the chair of the department may appoint an outside non-voting member to the examining committee. The outside member of the committee will read and critique the thesis/dissertation, will participate in the oral part of the exam, and will submit a report to the dean of the college and/or the chair/director of the academic unit.

The student must arrange to have a Guidance Committee meeting once a year. The student's progress and research plans are to be discussed and the Progress Report form must be signed by the committee members. The contents of the report are discussed with the student who receives a copy of the completed and signed form. Graduate students who wish to appeal any part of the faculty advisor's evaluation may do so in writing to the chair/director of the academic unit or the director of graduate studies, and this appeal will be filed together with the annual progress report.

The progress of the student will be assessed according to the following criteria:

- i. performance in advanced courses in the department or outside the department as determined by the committee
- ii. progress in research
- iii. appreciation of the broader context of their research program
- iv. successful communication of research results, orally and through written documents
- v. interacting with their colleagues and faculty members in a collegial and professional manner.

If progress is not satisfactory the student receives a warning at this time. Any conflicts are resolved by the procedure outlined in Section 12. Copies of the blank forms (first meeting and subsequent meetings) are given in Appendices G, H, and I and can be downloaded [24].

## 8. DISSERTATION DEFENSE, FINAL ORAL EXAMINATION AND FINAL TERM ENROLLMENT

To give the Ph.D. candidate's Guidance Committee and the faculty time to study the dissertation, it is the candidate's responsibility to circulate a final copy of the dissertation at least 2 weeks prior to the date of the dissertation defense. The student should provide either a printed or electronic version of the thesis to the members of the guidance committee, based on the preference of the individual committee members. The electronic version should be provided to the Physics & Astronomy Graduate Office, who will provide access to the Department by posting it online. The final dissertation defense and examination will then be scheduled for a date of ten or more business days after the examination copies have been distributed.

It is the expectation that students should schedule the defense and examination when all guidance committee members can be present in person. If this cannot be reasonably accomplished, one guidance committee member can join the defense/examination online or meet with the student at a different time. The online or delayed participation of more than one committee member requires consent from the Graduate Program Director, unless the MSU Graduate School mandates that online/delayed participation is acceptable under special circumstances.

The dissertation examination shall be open and all faculty, staff and students shall be welcome to attend and participate in questioning the candidate on the dissertation. However, the final deliberation (examination portion) of the guidance committee meeting shall be held in private. If the student fails the thesis examination there is a possibility of remediation in consultation with the Guidance Committee. In this case, the student will be required to submit a new thesis and undergo an examination based on the new thesis. If the student passes the dissertation examination but corrections or additions to the thesis are required, the student must provide a corrected copy of the thesis to the members of the Guidance Committee for approval. In cases of significant corrections, the student may be required to present a short oral defense of the corrected thesis.

The form of the thesis must conform to the guidelines set forth by the Graduate School. For details see ref. [25].

Once the oral dissertation is completed and approved, the student is responsible for binding their thesis and giving a bound copy to the graduate school, the PA department, and to the chairperson of their committee.

**Final term enrollment.** Normally students who are defending their thesis in Fall, Spring, or Summer terms must enroll with a minimum of 1 credit during the term they are planning to defend and submit their thesis. However, for students who were enrolled in the Spring and are defending their dissertations during the immediate Summer Semester, the department can request a waiver of the requirement that the student be enrolled for at least 1 credit the semester of the defense. These requests are to be directed to the Graduate School and must be endorsed by the student's department and college.

## 9. GRADUATE SCHOOL FUNDING AND DISSERTATION PUBLICATION

There are a wide variety of funding sources for graduate research. A general overview can be found at: <https://grad.msu.edu/funding>. Graduate students in the Department of Physics and Astronomy typically are funded through a combination of teaching assistantships and research assistantships while they pursue their Ph.D. degree. Research assistantship typically are supported through grants obtained by faculty members, while teaching assistantship require the student to carry out teaching duties. Details about teaching and research assistantships can be found at ref. [1].

Some students receive fellowships, which can be internal or external to MSU.

Receipt of externally funded fellowships by students who have written their own grant applications, university recruitment fellowships, and certain traineeships that are worth a certain amount can make the students eligible for in-state tuition rate. The details can be found at: [26].

The new publishing agreement for thesis/dissertations with ProQuest now provides an “Open Access Publishing Option” as an alternative to the traditional publishing option available to our students. Details can be found at: [27]. The Open Access option gives ProQuest the authorization to make the electronic version of the document accessible to all via the internet, including the selling of the document by commercial retailers and the accessibility to the work via search engines. A student selecting the Open Access option will not be eligible to receive royalties.

## 10. DEPARTMENTAL POLICIES: INTEGRITY AND SAFETY IN RESEARCH AND CREATIVE ACTIVITIES

Each faculty advisor and graduate student should be aware of the document “Guidelines for Integrity in Research and Creative Activities” [6].

Criteria for dismissal due to unethical or dishonest behavior is described in the Procedures Concerning Allegations of Misconduct in Research And Creative Activities [28].

Graduate students are required to follow an education program about Responsible Conduct of Research, Scholarship, and Creative Activities. The details of the program can be found at: [29], including a set of resources related to specific topics [30].

The Responsible Conduct of Research plan implemented for graduate students in the Department of Physics and Astronomy described the specific program elements required for graduate students in the department [31].

MSU guidelines on authorship can be found at Ref. [32]. The MSU institutional data policy [33] establishes minimum requirements for the appropriate stewardship of Institutional Data.

MSU, including the Department of Physics and Astronomy is committed to providing a safe environment for learning and working. Safety and high-quality work is a shared responsibility between the faculty advisor and the graduate student. Faculty advisors are responsible to understand the hazards, ensure that hazards are mitigated, make sure that graduate students are qualified, competent, and properly trained, and make sure that the students perform the work safely and with high quality. Graduate student are responsible for following procedures and trainings put in place to ensure a safe work environment and to communicate expeditiously with the advisor or Departmental leadership about safety issues and questions. All Department personnel must work closely with MSU Environmental Health and Safety [34] to ensure that activities are pursued in a safe manner.

All Department of Physics and Astronomy Graduate students working in a laboratory must complete the EHS Chemical Hygiene & Hazardous Waste Safety Training before they start working in the laboratory. They must also complete a refresher course each year. Information on safety training and regulations can be found at ref. [34]

Further safety training may be required for work in particular laboratories that the student does research in, whether on rotation or as a regular member of the laboratory. The student and the person supervising the work of the student will discuss the necessary training requirements and instructions prior to the commencement of the work by the student.

Information about health, wellness, and safety can be found at refs. [35] and [36].

## 11. GRADUATE STUDENT TRAVEL

All MSU related travel by graduate students (workshops, schools, conferences, experiments at other institutions, etc) must be authorized prior to the travel taking place. It is important that all travel is planned sufficiently far in advance for the authorization and all necessary procedures to be completed. Especially for students who travel for the first time, it is important to discuss the procedures with the faculty advisor. Detailed resources about preparing for travel, including resources about traveler safety, visas, travel health and insurance, and administrative procedures can be found on the website of the MSU Office of the Controller [37].

The MSU graduate school provides information about travel funding [38]

## 12. DEPARTMENTAL POLICIES: ACADEMIC PERFORMANCE

When a student is admitted into graduate program in the Department of Physics and Astronomy, it is with the full expectations that they will thrive academically as scholars and developing scientists. However, sometimes a student's academic performance does not meet the expectations that the student and our faculty have. This section deals with problems and standards for academic performance.

A 3.0 cumulative grade point average (GPA) is the minimum University standard. Research credits are not considered in determining the GPA. Attainment of the minimum GPA, is however, an insufficient indicator of potential for success in other aspects of the program and in the research field. The student's Guidance committee is responsible for evaluation of the student's competency and the rate of progress.

The accumulation of grades below 3.0 in more than three courses of three or more credits or "deferred" in more than three courses of three or more credits at any given time, or a combination of the above in excess of four courses automatically removes the student from candidacy for the degree. Until the first official Guidance Committee report is filed, all courses on the student's record are considered part of the required program.

To remain in good standing the student also needs to follow Departmental as well as University rules for completing their degree requirements in a timely manner. First year students will meet with the Graduate Program Director after their first spring semester to discuss progress and to plan further course and research work, including the steps to mitigate issues that negatively affected progress. In addition, the Graduate Program Director will meet with more senior students whose progress through the program requires additional attention and support, or who have not found a research group to start research in.

It is a disservice to permit a student to continue toward the advanced degree without the necessary qualifications for retention, including a high level of motivation, commitment, and aptitude. Judgment regarding retention is made by the student's Major Professor and/or the Guidance Committee, in consultation with the Graduate Program Director and if needed the Department Chairperson. If a majority of the Guidance Committee (or the examining committee for the AST 805 in case of Astronomy and Astrophysics graduate students) decides that a student lacks such standards, they may be asked to withdraw according to the procedures as defined in the Graduate Student Rights and Responsibilities document [3].

The student has a right to receive a warning when academic performance is judged to be unsatisfactory (see ref. [3], sections 2.4.8.1 and 2.4.8.2). The student has a right to access their educational records including the academic file the department keeps on them (ref. [3], 3.2.3). Request to view and/or copy the file should be made through the department Graduate Secretary.

If the student fails to pass in the Ph.D. Comprehensive examination (see Section 5), the student will be dismissed from the program. The final oral examinations for the Master's and Ph.D. degrees have pass/fail grades. A student who fails the Master's Dissertation Defense or Ph.D. Dissertation Defense will be given one opportunity to repeat the examination within six months (to be decided by the Guidance Committee). If the student fails the exam a second time, they will be dismissed from the program.

Further information on rights and responsibilities of graduate students can be found at the website of the University Ombudsperson [39].

## 13. POLICIES GOVERNING TA AND RA APPOINTMENTS

Most Ph.D. students are employed by the Physics and Astronomy department, either as assistants in our teaching programs (TA's) or as assistants in one of the research groups within the department (RA's). Professional behavior is expected from students in these positions and students in our program carry out their duties at a high level of performance. The TA's are governed by the MSU/GEU [40] contract [4]. Incoming students are usually supported first by a TA and then by a RA and are most often supported throughout their Ph.D. program.

International students who are not native speakers of English must meet certain requirements in order to be appointed as TA. These requirements are detailed at ref. [41]. If a student does not meet these requirements, the student will receive an assignment that does not require in-person teaching of students (e.g. serve as grader). In consultation with the Graduate Program Director, a plan to meet the requirements is developed.

Decisions on TA appointments are made by the director of graduate studies. Students will be informed as soon as reasonably possible whether they will have a TA position for the following academic year, subject to continued progress in their Ph.D. program, subject to continued adequate performance of their TA duties, and subject to the budgetary considerations.

Important factors in making these decisions are:

- Progress through the core physics or astronomy/astrophysics courses
- Professional and courteous performance of TA duties
- Identifying research opportunities and making adequate progress towards their degree

Students should seek an advisor with a RA opening before the end of their second year in the program, but are strongly encouraged to engage with potential advisors much earlier, for example for research during the summer sessions in their first year.

Decisions on RA appointments are made by individual faculty or by faculty groups involved in group research projects. Students will be informed as soon as reasonably possible whether their RA will be continued for the following academic year, subject to satisfactory performance of their RA duties and subject to the budgetary considerations.

The students who are appointed as a TA or a RA are expected to devote their time to their academic studies and to their TA/RA responsibilities. No outside work for pay can be undertaken without discussing with the Graduate Program Director (in the case of RA and TA's) and with their research advisors (in the case of RA's).

Tutoring can benefit graduate students intellectually as well as financially. It can help solidify your ideas about physics or chemistry and make you a better teacher. You should discuss the decision to tutor with your advisor (or Graduate Program Director if you haven't formed your guidance committee yet). Tutoring should not interfere with your research duties and thesis completion. As such, tutoring should be kept to a minimum, not to exceed an average of 5 hours per week.

If you are a TA, you are not allowed to act as a paid tutor for a student in the course you are assigned to. Such behavior would constitute a conflict of interest because you are being paid by the Department to provide office hours and direct contact support (recitation, lab, etc.) to students for that course. You may act as a paid tutor for a course to which you are not assigned as a TA in any given semester.

TA's and RA's should make themselves aware of the policies on Consensual Amorous or Sexual Relationships with Students [9] and Conflict of interest in Employment [10]. The former policy states that an instructor may not, under any circumstances, be in a relationship with a student for whom they have educational responsibility. The term "instructor" applies to faculty, academic staff, and graduate teaching assistants who have educational responsibilities for students. The latter policy requires that the department discloses relationship between

members in the department, whether they are a concern with respect to a conflict of interest or not. Here, a relationship between individuals or "relatives" is defined as a connection between persons by blood, marriage, adoption, domestic partnership, or other personal relationship in which objectivity might be impaired.

If students are sick or otherwise unable to complete their TA or RA duties, they must inform their TA or RA advisor immediately. Students who fail to carry out their duties and who fail to give an adequate reason for their absence will be sent a warning letter immediately. If the student fails to respond appropriately, the student's stipend will be stopped 10 days after the warning letter is sent. TA's should refer to article 18 of the GEU CBU [4] regarding medical and other types of leave, such as Jury Duty.

Grief absences: it is the responsibility of the student to: a) notify their advisor/major professor and faculty of the courses in which they are enrolled of the need for a grief absence in a timely manner, but no later than one week from the student's initial knowledge of the situation, b) provide appropriate verification of the grief absence as specified by the advisor/major professor and faculty, and c) complete all missed work as determined in consultation with the advisor/major professor and faculty. It is the responsibility of the advisor/major professor to: a) determine with the student the expected period of absence – it is expected that some bereavement processes may be more extensive than others depending on individual circumstances, b) receive verification of the authenticity of a grief absence request upon the student's return, and c) make reasonable accommodations so that the student is not penalized due to a verified grief absence. If employed as a RA or TE, the graduate student must also notify their employer. Both employer and student will swiftly communicate to determine how the student's responsibilities will be covered during their absence. Graduate teaching assistants (TAs) should refer to the bereavement policy in GEU CBU Article 18 [4].

## 14. POLICIES GOVERNING STUDENT RESPONSIBILITY, CONDUCT AND CONFLICT RESOLUTION

There are several departmental, college level and university level deadlines. It is the responsibility of the students to find out about these deadlines from the Graduate Secretary and/or the Graduate Program Director and make sure that these deadlines are met.

Graduate students are an integral and highly valued part of the department's research and teaching programs. Professional behavior is expected from all students and it is expected that students in our program to carry out their duties at a high level of performance. Departmental resources provided to the students for studying, teaching and research (e.g. computers, office supplies, copying etc) cannot be used for personal purposes.

Occasionally problems involving students, teaching assistants, research assistants and faculty do arise. Many of these problems are resolved by informal discussions with the associate chair for graduate studies or with the department chair. In rare cases, the issues remain unresolved and the department's procedure to handle such grievances is as follows, based on a template from the University Ombudsperson. The website from the University Ombudsperson has additional information about grievance procedures [42], including specifically for graduate students [43].



## Graduate Student Academic Grievance Hearing Procedures For the Ph.D. and M.S. Programs in the Department of Physics and Astronomy

Each right of an individual places a reciprocal duty upon others: the duty to permit the individual to exercise the right. The student, as a member of the academic community, has both rights and duties. Within that community, the student's most essential right is the right to learn. The University has a duty to provide for the student those privileges, opportunities, and protections which best promote the learning process in all its aspects. The student also has duties to other members of the academic community, the most important of which is to refrain from interference with those rights of others which are equally essential to the purposes and processes of the University. (GSRR Article 1.2)

The *Michigan State University Student Rights and Responsibilities (SRR)* and the *Graduate Student Rights and Responsibilities (GSRR)* documents establish the rights and responsibilities of MSU students and prescribe procedures to resolve allegations of violations of those rights through formal grievance hearings. In accordance with the SRR and the GSRR, the PhD and MS Programs has established the following Hearing Board procedures for adjudicating graduate student academic grievances and complaints. (See GSRR 5.4.)

### I. JURISDICTION OF THE PHD and MS PROGRAMS HEARING BOARD:

- A. The Hearing Board serves as the initial Hearing Board for academic grievance hearings involving graduate students who allege violations of academic rights or seek to contest an allegation of academic misconduct (academic dishonesty, violations of professional standards or falsifying admission and academic records). (See GSRR 2.3 and 5.1.1.)
- B. Students may not request an academic grievance hearing based on an allegation of incompetent instruction. (See GSRR 2.2.2)

### II. COMPOSITION OF THE PHD and MS PROGRAMS HEARING BOARD:

- A. The Program shall constitute a Hearing Board pool no later than the end of the tenth week of the spring semester according to established Program procedures. Hearing Board members serve one year terms with reappointment possible. The Hearing Board pool should include both faculty and graduate students. (See GSRR 5.1.2 and 5.1.6.)
- B. The Chair of the Hearing Board shall be the faculty member with rank who shall vote only in the event of a tie. In addition to the Chair, the Hearing Board shall include an equal number of voting graduate students and faculty. (See GSRR 5.1.2, and 5.1.5.)
- C. The Program will train hearing board members about these procedures and the applicable sections of the GSRR. (See GSRR 5.1.3.)

### III. REFERRAL TO THE HEARING BOARD:

- A. After consulting with the instructor and appropriate unit administrator, graduate students who remain dissatisfied with their attempt to resolve an allegation of a violation of student academic rights or an allegation of academic misconduct (academic dishonesty, violations of professional standards or falsifying admission and academic records) may request an academic grievance hearing. When appropriate, the Department Chair, in consultation with the Dean, may waive jurisdiction and refer the request for an initial hearing to the College Hearing Board. (See GSRR 5.3.6.2.)
- B. At any time in the grievance process, either party may consult with the University Ombudsperson. (See GSRR 5.3.2.)

- C. In cases of ambiguous jurisdiction, the Dean of The Graduate School will select the appropriate Hearing Board for cases involving graduate students. (See GSRR 5.3.5.)
- D. Generally, the deadline for submitting the written request for a hearing is the middle of the next semester in which the student is enrolled (including Summer). In cases in which a student seeks to contest an allegation of academic misconduct and the student's dean has called for an academic disciplinary hearing, the student has **10** class days to request an academic grievance to contest the allegation. (See GSRR 5.3.6.1 and 5.5.2.2.)
- E. If either the student (the complainant) or the respondent (usually, the instructor or an administrator) is absent from the university during that semester, or if other appropriate reasons emerge, the Hearing Board may grant an extension of this deadline. If the university no longer employs the respondent before the grievance hearing commences, the hearing may proceed. (See GSRR 5.4.9.)
- F. A written request for an academic grievance hearing must (1) specify the specific bases for the grievance, including the alleged violation(s), (2) identify the individual against whom the grievance is filed (the respondent) and (3) state the desired redress. Anonymous grievances will not be accepted. (See GSRR 5.1 and 5.3.6.)

#### IV. PRE-HEARING PROCEDURES

- A. After receiving a graduate student's written request for a hearing, the Chair of the Department will promptly refer the grievance to the Chair of the Hearing Board. (See GSRR 5.3.2, 5.4.3.)
- B. Within **5** class days, the Chair of the Hearing Board will:
  - 1. forward the request for a hearing to the respondent and ask for a written response;
  - 2. send the names of the Hearing Board members to both parties and, to avoid conflicts of interest between the two parties and the Hearing Board members, request written challenges, if any, within **3** class days of this notification. In addition to conflict of interest challenges, either party can challenge two hearing board members without cause (GSRR 5.1.7.c);
  - 3. rule promptly on any challenges, impanel a Hearing Board and send each party the names of the Hearing Board members. If the Chair of the Hearing Board is the subject of a challenge, the challenge shall be filed with the Dean of the College, or designee (See GSRR 5.1.7.). Decisions by the Hearing Board chair or the College Dean (or designee) on conflict of interest challenges are final;
  - 4. send the Hearing Board members a copy of the request for a hearing and the respondent's written response, and send all parties a copy of these procedures.
- C. Within **5** class days of being established, the Hearing Board shall review the request, and, after considering all requested and submitted information:
  - 1. accept the request, in full or in part, and promptly schedule a hearing.
  - 2. reject the request and provide a written explanation to appropriate parties; e.g., lack of jurisdiction. (The student may appeal this decision.)
  - 3. the GSRR allows the hearing board to invite the two parties to meet with the Hearing Board in an informal session to try to resolve the matter. Such a meeting does not preclude a later hearing. However, by the time a grievance is requested all informal

methods of conflict resolution should have been exhausted so this option is rarely used. (See GSRR 5.4.6.)

- D. If the Hearing Board calls for a hearing, the Chair of the Hearing Board shall promptly negotiate a hearing date, schedule an additional meeting only for the Hearing Board should additional deliberations on the findings become necessary, and request a written response to the grievance from the respondent.
- E. At least **5** class days before the scheduled hearing, the Chair of the Hearing Board shall notify the respondent and the complainant in writing of the (1) time, date, and place of the hearing; (2) the names of the parties to the grievance; (3) a copy of the hearing request and the respondent's reply; and (4) the names of the Hearing Board members after any challenges. (See GSRR 5.4.7.)
- F. At least **3** class days before the scheduled hearing, the parties must notify the Chair of the Hearing Board the names of their witnesses and advisor, if any, and request permission for the advisor to have voice at the hearing. The chair may grant or deny this request. The Chair will promptly forward the names given by the complainant to the respondent and visa versa. (See GSRR 5.4.7.1.)
- G. The Chair of the Hearing Board may accept written statements from either party's witnesses at least **3** class days before the hearing. (See GSRR 5.4.9.)
- H. In unusual circumstances and in lieu of a personal appearance, either party may request permission to submit a written statement to the Hearing Board or request permission to participate in the hearing through an electronic communication channel. Written statements must be submitted to the Hearing Board at least **3** class days before the scheduled hearing. (See GSRR 5.4.9c.)
- I. Either party to the grievance hearing may request a postponement of the hearing. The Hearing Board may either grant or deny the request. (See GSRR 5.4.8.)
- J. At its discretion, the Hearing Board may set a reasonable time limit for each party to present its case, and the Chair of the Hearing Board must inform the parties of such a time limit in the written notification of the hearing.
- K. Hearings are closed unless the student requests an open hearing, which would be open to all members of the MSU community. The Hearing Board may close an open hearing to protect the confidentiality of information or to maintain order. (See GSRR 5.4.10.4.)
- L. Members of the Hearing Board are expected to respect the confidentiality of the hearing process. (See GSRR 5.4.10.4.and 5.4.11.)

#### V. HEARING PROCEDURES:

- A. The Hearing will proceed as follows:
  - 1. Introductory remarks by the Chair of the Hearing Board: The Chair of the Hearing Board introduces hearing panel members, the complainant, the respondent and advisors, if any. The Chair reviews the hearing procedures, including announced time restraints for presentations by each party and the witnesses, and informs the parties if their advisors may have a voice in the hearings and if the proceedings are being

recorded. Witnesses shall be excluded from the proceedings except when testifying. The Chair also explains:

- In academic grievance hearings in which a graduate student alleges a violation of academic rights, the student bears the burden of proof.
  - In hearings in which a graduate student seeks to contest allegations of academic misconduct, the instructor bears the burden of proof.
  - All Hearing Board decisions must be reached by a majority of the Hearing Board, based on a "clear and convincing evidence." (See GSRR 5.4.10.1 and 8.1.18.) For various other definitions, see GSRR Article 8.)
2. If the complainant fails to appear in person or via an electronic channel at a scheduled hearing, the Hearing Board may postpone the hearing for demonstrated cause. (See GSRR 5.4.9a.)
  3. If the respondent fails to appear in person or via an electronic channel at a scheduled hearing, the Hearing Board may postpone the hearing or, only in unusual circumstances, hear the case in his or her absence. (See GSRR 5.4.9-b.)
  4. If the respondent is absent from the University during the semester of the grievance hearing or no longer employed by the University before the grievance procedure concludes, the hearing process may still proceed. (See GSRR 5.3.6.1.)
  5. To assure orderly questioning, the Chair of the Hearing Board will recognize individuals before they speak. All parties have a right to speak without interruption. Each party has a right to question the other party and to rebut any oral or written statements submitted to the Hearing Board. (See GSRR 5.4.10.2.)
  6. Presentation by the Complainant: The Chair recognizes the complainant to present without interruption any statements relevant to the complainant's case, including the redress sought. The Chair then recognizes questions directed at the complainant by the Hearing Board, the respondent and the respondent's advisor, if any.
  7. Presentation by the Complainant's Witnesses: The Chair recognizes the complainant's witnesses, if any, to present, without interruption, any statement directly relevant to the complainant's case. The Chair then recognizes questions directed at the witnesses by the Hearing Board, the respondent, and the respondent's advisor, if any.
  8. Presentation by the Respondent: The Chair recognizes the respondent to present without interruption any statements relevant to the respondent's case. The Chair then recognizes questions directed at the respondent by the Hearing Board, the complainant, and the complainant's advisor, if any.
  9. Presentation by the Respondent's Witnesses: The Chair recognizes the respondent's witnesses, if any, to present, without interruption, and statement directly relevant to the respondent's case. The Chair then recognizes questions directed at the witnesses by the Hearing Board, the complainant, and the complainant's advisor, if any.

10. Rebuttal and Closing Statement by Complainant: The complainant refutes statements by the respondent, the respondent's witnesses and advisor, if any, and presents a final summary statement.
11. Rebuttal and Closing Statement by Respondent: The respondent refutes statements by the complainant, the complainant's witnesses and advisor, if any, and presents a final summary statement.
12. Final questions by the Hearing Board: The Hearing Board asks questions of any of the participants in the hearing.

## VI. POST-HEARING PROCEDURES

### A. Deliberation:

After all evidence has been presented, with full opportunity for explanations, questions and rebuttal, the Chair of the Hearing Board shall excuse all parties to the grievance and convene the Hearing Board to determine its findings in executive session. When possible, deliberations should take place directly following the hearing and/or at the previously scheduled follow-up meeting. (See Section IV.D above.)

### B. Decision:

1. In grievance (non-disciplinary) hearings involving graduate students in which a majority of the Hearing Board finds, based on "clear and convincing evidence," that a violation of the student's academic rights has occurred and that redress is possible, it shall recommend an appropriate remedy to the Department Chair or School Director. Upon receiving the Hearing Board's recommendation, the Department Chair or School Director shall implement an appropriate remedy, in consultation with the Hearing Board, within **3** class days. If the Hearing Board finds that no violation of academic rights has occurred, it shall so inform the Chair or Director. The Chair of the Hearing Board shall promptly forward copies of the final decision to parties and the University Ombudsperson. (See GSRR 5.4.11.)
2. In grievance (non-disciplinary) hearings involving graduate students in which the Hearing Board serves as the initial hearing body to adjudicate an allegation of academic dishonesty and, based on "clear and convincing evidence," the Hearing Board finds for the student, the Hearing Board shall recommend to the Department Chair or School Director that the penalty grade be removed, the Academic Dishonesty Report be removed from the student's records and a "good faith judgment" of the student's academic performance in the course take place. If the Hearing Board finds for the instructor, the penalty grade shall stand and the Academic Dishonesty Report regarding the allegation will remain on file, pending an appeal, if any to the College Hearing Board within **5** class days of the Hearing Board's decision. If an academic disciplinary hearing is pending, and the Hearing Board decides for the instructor, the graduate student's disciplinary hearing before either the College Hearing Board or the Dean of The Graduate School would promptly follow, pending an appeal, if any, within **5** class days. (See GSRR 5.5.2.2 and 5.4.12.3)

### C. Written Report:

The Chair of the Hearing Board shall prepare a written report of the Hearing Board's findings, including recommended redress or sanctions for the complainant, if applicable, and forward a copy of the decision to the appropriate unit administrator within **3** class days of the hearing. The report shall indicate the rationale for the decision and the major elements of evidence, or lack thereof, that support the Hearing Board's decision. The administrator, in consultation with the Hearing Board, shall then implement an appropriate remedy. The report also should inform the parties of the right to appeal within **5** class days following notice of the decision, or **5** class days if an academic disciplinary hearing is pending. The Chair shall forward copies of the Hearing Board's report and the administrator's redress, if applicable, to the parties involved, the responsible administrators, the University Ombudsperson and the Dean of The Graduate School. All recipients must respect the confidentiality of the report and of the hearing board's deliberations resulting in a decision. (See GSRR 5.4.12 and 5.5.2.2)

VII. APPEAL OF THE HEARING BOARD DECISION:

- A. Either party may appeal a decision by the Hearing Board to the College Hearing Board for cases involving (1) academic grievances alleging violations of student rights and (2) alleged violations of regulations involving academic misconduct (academic dishonesty, professional standards or falsification of admission and academic records.) (See GSRR 5.4.12.)
- B. All appeals must be in writing, signed and submitted to the Chair of the College Hearing Board within **5** class days following notification of the Hearing Board's decision. While under appeal, the original decision of the Hearing Board will be held in abeyance. (See GSRR 5.4.12, 5.4.12.2 and 5.4.12.3.)
- C. A request for an appeal of a Hearing Board decision to the College Hearing Board must allege, in sufficient particularity to justify a hearing, that the initial Hearing Board failed to follow applicable procedures for adjudicating the hearing or that findings of the Hearing Board were not supported by "clear and convincing evidence." The request also must include the redress sought. Presentation of new evidence normally will be inappropriate. (See GSRR 5.4.12.1, 5.4.12.2 and 5.4.12.4.)

VIII. RECONSIDERATION:

If new evidence should arise, either party to a hearing may request the appropriate Hearing Board to reconsider the case within **30** days upon receipt of the hearing outcome. The written request for reconsideration is to be sent to the Chair of the Hearing Board, who shall promptly convene the Hearing Board to review the new material and render a decision on a new hearing. (See GSRR 5.4.13.)

IX. FILE COPY:

The Chair of the Department shall file a copy of these procedures with the Office of the Ombudsperson and with the Dean of The Graduate School. (See GSRR 5.4.1.)

Approved by Faculty (April, 2015)

## 15. APPENDICES

### A. SUGGESTED COURSE SEQUENCE FOR GRADUATE STUDENTS

Suggested Course sequence for physics graduate students

#### 1<sup>st</sup> Fall Semester:

Physics 810 (3 credits)	Methods of Theoretical Physics	
Physics 820 (3 credits)	Classical Mechanics	SUBJECT EXAM
Physics 851 (3 credits)	Quantum Mechanics I	

#### 1<sup>st</sup> Spring Semester:

Physics 852 (3 credits)	Quantum Mechanics II	SUBJECT EXAM
Physics 841 (3 credits)	Classical Electrodynamics I	SUBJECT EXAM
Physics 801 (3 credits) OR	Survey of Atomic and CMP	
802 (3 credits) OR	Survey of Nuclear Physics	
803 (3 credits)	Survey of Elementary Particle Physics	

#### 1<sup>st</sup> Summer Semester:

Physics 800 (3 credits)	Research Experience
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#### 2<sup>nd</sup> Fall Semester:

Physics 831 (3 credits)	Statistical Mechanics	SUBJECT EXAM
Physics 842 (3 credits)	Classical Electrodynamics II	

#### 2<sup>nd</sup> Summer Semester:

Physics 800 (3 credits)	Research Experience
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Suggested Course Sequence for Astronomy and Astrophysics Graduate Students

The core courses for the Astronomy and Astrophysics Ph.D. students are detailed in Section 4. The courses are normally completed in two years, following a schedule determined by consultation with the astronomy graduate advisor.

## B. SYLLABI FOR REQUIRED PHYSICS COURSES

The following short syllabi sketch the core material which is covered in the subject exam courses and other required physics courses. The instructor is free to select additional topics as well as to change the order in which the topics are taught. In QM and EM the subdivision into two semesters can also vary.

### METHODS OF THEORETICAL PHYSICS (PHY 810)

Scalar and vector fields, vector calculus. Basics of transformation groups. Complex calculus. Analyticity and singularities, residue calculus, conformal mapping. Fourier and Laplace transformations. Distributions and delta-function. Linear spaces. Operators, eigenfunctions, eigenvalues and diagonalization, orthogonal and unitary transformations. Differential equations of mathematical physics: wave equation, Laplace and Poisson equation, diffusion equation, Schrodinger equation, Helmholtz equation. Methods of solution: use of symmetry, separation variables, Sturm-Liouville problem, Fourier and Laplace transformations, boundary value problems, Green's function, variational methods. Special functions: orthogonal polynomials, spherical harmonics, cylindrical functions.

### CLASSICAL MECHANICS (PHY 820)

Calculus of variations and the least action principle. Lagrange equations. Hamilton equations. Symmetry and conservation laws. Motion with a central force. Kepler problem. Scattering problem, cross section. Small oscillations, resonance effect. Theory of normal modes. Rotation of a rigid body, inertia tensor. Chaos and introduction to phase space methods.

### QUANTUM MECHANICS (I + II) (PHY 851/852)

Limits of classical physics. Free motion, wave packets and uncertainty relations. Schrodinger equation, time-dependent and stationary, general properties; continuous and discrete spectra. General structure of quantum theory, Hilbert space and operators. One-dimensional problems including harmonic oscillator. Three-dimensional problems. Central fields and orbital momentum. Hydrogen atom. General theory of angular momentum. Spin  $\frac{1}{2}$ . Addition of angular momenta. Symmetry and conservation laws. Selection rules. Variational methods.

Stationary perturbation theory including degenerate case. Stark effect. Electron in a magnetic field. Landau levels, Zeeman effect, spin dynamics. Scattering theory, phase analysis and Born approximation. Time dependent perturbation theory, golden rule. Sudden and adiabatic approximations. Interaction with the radiation field, absorption, spontaneous and induced radiation of light. Many-body systems, Bose and Fermi statistics. Main properties of atomic and molecular spectra.

### CLASSICAL ELECTRODYNAMICS I (PHY 841)

Review of electrodynamics at the undergraduate level, 4-dim space-time and Special Relativity, Motion of charges in constant electric and magnetic fields, Field equations and energy momentum tensor, Fields generated by simple sources; Multipole expansion,

Electromagnetic wave in vacuum; Polarization, Fields of moving charges and radiation,

Scattering of charged particles; Synchrotron radiation, Brief description of radiation reaction

### CLASSICAL ELECTRODYNAMICS II (PHY842)

Electrostatics of conductors, Electrostatics of dielectrics, Microscopic models of dielectric media, Magnetostatics., Para-, dia-, and ferromagnetism., Quasistationary fields, skin effect,



Electromagnetic waves in material media, propagation, reflection, refraction and polarization.

Waveguides and resonant cavities. Scattering and diffraction. Electrodynamics of special media (plasma, superconductors). Energy loss by charged particles, Cherenkov radiation.

#### STATISTICAL MECHANICS (PHY831)

Probabilistic description. Thermodynamic equilibrium and the second law. Thermodynamic limit, extensive and intensive quantities. Equilibrium Gibbs ensembles (microcanonical, canonical, grand canonical), thermodynamical potentials and identities. Classical limit. Maxwell-Boltzmann gas. Fermi and Bose statistics. Perfect gas, applications (metals, stars, nuclei). Gas of wave quanta. Black body radiation. Phonons in solids. Bose gas. Bose-Einstein condensation. Mean field theory, magnetism. Phase transitions of first and second order.

### C. INTRODUCTION TO RESEARCH ASTRONOMY 800 OR PHYSICS 800

All incoming graduate students, unless otherwise involved in a research program, may enroll in Physics 800 or Astronomy 800 (3 credits), "Introduction to Research". The first summer in the graduate program is a convenient time to take this for the first time. Some students who, for some reason, will not be taking the standard first year courses, may take this course earlier. Others, who wish to speed up their participation in research, may take this course in addition to the standard courses. Informal research activity is also encouraged for first year students.

The general procedure is that each student, who has no particular research preference, will spend each of two semesters in different major areas of Physics represented in the department. After two such semesters, the student should thereby get an intelligent view of what goes on in these areas. However, if a student has a strong preference for a particular area, their early deeper involvement with the research in that area should certainly take precedence over getting a quick and broad view of everything. This procedure will (1) assist Ph.D. candidates and faculty to get better acquainted with each other before making long term commitments, (2) solve the problem of how to get Ph.D. students involved with research early, and (3) give M.S. students that modicum of research experience that may make them more employable.

A student enrolling for Physics or Astronomy 800 for the 3 credits per semester will spend a minimum of 10 hours per week in the laboratory of a faculty member, learning all that (s)he can by just being there, learning from the more advanced graduate students, assisting in data taking, computer work, etc. Interested students should make contact with faculty members before enrolling for the course, and make the necessary arrangements for the affiliation. Physics 800 is offered only on the Pass-No Pass (P-N) grade basis.

## D. PHYSICS GRADUATE STUDENT BYLAWS

### I. Nature, Name and Purpose

- A. The graduate students of the Physics Department comprise a group to be called the Physics Graduate Organization (PGO)
- B. The elected representatives of the PGO constitute a body called the Physics Graduate Council (PGC). Their principal function is to represent the views of the physics graduate students to the administration of the department, college and university, and to inform their constituents of their own representative actions and administrative decisions that affect graduate students.

### II. Composition of the PGC: Duties and Prerogatives

#### A. The PGC shall be composed of eight members:

- 1) *President*, who shall also be a representative to the Advisory Committee.
- 2) *One Representative*, to both the Council of Graduate Students and the Advisory Committee.
- 3) *One Representative*, to both the Graduate Course and Program, and the Graduate Admissions Committee.
- 4) *One Representative*, to serve on three committees: Teaching Assignment, Educational Policies, and Service Course. This person should have at least one year of teaching experience.
- 5) *One Representative*, to both the P-A Shop and related technical services, and the Space Utilization and Remodeling committees.
- 6) *One Representative*, to both the Library and the Publicity committees.
- 7) *One Representative*, to the Graduate Student Council of the College of Natural Science.

#### B. The same person may not simultaneously fill the positions of President of PGO and Council of Graduate Students representative.

#### C. The members of the PGC shall be nominated and elected in an ordinary meeting of the PGO. They may be recalled in any meeting of the PGO.

#### D. The PGC may submit statements that represent graduate student opinion to departmental and ad hoc committees with the understanding that these statements will be considered.

#### E. The representatives shall have power to initiate and second motions and to vote in the committees on which they sit. They shall, at the same time, be ready to assume committee work.

#### F. The President, in consultation with the Council of Graduate Students representative, shall make or delegate decisions and responsibilities of routine nature or minor importance.

#### G. The Council of Graduate Students representative shall have power to represent the physics graduate students at meetings of the Advisory Committee.

### III. Meetings

#### A. Meetings of the PGO shall be of two kinds:

- 1) *Ordinary* An ordinary meeting of the PGO shall be called in the Spring of the year by the president for the purpose of electing representatives to the standing committees of the department (named in Section III),

a representative to the Council of Graduate Students, a representative to the Graduate Student Council of the College of Natural Science, and a new President of PGO.

2) *Extraordinary* For matters of great importance a meeting of the PGO must be called by the president. (S)he must also do so upon the written request of at least five graduate students.

B. Meetings of the PGC are called by the president when (s)he deems necessary or upon the request of at least two members of the PGC, but no less than once a semester.

C. Robert's Rules of Order shall be observed at meetings of the PGO. These rules may be suspended by unanimous vote.



F. ASTROPHYSICS COMPREHENSIVE EXAM COMPLETION FORM  
ASTROPHYSICS COMPREHENSIVE EXAM  
COMPLETION FORM

Student's Name: \_\_\_\_\_

Thesis has been:      \_\_\_\_\_ Accepted                      \_\_\_\_\_ Rejected

\_\_\_\_\_ Accepted subject to revisions (beyond  
minor editorial changes)

Oral Examination in defense of the thesis was conducted on:

\_\_\_\_\_

EXAMINING COMMITTEE:

\_\_\_\_\_  
Committee Chairperson                      Date

\_\_\_\_\_  
Department Chairperson                      Date

\_\_\_\_\_  
Date

\_\_\_\_\_  
Dean                      Date

\_\_\_\_\_  
Date

G. PHYSICS Ph.D. GUIDANCE COMMITTEE REPORT FORM I

See: <https://pa.msu.edu/academics/graduate-program/current-graduate-students/forms/>

H. ASTROPHYSICS Ph.D. GUIDANCE COMMITTEE REPORT FORM I

Student Name: \_\_\_\_\_ Date \_\_\_\_\_

Research Advisor: \_\_\_\_\_

Qualifier exam passed: \_\_\_ PhD level \_\_\_ MS level

Core courses/subject exams completed (enter grade):

\_\_\_ Mechanics \_\_\_ E&M \_\_\_ Stat.Mech. \_\_\_ Rad.Processes

\_\_\_ Stars \_\_\_ Galactic \_\_\_ Extragalactic \_\_\_ Nuc.Astro.

\_\_\_ GPA for core courses (3.375 required)

2<sup>nd</sup> Yr Project: \_\_\_ Proposal submitted \_\_\_ Semesters AST805 \_\_\_ Oral Exam

Guidance comm. form completed: \_\_\_ Yes \_\_\_ No

Research plan presented: \_\_\_ Yes \_\_\_ No, tentative date \_\_\_\_\_

If yes: \_\_\_ Satisfactory

\_\_\_ Not satisfactory, reschedule for: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_

Goals for next year: \_\_\_\_\_

\_\_\_\_\_

Progress and continuing support recommendation:

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Approved by the Guidance Committee:

Name:

Signature:

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Student (Signature):

Department Chair:

\_\_\_\_\_

\_\_\_\_\_

cc: Student, Advisor, Department Chair



**Consult your adviser before answering the following questions**

Describe the policies or criteria that will determine authorship for any paper(s) for which you are currently or have been working. Include how the ordering of authors will be determined. If you are in a large collaboration, describe the procedures for being chosen to present and give presentations on behalf of the collaboration, and for submitting manuscripts on behalf of the collaboration.

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Describe the steps you take to make sure your work is as reproducible as possible. This would include documenting codes, maintaining lab notebooks, etc.

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I. Ph.D. GUIDANCE COMMITTEE REPORT FORM II

<https://pa.msu.edu/academics/graduate-program/current-graduate-students/forms/>

## 16. References

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