DEPARTMENT OF ASTRONOMY

Graduate Study Handbook

Adopted by the Graduate Studies Committee

Of the Department of Astronomy

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Chair Date

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Table of Contents

Introduction

Policies and Standards of the Graduate School of The Ohio State University are contained in the *Graduate School Handbook* (hereafter GSH), which is published and distributed by the Graduate School. The Graduate School Handbook is also available online at http://gradsch.osu.edu/Faculty/GSpubs/Handbook.html. As set forth in §2 of the GSH, each academic unit is required to publish and distribute a Graduate Student Handbook that outlines the policies, rules, and procedures relevant to its own program.

The purpose of this handbook is to clearly set forth the policies, rules, and requirements of the graduate program of the Department of Astronomy. It is intended as a companion to the GSH. The policies, rules, and procedures are intended to be consistent with those given in the GSH; in the cases of possible conflict or disagreement, the discrepancy should be pointed out to the Graduate Studies Committee (GSC) of the Department of Astronomy, and the rules as outlined in the GSH shall take precedence in cases where the University rules clearly disallow any rule, policy, or procedure which appears in this handbook.

II. Academic Requirements for Graduate Students

Overview

The primary goal of the graduate program of the Department of Astronomy is to produce professional astronomers who are well prepared for research and teaching careers. The faculty regards as paramount the development of the student's ability to plan and carry out original research in astronomy and astrophysics.

Formal coursework is concentrated in the first two years of study, during which time the students take their required core courses and seminars. Students are also expected to begin working on directed research projects as early as possible. Students are admitted to candidacy for the PhD upon completing their required courses and successfully passing the Candidacy Examination, which is normally taken at the beginning of the third year of study. Subsequently students spend most of their time on research under the direction of one or more faculty members, one of whom will be the student's dissertation adviser. While carrying out dissertation research, students are still expected to participate in seminars, colloquia, morning coffee and other aspects of the intellectual life of the Department. The Ph.D. is awarded upon completion and approval by the student's dissertation committee of a dissertation based on original research, and successful defense of the

dissertation in an oral examination. It is normally expected that students will complete all requirements for the Ph.D. within five years of entering the program, though a longer period may be required in exceptional circumstances.

Students are generally admitted to the program only to pursue the Ph.D., although the M.S. is also offered by the Department. The program is designed so that a well-prepared student should be able to complete the Ph.D. requirements in five years of full-time work. The M.S. program can be completed in less than two years. Along with completion of the required courses, the Candidacy Examination fulfills the formal requirements for the M.S. Most students elect to receive the M.S. upon completion of these requirements.

Summary of Academic Requirements

In the information that follows:
(U) denotes a University requirement
(D) denotes a Departmental requirement
Section numbers indicate the relevant sections of the GSH..

All Students

I. Advisers (D, U)

A. Upon enrollment in the University, the GSC will assign each student an academic adviser who is a member of the Graduate Faculty. The academic adviser serves for the first year only.

B. At the end of the first year the student chooses a research adviser. The GSC must be notified of the new adviser, and the student must have obtained the consent of the adviser prior to notifying the GSC. The research adviser should be a graduate faculty member with whom the student has conducted is conducting a research project, but it is not necessarily assumed that the research adviser will become the student's dissertation adviser. The research faculty adviser takes over the overall advising duties for the student, but only after the end of the first year.

C. At some time prior to the Candidacy Exam, the student must select a dissertation adviser from among the eligible Graduate Faculty, which can include members who hold appointments in other units of the University. The student must obtain the consent of the faculty member whom he or she wishes to serve as the dissertation adviser. A student may have more than one dissertation adviser, although one faculty member must be the adviser of record for administrative purposes. The student and the dissertation adviser then notify the GSC of the names of the members of the student's dissertation committee, which consists of at least two eligible members of the Graduate

Faculty in addition to the adviser. The consent of members of the dissertation committee must be obtained prior to having them serve on that committee. The GSC must be notified by the dissertation adviser of the dissertation committee membership and of any subsequent changes in the committee membership.

D. The GSC chairman must be notified by both the student and adviser if a student decides to change dissertation advisers. A student who changes advisers after having passed the Candidacy Examination is expected to meet with his or her dissertation committee within one academic quarter to discuss any changes to the nature and scope of the dissertation.

E. Advisers are expected to meet with their students at least quarterly, and both dissertation and research advisers will typically do so much more frequently. The advisers must approve the courses for which the student has enrolled and should be available for advice in the event that the student is experiencing difficulties in the program. Advisers also have the following specific responsibilities:

- The adviser is responsible for signing off on graduate student usage of their departmental research funds, discussed below.
- The adviser submits to the GSC an annual written report that will be used as part of annual graduate student evaluations, discussed further in sections III and VI. In the event that there are issues with the student's progress, advisers may refer cases to the GSC for evaluation and discussion at any other time.
- The dissertation adviser (post-candidacy) serves as chairperson of the dissertation committee (U) (II.6.12.2)

2. **Evaluation** (D)

Graduate student evaluations are conducted quarterly by the GSC and annually by the Graduate Faculty as a whole at the end of each Spring Quarter. Evaluations are described in more detail in Section III.

3. **Support** (U, D) (II.8, II.9)

Graduate students in the Department of Astronomy receive financial support generally through one of three types of appointment: Graduate Teaching Associateships (GTA) and Graduate Research Associateships (GRA) (II.8); and Fellowships (II.9). Financial support is discussed in Sections VIII and IX.

The Department places a high priority on graduate student research. One important aspect of such research is traveling to present the results of their research at scientific meetings. In addition to stipends received as part of their formal appointments in the Department, graduate students receive funds through a personal research account in support of their individual research. These

funds are intended primarily for attending scientific meetings, although they may be used for other purposes, subject to University and Department regulations and policies. Specifically:

Incoming students are given an initial research account balance, plus an allowance for moving expenses as specified in the letter of offer. These funds can be accessed by students only with approval of their adviser (or graduate studies chair if the student does not currently have an adviser)

Departmental research funds are intended to be used primarily for travel expenses related to scientific meetings or collaborative research. Students are encouraged, however, to seek out subsidies for student travel from other sources; for example, many conferences have funding set aside to encourage graduate student participation. Note that reimbursement for travel requires that a travel form be submitted before leaving on a trip. Moreover, many travel expenses can be prepaid (notably airfare and meeting registration fees) and graduate students are eligible to receive cash advances prior to approved travel. Students should consult with the office staff when planning travel.

First and second year students only may use up to $200 from their personal research accounts for books required for their courses.

For students in their final year of dissertation work, the GSC will fully fund a trip to present a dissertation talk at the winter AAS meeting, and will provide airfare for a graduating student to present dissertation research at an appropriate international conference.

Funds from graduate student research accounts are not to be used for:
a) Equipment - this is funded through the computer committee or through grants or other funds available to faculty;
b) Observing trips - these are funded by the sponsoring faculty member;
c) Page charges for journal papers - these are funded through the department or other funds available to faculty.

Faculty members are expected to contribute matching funds to assist in graduate student travel whenever possible. Advisers should keep in mind that the fund is designed to last the students for five years when discussing expensive trips during the first years of graduate study. Students should attempt to limit expenses to no more than $1000 per academic year barring exceptional circumstances; spending above that level requires the approval of the GSC chair as well as the adviser.

Pre-Candidacy (First 2 years)

1. Satisfactory Completion of the Core Graduate Curriculum of Classes (D, U)

Formal classes are concentrated in the first two years of study. These are centered on sequences of core courses, which are offered in alternate years. These are listed in Section V.

There is a minimum cumulative GPA of 3.0 required to avoid academic Probation: (U) - Section II.4

Note: some Fellowship Programs also require a minimum cumulative GPA.

2. Research Project (D)

It is expected that during the first two years of study, the student will develop an area or areas of research interest. These may be pursued through directed research courses with professors in the Department and/or appointment as a Graduate Research Associate. The Department strongly encourages student participation in research during the first two years of study in preparation for the more intense dedication to research during the later years of study, and recommends that students undertake at least two distinct research projects with at least two different faculty members prior to selecting a dissertation adviser and area of research concentration.

Submission of a co-authored paper to a refereed journal is normally required for advancement to candidacy. A student presentation on such a completed research project forms the basis of the oral portion of the Candidacy Examination, which is discussed in Section VI. Students may petition the Graduate Studies Committee for exceptions to the above requirement. Exceptions may be granted under extenuating circumstances by majority vote of the faculty.

3. Credit Hours Enrolled (U) (II.2.1)

A full-time student appointed at least half time on a GTA, GRA, or Fellowship must enroll for at least 9 credit hours per quarter (except for the Summer Quarter, when the minimum is 7 credit hours). (U)

The typical course load for full-time students ranges between 12 and 15 credit hours per quarter; enrolling for more than 18 hours is strongly discouraged and requires an adviser's signature (U).(D).

4. English Language Competency (Foreign Students Only) (D) (II.1.7)

The Ohio State University requires that most foreign teaching assistants pass an examination demonstrating proficiency in English before they can serve as GTAs who are in contact with students. In addition to this requirement, the Faculty believes that a strong background in English is required for a successful career as a research scientist.

Foreign graduate students must therefore be certified for English proficiency as soon as possible upon entering the program, but by no later than the end of the Spring Quarter of their second academic year regardless of the nature of their appointment. After this time, the Department will not support uncertified students until they have been certified for English proficiency. Individual faculty members may, however, support uncertified students as GRAs through their own research funds.

5. Colloquium, Journal Club, and Morning Coffee.

Students in the first 2 years (only) are required to sign up for the seminars (Astron 801, 802, 803 in Autumn, Winter and Spring Quarters, respectively). These courses are graded on a S/U basis only (D). A satisfactory grade in these courses requires regular attendance at Department Colloquia (typically held on Thursday afternoons) and Journal Club (typically held on Friday at lunchtime). Graduate students in all stages of the program are expected to attend colloquia and journal club, and to periodically make voluntary Journal Club presentations.

The Department also holds daily morning coffee discussions on preprints submitted to astronomical journals. Students are strongly encouraged to attend morning coffee and participate in the discussion.

Candidacy Examination

After satisfactory completion of coursework students must pass a Written and Oral Exam for admission to candidacy for the Ph.D (U) (II.6.10)

In most cases, the Candidacy Examination is taken during the Summer Quarter of the student's second year of study after the completion of coursework. A detailed description of the Candidacy Examination is given in Section VI.

Post-Candidacy (Dissertation Students)

1. Courses and Academic Standing.

The only class students enroll in after completing their candidacy exam is Astron 999, typically for 12-15 credit hours. (U)

Students must meet the requirements for maintaining good academic standing that are discussed in Section VI, or they may be asked to leave the program.

2. Time to Degree.
A graduate student must complete the PhD program within 5 years after admission to candidacy (U) (II.6.11) or pass a supplementary candidacy examination that may be offered at the discretion of the Department. The Department of Astronomy does not currently permit supplementary candidacy examinations, which means that students may not continue in the program if they exceed the five-year limit. Normally students are expected to finish their degrees within approximately three years of their admission to candidacy.

3. Dissertation Committee (U, D)
In consultation with the dissertation adviser, the student selects a dissertation committee. The dissertation committee is composed of the student dissertation's adviser plus a minimum of two other eligible members of the Graduate Faculty. Members of the dissertation committee must consent to serve. By the end of the quarter in which the Candidacy Examination is successfully passed, the GSC must be notified by the dissertation adviser as to the membership of the student's dissertation committee. Any changes in the composition of the committee must also be reported to the GSC.

4. Dissertation Proposal Presentation (D)
Within one academic year after successful completion of the Candidacy Examination, each student is expected to submit in writing a dissertation proposal and to make a formal dissertation proposal presentation to his or her dissertation committee. In the event that the dissertation committee judges this presentation to be unsatisfactory, further attempts are permitted. Failure to present a successful Dissertation Proposal within one year of passing the Candidacy Examination will result in academic consequences as spelled out in Section VI.

5. Dissertation (D, U) (II.6.12, III)
The student must prepare a dissertation of original scientific research according to University guidelines.

6. Final Oral Exam (U) (II.6.13)
The student must pass a final oral dissertation defense. The committee for the oral exam will include the Dissertation Committee plus an external faculty member chosen by the Graduate School.
The Graduate School requires a minimum of two weeks advance notice for scheduling a final oral exam.

7. Other Requirements for Degree (U) (II.6.16)

The student must satisfy all of the other requirements for a PhD included in the graduate school handbook (total credit hours, residency, etc. – typically easily achieved by students in the normal course of the program).

III. The Graduate School and the Graduate Studies Committee

The Structure of the Graduate School and its principal legislative body, the Council on Research and Graduate Studies, is set forth in §1 of the GSH.

Within the Department of Astronomy, conduct of the graduate program is overseen by the Graduate Studies Committee (see also §2 of GSH). The Graduate Studies Committee (hereafter GSC) and its chairman are appointed annually by the Chair of the Department. There is no restriction on the number of terms a faculty member may be asked to serve, nor is there a restriction on the length of term for the GSC Chair. The GSC must consist of no fewer than three members, as set forth in the University rules. The many functions of the GSC are outlined in §2 of the GSH.

Policies, rules, and procedures concerning the graduate program are determined by the GSC and circulated to the faculty and graduate students in the form of the *Department of Astronomy Graduate Student Handbook* (i.e., this document) and through subsequent written memoranda. Major policy decisions, e.g., changes in degree requirements, must be presented to the entire Graduate Faculty of the Department for approval (based on a majority vote) before they can be adopted.

The GSC is responsible for the following activities:

A. Orientation. There will be an orientation for incoming graduate students at the beginning of the Autumn Quarter conducted by the GSC Chair.

B. Academic Advisers. Incoming graduate students will be assigned Academic Advisers by the Graduate Admissions Committee in consultation with the GSC and Department Chairs.

C. Handbook. The GSC is responsible for producing and maintaining a current Graduate Handbook to pass out to all incoming students and posting it on the website.

D. There will be an annual practical orientation to the realities of the job market. This orientation is primarily designed for students who anticipate graduating at the end of the following year, but

all students may attend. The senior graduate students and the graduate committee will be jointly responsible for organizing this activity.

Student Evaluations and Feedback

Graduate students have the right to receive regular feedback on their academic performance and are also expected to provide reports on their activities to the department.

1. Research Projects. Graduate students involved in research projects receive written quarterly evaluations by the faculty with whom the research is being conducted. Copies of these evaluations must also be given to the GSC.
2. Annual Evaluations. A graduate student adviser is responsible for providing an annual evaluation of student progress towards a degree to the GSC. This is an important component of the Spring Quarter Graduate Student Evaluations.
3. Graduate students must provide their adviser and the GSC chair with a brief quarterly report on their overall activities and progress. A paragraph or two will be sufficient, except for the annual report due during Spring Quarter. The annual report from the student should be more detailed, including papers published, observing trips taken, and meetings attended. **Information provided to the Graduate Admissions Committee on these matters can be used for the annual report.**

At the end of each Quarter the GSC performs student evaluations. The adviser is responsible for referring cases requiring discussion to the GSC chair prior to the quarterly meeting. As a result of these evaluations the GSC may recommend calling a faculty meeting to discuss individual student cases.

Each Spring Quarter, the GSC reports to the entire Graduate Faculty on the progress of each student in the Astronomy program and reports on graduate admissions for the next academic year. The Graduate Faculty then reviews the progress of each graduate student, as set forth in §VI of this handbook. Advisers are responsible for scheduling a meeting with their advisees to give them an annual performance evaluation.

IV. Admission to the Program

Applications to the graduate program in astronomy normally are considered only for Autumn Quarter entry; admission for other quarters is considered only under exceptional circumstances. All applicants are considered equally regardless of sex, race, religion, or national origin.

Advanced undergraduate preparation in physics (classical mechanics, electricity and magnetism, thermodynamics and statistical mechanics, and quantum mechanics), as usually required for an undergraduate degree with a major in physics or astronomy, is normally required for admission.

All applicants are required to submit official (through Educational Testing Service of Princeton, New Jersey) Graduate Record Examination (GRE) aptitude scores and GRE Advanced Physics Scores.

A complete application consists of the following: (1) a completed and signed application form, official transcripts from each college or university attended, official GRE scores (i.e., mailed directly from ETS), a one-page autobiographical sketch, including a statement of goals and objectives for graduate study, and three letters of recommendation sent on the candidate's behalf. In order to receive full consideration for Autumn Quarter admission and financial assistance, all application materials should be received by the preceding February 1.

Students from non-English-speaking countries must also submit Test of English as a Foreign Language (TOEFL) scores, and Test of Spoken English (TSE) scores, unless they have earned degrees at universities in English-speaking countries. In general, TOEFL and TSE scores of 550 and 230, respectively, are required for consideration for financial assistance. The University also assesses a $50.00 application fee from foreign applicants.

V. Graduate Courses

Graduate courses are taught in a 2-year cycle, with the exception of Astron 830 which is taught every Autumn Quarter to all in-coming first-year graduate students.

The Astronomy core courses are the following:

Courses Offered in Even Academic Years (e.g., 2004/05)

Astron 830: *Observed Properties of Stars and Galaxies.*

Observed properties of individual stars and normal (non-active) galaxies. Measurements of stellar luminosities, masses, radii, temperatures, and spectra; Properties of the Milky Way Galaxy; Basic properties of galaxies, groups, and clusters. Note: Offered every year for first-year students only.

Astron 823: *Theoretical Spectroscopy.*

Theory of atomic spectra including radiative and collisional processes for line formation by atoms, ions, and molecules in low-density plasmas and stellar atmospheres.

Astron 825: *Radiative Gas Dynamics.*

Dynamics of gas flows in astrophysical situations, including stellar winds, accretion, shock waves, and jets.

Astron 869: *Observational Cosmology.*
Properties of active galactic nuclei and quasars, the cosmological distance scale, and observational tests of cosmological models.
Astron 871:*Physics of the Interstellar Medium.*
Physical processes occurring in interstellar gas and dust.

Courses Offered in Odd Academic Years (e.g., 2005/06)

Astron 830: *Observed Properties of Stars and Galaxies.*
Same as in even years. Offered every year for first-year students only.
Astron 822: *Electromagnetic Radiation.*
Continuum radiation processes of astrophysical interest.
Astron 831: *Stellar Structure and Evolution.*
Theoretical aspects of the interiors and evolution of single stars.
Astron 870: *Stellar Systems.*
Dynamics and evolution of N-body systems, with application to globular clusters and galaxies.
Astron 873: *Cosmology.*
Structure and evolution of the Universe; physical processes in the Big Bang.

In addition to the above required core courses, students may choose additional courses from the following list:

Following successful completion of formal courses, the student should enroll for Astron 693 (Directed Research) until passing the Candidacy Examination. After the Candidacy Examination is passed, students generally enroll only for Astron 999 (Dissertation or Thesis Research).

VI. Degree Requirements

A. Requirements for the Master's Degree

Required Courses Students must register for and complete all of the aforementioned core courses

Annual Review The progress of each graduate student will be reviewed by the Astronomy Graduate Faculty in the Spring Quarter of each year. This review will take place prior to

awarding continuing students departmental financial aid for the next academic year. On the basis of progress in formal class work and seminars and evaluation of other department activities, first-year students will be advised of a recommended program. This recommendation will normally take one of the following forms:

1. Recommend that the student continue in the Ph.D program. This will not preclude earning a Master's Degree as a matter of course, if the student elects to do so.

2. Recommend that the student proceed towards a Master's Degree, but advise that the student not consider further work toward the Ph.D. In this case, the Master's requirements must be completed within two calendar years of the end of that Spring Quarter. Moreover, if the student wishes to attempt a Ph.D. despite the faculty recommendations, the student will not be permitted to attempt the Candidacy Examination until the Master's Degree requirements have been completed.

3. Recommend that the student not proceed further in either the Master's or Doctoral program. If the student is currently on academic probation and fails to raise his or her GPA to the required 3.0 level by the end of that Spring Quarter, the student's registration will be canceled before the beginning of the next quarter.

Examination The Master's Degree examination is an oral examination that will test the student's knowledge of the general principles of astronomy and the subject of his or her thesis. The results of this examination in combination with the quality of the thesis will form the basis for a decision by the examining committee concerning the awarding of the Master's Degree. Successful completion of the Ph.D. Candidacy Examination is deemed to meet this requirement.

Time Limits Any student working towards a Master's Degree who has not taken the Candidacy Examination must complete all requirements for that degree within two calendar years of the first Spring Quarter in which he or she is enrolled.

Under extenuating circumstances, the student may petition the Graduate Committee for an extension of these time limitations.

B. Requirements for the Doctor of Philosophy Degree

Credit Hours The Student must complete at least 135 quarter-hours of advanced astronomy, physics, mathematics, and engineering courses. A student with a Master's Degree must complete at least 90 quarter-hours beyond the Master's Degree.

Required Courses Students must register for and complete the aforementioned 9 core courses.

All formal course work must be completed before the Candidacy Examination can be attempted.

Annual Review The progress of each graduate student will be reviewed annually during the Spring Quarter, as outlined in the section on Master's Degree requirements.

Candidacy Examination:

Purpose The purpose of the Candidacy Examination is to test the student's understanding of basic astrophysics and depth of knowledge in his or her chosen research specialty. It is composed of two parts, a written part and an oral part. The written part is designed to examine the student's breadth of knowledge of basic astrophysics, as reflected primarily in the content of the core courses. The oral part is intended to test the student's depth of understanding and preparation for research in a particular area of astronomy.

Overall Summary of University and Departmental Requirements

1. **Candidacy Exams**. After satisfactory completion of coursework students must pass a Written and Oral Exam (U) (II.6.10). This is normally done within a quarter of completing all course requirements, but must be done within one year of completing course requirements

2. **Written Exam** (U, D) (II.6.10.7)
The written exam has five components. The student is asked to write a paper on a general research topic, summarize three papers in the field, and solve an order of magnitude problem. (D)
The written exam is graded by all committee members separately. It is given an overall passing mark unless more than one committee members assigns an overall failing grade.(D)
The Graduate Committee recommends that a student take the oral exam upon successful completion of the written exam. (D)

3. **Oral Exam** (U, D) (II.6.10.8)
The Astronomy Department oral exam is based upon a research project undertaken in the first 2 years of graduate school. (D)
The oral exam must be scheduled within one month of the written portion, and should be approximately 2 hours in length. (U)
The Candidacy Examination Committee must consist of 4 Astronomy faculty members plus one external member selected by and representing the Graduate School (U).

The Candidacy Examination Committee is chaired by the student's dissertation adviser. The student and the dissertation adviser select the Committee members from among the eligible Graduate Faculty members, who must consent to serve. The membership of the Candidacy Examination Committee must be approved in advance by the GSC Chair.
The Graduate School requires a minimum of 2 weeks notice of the time and place of the exam so that an external examiner can be found (U)
Materials for the Oral Exam must be given to the committee members a minimum of one week in advance of the exam, including the student's answers to the written portion of the exam (U)

4. **Candidacy** (D, U) (II.6.10.9, II.6.11)

A student who does not pass the Written and Oral Exams may, at the discretion of the Candidacy Examination Committee, be permitted opportunity to repeat the Candidacy Examination. Not more than two attempts are permitted barring unusual circumstances. (U)
Successful completion of the Written and Oral Exams admits students to candidacy for the doctoral degree.

Detailed Information

Timing of the Examination

Normally students are expected to take the Candidacy Examination the quarter after completing their core courses, i.e., Summer Quarter of their second year. The GSC can approve (or even recommend) changes to this schedule in individual cases. Students who have met the course requirements may take the Candidacy Examination any time it is administered, but must take the Candidacy Examination no later than the Spring Quarter of the third year of study, unless a special extension is granted by the GSC. If the student's Candidacy Examination Committee allows the student to attempt the Candidacy Examination a second time after failing the first time, the second attempt must follow the first attempt by no more than two quarters.

Notification Any student wishing to take the Candidacy Examination must inform the GSC Chair of his or her intent one quarter prior to the quarter during which the exam is given.

Structure of the Examination. Administration of the Candidacy Exam will be overseen by the Graduate Committee. The GSC will be directly responsible for preparing and grading the written part of the Candidacy Examination, which will be common to all students' Candidacy Examination given that particular quarter, as outlined below. The written examination is to be administered by the and should be completed within a two-week period normally ending no later than the end of the fifth week of the quarter, unless an extension is granted by the GSC; such an extension shall be obtained with the advice and consent of the participating students and their advisers. The written examination is to be graded on the basis that 60% normally represents a passing score. The oral part of the examination must be taken within one month of the completion of the written part of the Examination.

The Written Part:

Before beginning the written portion of the general exam, the student identifies an examination committee (4 faculty) and an examination committee chair. The student selects, with the agreement of the EC Chair, a research field that will be the subject of the exam. The choice of topic should also be approved by the Graduate Committee Chair. The breadth of the field can vary, though it should be neither extremely narrow (e.g., measuring galaxy velocity dispersions) nor overly broad (e.g., cosmology). The oral portion of the general exam can include questions arising from the written portion in addition to questions about the research project presented in the oral exam itself. The written exam has three parts:

1. A Summary of 3 Important Papers in the Field

The EC chair assigns three papers in the field for the student to read and summarize in written form, in three separate reports. Each report should be 2-3 typewritten (double spaced) pages and should summarize, in the student's words, the methods and principal findings of the paper, and should comment on its strengths and limitations.

2. An Order-of-magnitude Calculation

The student defines an order-of-magnitude calculation that illustrates some significant point within the field. The student may consult with the EC chair when formulating the question and it must be approved by the exam committee. The problem should be at the level of difficulty of

typical exercises in the order-of-magnitude class, but should not repeat in-class examples. This section of the exam states the calculation to be done and presents the student's solution. It will be graded on the basis of the quality of the question (creativity and relevance to the topic); the ability of the student to identify the important ingredients required for a solution; and the reasonableness of the answer.

3. A Description of the Field

The student should write a 5-10 page (typewritten, double-spaced) description of the current state of the research field. This description should answer the following questions:
* What are the field's basic, well established results?
* What are the key open questions?
* What are some of the most promising directions for future progress?

The written exam must be handed in within 2 weeks of the final assignment of papers and the order of magnitude problem. All four members of the committee independently grade the written exam. The candidate will have passed the exam if 3 or more members of the committee assign a passing grade. Marks will be assigned primarily on the underlying merit of the scientific argument and not on writing style.

Results of the Written Part

The GSC shall inform the student's Candidacy Examination Committee If the Committee members see no possibility for a satisfactory overall performance on the Candidacy Examination based on the written part of the examination, the Committee may recommend to the student that he or she waive the right to take the oral part. The student's adviser is responsible for informing the student of the results of the written examination and whether or not the Candidacy Examination Committee recommends that the student proceed with the oral part of the examination.

The Oral Part:

In the oral part of the examination, the student will be required to demonstrate his or her depth of understanding of a particular area of astronomical research and to demonstrate readiness to undertake independent research activity. As part of this examination, the student will present a review of a research project undertaken by the student in collaboration with a Graduate Faculty member during their prior Ohio State graduate studies. Under ordinary circumstances a paper co-authored by the student and submitted to a refereed journal will be the basis of the oral exam. This presentation should not exceed thirty minutes in length. The problem to be addressed by the student should be approved by the student's Candidacy Examination Committee well in advance of the oral part of the examination. The oral part of the examination normally will not exceed two

hours duration. The oral portion of the general exam can include questions arising from the written portion.

Dissertation Proposal:

Within one academic year of having been granted admission to candidacy, the candidate shall submit a written dissertation proposal to their dissertation committee and make a formal presentation on this proposal to their dissertation committee. Normally, the presentation will be made during the Autumn or Winter Quarter of the student's third year. The purpose of the dissertation proposal is twofold. First, it is to ensure that the student has picked a scientifically interesting topic that is likely to be completed in a reasonable period of time. The examination is also intended to familiarize the members of the committee with the thesis work and provide opportunities for constructive feedback to both the student and advisor from the other committee members. A written proposal in advance of the oral presentation is especially helpful for the members of the committee other than the advisor, so that the oral presentation can be more fruitful. The written dissertation proposal should describe the motivation for the planned research program, the anticipated outcomes, any relevant preliminary results, and a realistic plan of work that clearly identifies the next steps of the research program and describes what will be necessary to complete it by summer of their 5th year.

Typical written proposals are 5-10 pages, and should be distributed to dissertation committee members at least one week in advance of the presentation itself. The student will make an oral presentation to their committee of approximately 30 minutes, to be followed by questions from the committee members. The entire presentation should not exceed 1½ hours. The dissertation committee should provide a brief written report to the GSC of the outcome of the dissertation proposal presentation.

Approval of the dissertation proposal/defense by the dissertation committee indicates that the committee thinks the student has a viable plan that should lead to a successful and completed dissertation by summer of the student's 5th year, or by another date approved by the GSC. If the dissertation committee cannot reach consensus on whether the student has presented an acceptable proposal, a majority vote will prevail. The completed proposal will be made available to the GSC.

If a student's dissertation proposal presentation is deemed to be unsatisfactory, a second attempt must be made within two quarters of the original presentation. Failure to make the second attempt within two quarters will result in the student receiving an "unsatisfactory" grade in Astron999 s until a second presentation is made. A student who has not successfully completed the formal dissertation proposal presentation within one year of passing the Candidacy Examination will also receive a grade of "unsatisfactory" in Astron 999 a satisfactory oral presentation has been made regardless of the timing of their initial presentation.

Students who receive grades of "unsatisfactory" in Astron 999 grades for two or more consecutive quarters may be denied Department funding until their grades are again "satisfactory." The decision is at the discretion of the GSC and a student may appeal the GSC decision to the Department Chair. Any student who receives an "unsatisfactory" grade in Astron 999 should be given written notification of this policy by the GSC chair.

A second unsatisfactory dissertation proposal presentation can result in dismissal from the graduate program on the grounds of failure to make progress towards a degree.

Annual Dissertation Committee Meetings. The dissertation committee will meet with the student at least once a year. One year after passing the dissertation proposal defense, the student should present a brief progress report to the dissertation committee. The written progress report should be a summary of progress to date (a page or so would be typical), and the student should arrange a ~30-60 minute meeting with the dissertation committee to discuss the report and the student's progress towards a degree.

Approval of the progress report indicates that the dissertation committee believes that the student is on track to complete a successful dissertation on the planned schedule. The student may use the progress report to request an extension of this schedule, e.g., continuation of the dissertation period into or through the sixth year. The dissertation committee will make a written recommendation to the GSC, which will approve or disapprove the request and notify the student accordingly.

If the committee believes that the student is not making adequate progress, they can require an interim progress report within two quarters. If the student is still not making adequate progress, he or she will be given a grade of "Unsatisfactory" in Astron 999 grades until he or she presents evidence of adequate progress to the dissertation committee. The dissertation committee will provide brief written notice of the outcome of each progress report to the GSC.

Subsequent progress reports should be presented on an annual schedule. Under normal circumstances, there will be only one further progress report, mid-way through the student's fifth year, allowing the committee to identify any obstacles on the path to timely completion of the dissertation.

A student who does not successfully defend his/her dissertation by the approved time (e.g., summer of 5th year or a later deadline that has been approved by the graduate committee) gets an automatic one-quarter "grace period" of further support. Continuation of financial support beyond this one extra quarter requires an explicit, approved extension of the dissertation deadline by the graduate committee

Time Limit. University rules require the student to present the doctoral dissertation to the Department within five years of the quarter on which he or she was admitted to candidacy. t students may not continue in the program if they exceed the five-year limit.

Enrollment Any individual engaged in research requiring the facilities of The Ohio State University Department of Astronomy, which he or she intends to present in any way as partial fulfillment of the requirements for a degree in Astronomy, must be enrolled in the Department as a part-time or full-time student during the quarter or quarters in which the facilities are in use.

Final Examination:

Structure of the Examination Normally the candidate will present a summary of his or her dissertation, lasting not longer than 45 minutes. Questions in the oral examination will be mostly confined to the dissertation and related topics.

Attendance at the Final Oral Examination Faculty members who are not members of the official examining committee (the dissertation committee plus an external member appointed by the Graduate School) may attend a Final Oral Examination. They may participate to the extent of questioning the candidate, subject to the availability of tie, at the discretion of the chairman of the examining committee.

With the permission of the dissertation adviser and the candidate, other individuals may attend the examination as auditors. Such individuals may not be present during discussion of the candidate's performance in the examination.

Decision A candidate will be deemed to have passed the Final Oral Examination when there is no more than one negative vote.

VII. Departmental Research Facilities

1. Ohio State is a 1/8 partner in the Large Binocular Telescope (LBT) project and received approximately 16.5% of the observing time on this telescope. It is expected to come into full two-mirror scientific operation in late-2006/early-2007. OSU is building the MODS optical spectrometers, a pair of powerful optical multi-object spectrograph for the LBT, and we have also designed and built the primary-mirror aluminization system. The first MODS spectrograph will be commissioned in mid-2006 (assembly and testing of MODS1 at OSU starts in earnest in 2005), with the second MODS spectrograph coming online about a year later in 2007.

A graduate student entering our program in the Autumn Quarter 2005 would have immediate access to the MDM telescopes for research (see below), as well as the unparalleled opportunity of participating in building a major LBT facility instrument and taking part in observatory commissioning activities. By this student's third year (2007/8), LBT is expected to be operational and ready for dissertation research projects.

2. Ohio State is a 1/4 partner in the MDM Observatory Consortium, which includes Dartmouth, Michigan, Columbia, and Ohio University in Athens. This gives us 25% of the time on (a) a superb 2.4-m telescope on a Kitt Peak site that routinely delivers sub-arcsecond images, and (b) a 1.3-m telescope on the same site, which we have been using heavily for photometric monitoring and wide-field imaging studies, as well as spectroscopic monitoring of bright extragalactic sources. OSU has provided three facility instruments to MDM: an infrared imager/spectrometer, a CCD spectrometer, and RETROCAM, a side-port CCD camera on the 2.4-meter. A new wide-field 4Kx4K CCD imager for the 1.3-m is being constructed. RETROCAM and the MDM4K camera projects were designed and carried out in large part by OSU graduate students.

3. Ohio State has also been actively engaged in research with small telescopes for a variety of projects, including photometric follow-up of gravitational microlensing events to search for planets. The dual-beam optical/infrared cameras that have been used for this work in Chile by the MicroFUN collaboration were built at OSU. We are continuing our efforts to equip 1-meter class telescopes in the southern hemisphere for related work, particularly as founding members of the SMARTS consortium that now operates the small and medium aperture telescopes at CTIO. For the 1-meter we have provided a CCD camera and 12-position filter wheel, the later designed and built by OSU graduate students. OSU students regularly observe at CTIO as part of our SMARTS projects.

4. The department has been aggressively expanding its computational resources, including:

- A 24-node, 48-processor Beowulf cluster granted to the department by the Ohio Supercomputing Center's Cluster Ohio project for large projects requiring massively parallel

computing (or just serious trivial parallelism). Each node has 2Gb of RAM shared between two processors, and a front-end node with 1TB of storage.
- Two 4-processor Xeon machines with 8Gb and 6Gb of memory, respectively, the latter hosting a 3Tb disk farm, for smaller number-crunching or analysis tasks.
- A network of about 50 Linux workstations, all with at least AMD XP1700+ processors or faster, assigned to individual students, postdocs, or faculty for their exclusive use that we will be configuring for distributed grid computing on off-hours.

All of these computing resources are available to students in our program (in fact, they are often the primary users).

The main astronomical library collection is housed in the Science & Engineering Library. The Astronomy Department also contains a reading room to provide read access to frequently used material and the most recent issues of journals.

The Department also provides a machine shop, an electronics shop, instrumentation for data reduction, and a complete support staff.

Students have access to these various resources and ancillary resources (such as word processors and photocopying machines) in support of their approved research projects.

Observational research interests of the Ohio State faculty include searches for extrasolar planets, star formation, stellar evolution, stellar populations, the interstellar medium, the Galactic center, Galactic structure, gravitational microlensing, galaxies, AGNs, the evolution of quasars, and large-scale structure. Theoretical research interests include atomic astrophysics, primordial and stellar nucleosynthesis, stellar structure and evolution, the interstellar medium, Galactic structure, dark matter, galaxy dynamics, AGN's, galaxy formation, the intergalactic medium, large scale structure, and determination of cosmological parameters. On many topics, a student has a choice of several possible research advisers. Interested students also have the opportunity to work on instrumentation through the department's Imaging Sciences Laboratory, a group of ten research staff with expertise in optics, detectors, electronics, mechanical design, and software engineering. This group works closely with the observational faculty and builds optical and infrared instruments for a variety of telescopes.

Ohio State is a close-knit department with a lively atmosphere and a lot of contact between students and faculty, through research supervision and classes, and also through daily coffee, weekly journal clubs and colloquia, student-organized reading groups, and many informal events. Students at Ohio State have more opportunity to learn from close interaction with faculty than they would in virtually any other astronomy program.

VIII. Financial Award Policies

The purpose of awarding financial assistance to graduate students is multifold. First and foremost, financial assistance provides the student with a means of support while studying towards an advanced degree. Second, Graduate Teaching Associateships (GTAs) and Graduate Research Associateships (GRAs) provide opportunities for students to learn the teaching and research skills they will need throughout their careers. Third, participation in research by graduate students provides an important component in University research efforts, and fourth, GTAs help provide the necessary personnel to teach large sections of introductory astronomy classes effectively.

The Department therefore regards financial assistance as an extremely important aspect of the graduate program. Consistent with the above statements, financial assistance is awarded to students on the basis of merit. Outstanding ability and effort is recognized by the University and the Department through fellowships and research associateships, in particular.

Although a few multiple-year financial assistance commitments are made, in general awards of associateships are made by the Department on the basis of the annual review of each student's progress. All associateships are awarded on a merit basis. Criteria for financial aid awards are (1) performance in graduate classes, (2) past performance as a teaching or research associate, (3) past research performance, regardless of the nature of the appointment held by the individual, (4) research promise, as judged by the faculty, and (5) progress towards the Ph.D. In particular, consistent with the last criterion, students in their sixth year of study or beyond and students pursuing a terminal Master's degree are given the lowest priority for financial support, except in extraordinary circumstances. The relative importance of the criteria listed above depends on each student's standing in the program, and is increasingly weighted towards the research-based criteria as the student proceeds toward the Ph.D.

IX. Formal Duties of Graduate Associates

A. Assignments for GTAs are made quarterly by the Graduate Studies Committee.

B. In general, the specific duties of each GTA or GRA are determined by the faculty member to whom the associate is assigned. It is the responsibility of the faculty member to make his or her expectations clear to the associates under his or her direction. In no case may an associate's formal duties require more than 20 hours per week. If a student feels that any of his or her job requirements are unreasonable or if the student has a job-related grievance, the student should discuss the problem with the Head Teaching Associate and, as necessary and appropriate, the ViceChair or the Chair of the Department.

C. The Head Teaching Associate

The Head Teaching Associate is a twelve-month GTA position. This position is generally awarded to an advanced graduate student who is familiar with all aspects of the undergraduate service courses. The particular duties of the Head TA are (1) to help maintain the Astronomy Department computer-based Question Bank, (2) to instruct new GTAs in the use of Department teaching facilities, including the Question Bank, (3) to oversee all aspects of the Roof Nights for the undergraduate service courses, and (4) to serve as ombudsman for graduate student grievances and to work with the Vice-Chair for Graduate and Undergraduate Studies and the Chair of the Department towards resolution of problems affecting GTAs and/or the undergraduate service courses. The Head TA will work with the Vice-Chair of the Department and the GSC chairin coordinating an orientation program for new GTAs during the week prior to the beginning of Autumn Quarter classes. Compensation for the increased level of responsibility includes an otherwise reduced teaching workload and a higher stipend. The Head TA reports to the Vice-Chair of the Department .