Astronomy Graduate Program: Assessment Report

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The Astronomy Graduate Program, although part of the Department of Physics and Astronomy, is run by the Institute for Astronomy (IfA). The IfA is fundamentally a research institution, but offers graduate degrees in astronomy as well as a selection of undergraduate classes.

1 SLOs for the MS and PhD degrees

The IfA's Graduate Program offers PhD and MS degrees in Astronomy. Our focus is on training research scientists. Since a PhD is generally necessary for a research career, most (roughly 95%) of our students enter the program with the intention of getting a PhD; en route, they obtain a “Plan B” MS degree.

To prepare students for a career in astronomical research, our program emphasizes:

1. Acquisition of a broad knowledge of astronomy, both within and outside each student’s area of specialization, and familiarity with both observational and theoretical techniques.
2. Exposure to a variety of advanced and specialized topics in modern astronomy.
3. Extensive opportunities for “hands-on” research, including two supervised research projects undertaken during the first two years of graduate study.
4. Experience writing research papers, observing proposals, and other scientific documents, and presenting talks describing reviewing the literature and describing new research.
5. Formulation of a dissertation research project, completion of the proposed research, publication of the results in peer-reviewed journals, and a public defense of the research before a group of professional astronomers.

2 Where are SLOs published?

Our graduate curriculum and learning objectives are extensively described on our web-pages (see http://www.ifa.hawaii.edu/gradprog/introduction.htm).

- See (http://www.ifa.hawaii.edu/gradprog/graduate_courses.htm) for descriptions of individual courses.
- See (http://www.ifa.hawaii.edu/gradprog/astro_699.htm) for a discussion of research projects students undertake during their first two years.
- See (http://www.ifa.hawaii.edu/gradprog/ms_degree.htm) for requirements for the MS.
- See (http://www.ifa.hawaii.edu/gradprog/phd_progress.htm) for requirements for the PhD.

3 How do SLOs map onto the curriculum?

1. We offer a range of 600-level courses designed to impart a broad knowledge of astronomy at the graduate level. These include courses on Astrophysical Techniques, Fundamentals of Astrophysics, The Solar System, Stellar Interiors, Stellar Atmospheres, Interstellar Material, Galaxies, Active Galaxies, Cosmology, General Relativity, and Astrochemistry (cross-listed with Chemistry).

The Astrophysical Techniques course, which covers basic concepts of observational astronomy and data analysis, is offered every year and is required of all students. In addition, students taking a Plan B MS degree take at least five more 600-level astronomy courses (Plan A students take at least four). This allows some flexibility, while insuring that students are exposed to a range of subjects.
2. IfA faculty and visitors offer 700-level seminars covering advanced and specialized topics of current interest. Many of these offerings change every year. In addition, two 700-level courses, in Astrobiology and in Star Formation, have recently been added to the catalog and will be offered on a regular basis. Students are required to take at least three 700-level courses.

3. During their first two years, students must undertake two directed research projects, and satisfactorily complete at least one of these. These projects are supervised by a faculty member, and reviewed at various stages by a committee of IfA faculty.

4. Experience with scientific writing and speaking is gained in a variety of contexts throughout the graduate curriculum. Brief written and oral reports are often required in 600-level courses. The supervised research projects undertaken during the first two years are expected to produce papers suitable for publication; this research is also presented orally before an audience of all interested IfA faculty and students.

Students advancing to PhD candidacy must write detailed proposals of their research. At this stage, students must also craft carefully written proposals to obtain access to telescope time.

4 What populations are assessed?

Our graduate students are assessed from the time they enter the program, as follows:

- Students not yet advanced to candidacy are evaluated through coursework and performance on research projects.
- Students advancing to candidacy are evaluated by our Qualifying Exam committee.
- Students preparing dissertations provide semi-regular progress reports to their dissertation committees.
- Students completing dissertations are assessed by their dissertation committees.

We also assess the performance of the teaching faculty in order to maintain a high level of graduate (and undergraduate) instruction.

5 Methods of assessment

Graduate student coursework is evaluated through a variety of methods; these include a) problem-sets based on material presented in lectures, b) in-class quizzes and written exams, c) presentation of brief oral and/or written reports on selected topics, d) preparation and evaluation of observing proposals, e) collaboration on small-scale research projects, and f) final in-class or take-home exams. In addition to letter grades, students receive brief written reports on their coursework at the end of each semester.

The role of coursework in student learning is also assessed via course evaluations which students complete at the end of each semester. After experimenting with on-line course evaluations, we recently returned to a paper-based procedure which yields a response rate of about 90%. While the primary focus of these evaluations is on the quality of instruction, we also ask students to rate and comment on the syllabus and the content of each course in relation to their understanding of astronomy as a whole. Extensive feedback – including transcriptions of comments from individual students – is given to the instructors; summary evaluations for each graduate (and undergraduate) course are also posted on an internal IfA web-page.

Each of the two research projects students undertake during their first two years is independently assessed by a supervising faculty member and by a standing committee (the Graduate Research Oversight Group, or “GROG”) composed of four IfA research scientists. The supervising faculty members provide letter grades and brief progress reports, and a longer summary of the student’s efforts once the project is complete. Each student prepares a report of their research in a form suitable for submission for publication, and presents a brief (15 minute) oral description of their work. The GROG reviews these summaries, papers and presentations, and provides detailed feedback to each student.
At the beginning of their third year of graduate study, students take a Qualifying Exam based on the material covered in their coursework. This exam includes both oral and written components; the oral part is evaluated by an exam sub-committee, while written answers are graded by individual faculty members. Following the exam, the Qualifying Exam Committee reviews the entire body of each student’s work to date, giving roughly equal weight to a) coursework, b) student research, and c) performance on the written and oral qualifying exams. There are three possible outcomes: students receiving a “P*” proceed to the PhD program and get a Plan B Master’s degree; students receiving a “P” get only a Plan B Master’s degree, and students receiving an “F” fail the exam. In cases where the written and oral components are satisfactory but some aspect of the student’s research is problematic, the Qualifying Exam Committee may ask the student for further work before awarding a P* or P.

In their third year, PhD students assemble a doctoral committee and develop a detailed dissertation proposal. This proposal becomes the main subject of an oral Comprehensive Exam administered by the doctoral committee. In this exam a student normally presents a talk reviewing the background of their subject and detailing the objectives, methods, and milestones of their proposed research. Criteria considered in assessing a proposal include a) the student’s familiarity with current knowledge in the subject of the proposal, b) feasibility, importance, and originality of the proposed research, c) the student’s technical and intellectual skills, d) availability of telescope time and/or other necessary resources, and d) a plausible time-line for completion of the research.

A student who has passed the Comprehensive Exam and begun dissertation research normally arranges to meet with their doctoral committee on a yearly basis. These meetings update the committee on progress toward completion of the dissertation; if changes in the scope or objectives of the dissertation are necessary, the committee may take a more active role in guiding the project.

The final assessment of a complete dissertation has several components including a) a detailed review of the written dissertation by individual committee members, b) a public talk presenting the key results and conclusions of the research, c) a defense addressing questions, comments, and constructive criticism from the public or the dissertation committee.

In addition to these formal methods, we obtain informal feedback from students. The graduate chair meets privately with individual students on a fairly regular basis throughout their careers. These meetings provide a way to monitor student progress and evaluate the effectiveness of various components of the degree program; they also provide students with opportunities to voice concerns or discuss problems.

6 Graduate student contributions

Graduate students are integrated into many activities of the IfA. Students are represented on several IfA committees, including the Admissions and Qualifying Exam committees as well as the important Time Allocation Committee, which reviews all requests for observing time on the Mauna Kea telescopes. Students make up a substantial fraction of the audience at IfA colloquia and are encouraged, via a modest subsidy, to attend post-colloquium dinners with the invited speakers.

Student participation in research is evident from the number of students appearing in IfA press releases. For example, of the eight research-oriented press releases issued by the IfA since January 2004 (see http://www.ifa.hawaii.edu/info/press-releases/), four (50%) mention present and former students by name. In many cases the results described are part of the student’s dissertation, showing that IfA students perform groundbreaking research. Some releases highlighting student work include the widespread detection of protoplanetary systems around other stars, the discovery of several new moons of Jupiter, and a record-breaking observation of the most distant galaxy known.

In a fast-moving field like astronomy, rapid publication of research is essential. We strongly encourage students to publish new results as soon as possible. Many of the research projects students undertake in their first two years result in publications. Almost all PhD dissertations contain one or more chapters based on papers already published or submitted for publication. In 2004, the most recent year for which data are available, some 18 different IfA graduate students – about two-thirds of the students enrolled in our program – were listed as authors on 29 papers published in refereed journals.

Student participation in conferences is the norm in our program. Most grant applications from the IfA requesting support for graduate students include budget items for travel to the mainland, Europe, or Asia on
an annual basis. Many of our students attend meetings on topics related to their research work, where they often give short oral or poster presentations. Students approaching the end of their dissertation research and entering the job market usually go to one or more meetings of the American Astronomical Society, where they present longer talks on their research. These presentations often result in publication in non-refereed conference proceedings, in addition to the refereed publications reported above.

7 Tracking students after graduation

We have current data on more than 90% of our graduates (see (http://www.ifa.hawaii.edu/gradprog/alumni-alpha.htm) for a list of current positions). Over 85% of our PhD alumni and over 50% of our MS alumni are currently actively employed as astronomers or physicists in universities, observatories, or government laboratories. Most of the remainder are working in the information and communications industries.

8 Use of assessment data

Assessment data and feedback from students has been instrumental in developing the IfA’s graduate program. The Fundamentals of Astrophysics course was created after assessments showed that incoming students sometimes lack background knowledge of physics needed for research in astronomy. Positive assessments and strong student interest also led us to introduce the Active Galaxies, General Relativity, Astrobiology, and Star Formation courses. Course evaluations and evidence of learning inform teaching assignments. Results from the independent research projects and the Qualifying Exam are considered in shaping these components of the program; for example, recent assessments and comments from students suggest that evidence of independent research ability should be given more weight in advancing students toward PhD candidacy. In summary, the IfA’s graduate program constantly evolves as the field of astronomy develops; student assessments are crucial in guiding this process.