

# **Department of Astrophysical & Planetary Sciences Comprehensive Examination Guidelines**

**Revised: 2021-22 Academic Year**

The Department of Astrophysical & Planetary Sciences (APS) graduate Comprehensive Examination is designed to evaluate a Ph.D. candidate's ability to carry out semi-independent research. The Comprehensive Examination also encourages students to develop skills in written communication, oral presentation, and time management. The exam consists of a written research paper, a presentation of that research, and an oral examination. The paper and presentation should represent an original contribution to the field of study, while the oral examination shall include topics from their research project as well as broader topics from the relevant fields of physics and astrophysics. The exam is typically taken during the student's fifth semester in APS. Successful completion of the Comprehensive Examination is a key milestone in the student's advancement to doctoral candidacy.

This document provides an outline of the objectives and guidelines for APS students taking the Comprehensive Examination, as well as their committee members. This document assumes that students have successfully completed the APS core courses, in accordance with the revised Preliminary Examination (formerly Comps-1) guidelines formalized during the Spring 2020 semester.

## **I. Structure and Topics**

A) The APS Comprehensive Examination (formerly Comps-2, hereafter Comps) has three components: a written paper describing the student's research project, an oral presentation to an examination committee (including a presentation closed to the public, if desired by the student), and a closed oral examination.

B) The Comps paper and presentation should describe the work carried out as part of an individual research project, conducted primarily by the student, typically under the mentorship of a research advisor in the Boulder area (APS faculty, CU research staff, or local scientist; e.g., NIST, SwRI, NSO, etc).

C) The Comps exam must be completed by October 31 in the student's 5th semester in APS. Requests for exemptions to the above date, under special circumstances, should be submitted in writing to the APS Chair. Graduate school rules require all Comps exams to be completed by four years from matriculation into the APS graduate program.

D) The student is encouraged to identify their Comps research advisor by the beginning of their 4th semester and notify the Graduate Program Assistant via email.

## **II. Paper and Presentation Guidelines**

A) The research paper should represent an original contribution to the field of study, not necessarily related directly to the student's intended doctoral dissertation subject. The paper should provide relevant background material, a discussion of methodology and results, and should make clear the contribution of the student to the original work presented. The student is encouraged to present a paper that is suitable for publication in a refereed journal in the field of study, or will be, following post-Comps and collaborator revisions. There is no formal requirement on the length or format of the Comps research paper.

B) The student is recommended to submit their research paper to their committee 2 weeks prior to the exam, but this may be reduced to 1 week before the exam with the approval of the exam committee in the case of extenuating circumstances.

C) The presentation should be approximately 30 to 45 minutes in length, and the student should anticipate some limited questions during the talk, a few minutes for general audience questions after the talk, followed by a closed-door oral examination (see Section III) with their committee. The student is responsible for selecting and reserving the time and venue for the presentation (the presentation + oral examination is typically scheduled for a two-hour window), in consultation with their committee and APS scheduling availability.

## **III. Oral Examination Guidelines**

A) The closed oral examination will focus on topics presented in the paper or presentation, related topics in the field of study, and shall address qualitative and quantitative questions on broader topics in physics, astrophysics, planetary, solar, and space physics as appropriate (see [graduate school requirements](#) for a Comprehensive Examination). These questions may cover, e.g., topics in physics and astronomy that are related to the research project, background material presented in the student's project introduction, or physical processes examined as part of the research project. The oral exam may include questions on additional related topics, including but not limited to, research methods, statistical and computational analysis, error analysis, and future work.

B) All members of the Comps examination committee, including the research advisor, are encouraged to participate in the oral examination and ask questions to the student. The non-advocate chair determines the protocol (in consultation with the rest of the committee) for how the questioning is to be carried out. In order to test the student's knowledge of a broad range of relevant topics in physics, astrophysics, planetary, solar, and space physics, the Examination Committee member can choose to focus part of the oral examination on topics beyond the immediate details of their research project.

C) The Comps examination is not meant to duplicate the final exams in the APS core courses. Its goal, as summarized above, is to test the student's ability to do original research and the student's broader knowledge of their field. Thus, the most specific and in-depth questions are usually more closely related to the research project itself, and questions less tied to the project tend to become broader in nature. For example, after presenting a project involving spectroscopy and radiative transfer, a student may be expected to answer questions about the definition of the Planck function or the concept of optical depth.

D) The closed oral examination has a duration of approximately 30 to 60 minutes.

#### **IV. Committee Make-Up**

A) A Comps examination committee must conform to [grad school rules](#) for both the masters final and the doctoral comprehensive exams. The Comps committee shall have five or six members, including the student's Comps project research advisor and a non-advocate chair, which cannot be the same person. The primary roles of the non-advocate chair are to meet with the student to discuss their project and examination expectations, mediate miscommunications or disagreements between the student and the advisor during the research phase, and act as the impartial referee during the presentation and oral examination. The non-advocate chair must be rostered in the APS department. Rostered faculty consist of all individuals who hold the rank of Professor, Associate Professor, Assistant Professor, and Senior Instructor in APS. It is the role of the research advisor and/or non-advocate chair to work with the student to identify relevant subject matter experts to sit on the committee. It is the student's responsibility to initiate these discussions and contact the committee members.

B) A minimum of three of the committee members must be rostered in the APS department or hold the position of APS research or emeritus faculty. Potential committee members who are neither rostered nor research or emeritus faculty can be granted graduate faculty appointments within the graduate school to sit on the committee. The student should contact the graduate program advisor to arrange these appointments at least 4 weeks in advance of the presentation.

C) It is strongly recommended that the members of the committee are not all from the same research institute or center. Similarly, it is recommended that the committee contain one or more members from outside the specific field of the student's research project. Per the APS bylaws, all Comprehensive Examination Committees shall be approved by the APS Associate Chair for Graduate Studies.

D) The non-advocate chair should be selected by July 1st in the summer prior to the student's 5th semester in APS (and even during the student's 4th semester is advisable). It is strongly recommended that the full committee be assembled prior to the student's 5th semester in APS. The student is encouraged to convene a meeting with their non-advocate chair (and other members of their committee as available) to discuss their research topic, progress of the project, and expectations for the exam during the summer preceding the examination. The

student is also encouraged to send a copy of these guidelines to committee members who may not have served on a Comps examination committee before.

E) One member of each Comprehensive Examination Committee shall be a member of the APS Examinations Committee. The research advisor cannot serve the role of the Exams Committee member on the Comps committee. This is intended to increase uniformity across the oral examination component of the Comprehensive Exam.

## **V. Examination Criteria**

A) Following the examination, the student's performance in all three areas (written paper, presentation, oral examination) will be evaluated by all members of the committee. The student must be judged acceptable in all three areas to advance to candidacy. Being judged acceptable in one or two areas may be sufficient for the committee to recommend that the requirements for a Master's degree have been fulfilled. The committee will make a recommendation for a pass, a conditional pass, or a fail to the APS faculty. Conditional passes may require, for example, that the student take a certain course and pass with a certain minimum grade, revise and resubmit a portion of the research paper, etc.

B) Approval of the Comprehensive examination project will be made by a vote of the APS faculty, upon recommendation of the committee. The non-advocate chair will present the committee's recommendation to the faculty and the student's research advisor will be invited (by the non-advocate chair) to be present at the APS faculty meeting where the student's exam is discussed. APS faculty review will typically take place at the first faculty meeting following the student's Comps examination, which may be up to two weeks from the date of the examination. Pending the student's successful completion of the APS Preliminary Exam requirements and 30 course credit hours with grades of B- or better, this will mark the student's advancement to Ph.D. candidacy.

C) A student is permitted to take the Comprehensive examination twice. The first attempt at the Comprehensive examination must be made prior to the end of their fifth semester; deferring the first attempt beyond the fifth semester counts as a failed attempt. If a student fails the Comprehensive Examination, the Associate Chair for Graduate Studies will convene a meeting with the student, the research advisor, and non-advocate chair to discuss plans for a successful second Comps exam. The student must successfully complete the Comprehensive examination prior to the end of their fourth year in the program. If a student fails the Comprehensive examination twice, they will be dismissed from the APS graduate program.

D) The previous "high pass" recommendation is eliminated. Final decisions on pass, fail, or conditional pass are decided by faculty vote (see V.B above).