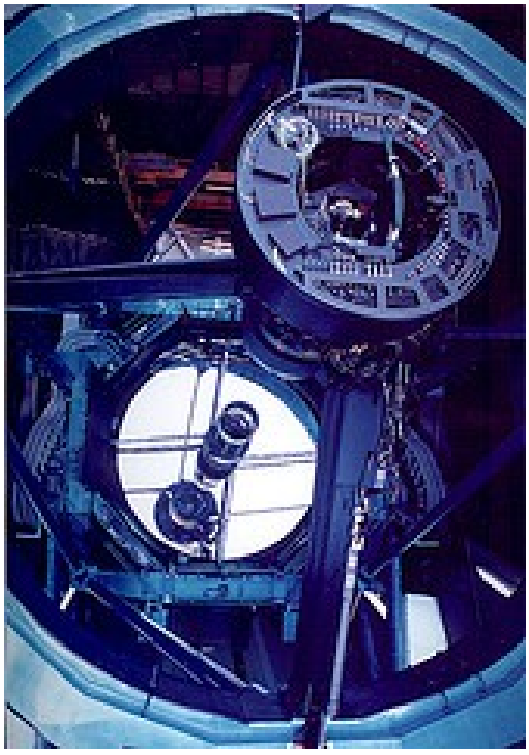
Independent Work in Astrophysical Sciences
Princeton University

Guide to Junior Independent Work and Senior Thesis
(Updated May 17, 2023)



The prime focus unit and primary mirror of Subaru telescope

Director of Undergraduate Program: Prof. Neta Bahcall
neta@astro.princeton.edu

Academic Program Administrator: Polly Strauss
pstrauss@astro.princeton.edu

Table of Contents

Astrophysical Sciences Undergraduate Program

Overview and Goals

The Department of Astrophysical Sciences offers an outstanding program for Astrophysics majors, with the flexibility to accommodate students with a broad range of interests. The main goal of our program is for our students to become successful scientists, researchers, science educators, or follow other directions of interest in science such as science policy, space exploration, data science, hi-tech, and more. Our program offers a flexible choice of courses and research projects that can smoothly accommodate the student's goals. Many of our majors continue in graduate school in Astrophysics at top universities around the country and the world. Some of the students continue in other directions as mentioned above. A small number of students decide to continue their careers in yet other directions such as law, medicine, finance, and teaching. The training they obtain in our program in quantitative methods, problem solving, computational methods, and critical scientific thinking helps them in these endeavors.

Our program consists of two components: our students need to take advanced courses in Astrophysics, Physics, and Math; and they carry out three Independent Research Projects: two Juniors Projects and one year-long Senior Thesis. These projects are generally original research in Astrophysics carried out by the student under the supervision of a faculty member. All major fields of Astrophysics are available to our students and are practiced by our scientists — from planets, to stars, black holes, galaxies, quasars, dark matter, dark energy, and the evolution of the Universe from the Big Bang to today. The relatively small size of the department provides an informal, flexible, and friendly setting for students. The department is known for providing strong and supportive mentorship to all students, for cutting-edge independent research done by our students for their Independent Research Work, and for its warm and amiable atmosphere. Full accessibility to all faculty members and to the excellent departmental facilities, including our on-campus and remote telescopes and sophisticated computer system, is provided.

Research in Astrophysical Sciences

The Astrophysics program is known for its excellence in research and in teaching. Our Majors – typically 15 to 25 students -- have access to some of the most advanced observational and computational facilities in the world for research in Astronomy and Astrophysics. The program is described on our Departmental website at https://web.astro.princeton.edu/academic/undergraduate-program. Follow the links on the left to find out more about the program.

Introduction for Freshmen and Sophomores

What is Astrophysics? Why Study Astrophysics?

The study of Astrophysics -- understanding the universe we live in -- has been an exciting field of exploration for centuries. How big is the universe? How did it start and what is

its fate? What's out there in deep space? What are the stars and galaxies made of? What makes them shine? Are there other planets in the universe and, if so, how many? These fundamental questions have occupied people thoughts for generations in attempt to uncover the mysteries of the universe. Remarkable discoveries have been made in Astrophysics in recent years and decades ranging from the Big-Bang and the early stages of the universe, to measurements of the structure in the universe, to the existence of Dark Matter and Dark Energy, the discovery of Black Holes, and the discovery of planets around other stars. These discoveries have provided some answers to these fundamental questions. The new discoveries have also produced new fundamental questions: What is the nature of the Dark Matter and the Dark Energy? How do planets form around stars? How does life form on planets (the new field of Astro-biology)? How do massive blackholes form? And more.

Observations needed to probe the universe and answer these questions are carried out mostly with telescopes, not only the familiar ones sensitive to optical light rays, but also with instruments designed to receive radio waves, X-rays, and Gamma-rays. Within the solar system, astronomers use space probes. The vast amount of observational detail obtained with these techniques is then interpreted by means of the basic laws of physics. Especially in recent decades, the new tools of radio telescopes on the ground and X-ray, optical, and ultraviolet telescopes in space have permitted us to make the startling discoveries about the heavens mentioned above. In addition, we know, for example,of dense stars that consist almost entirely of neutrons, with the same amount of material as in the sun compressed into a sphere only a few miles in diameter, with a resultant density of millions of tons packed into each cubic inch. We find even smaller, more massive, objects -- black holes -- whose gravitational attraction is so great that any light waves from the surface cannot escape but are attracted back. We find that most galaxies contain a supermassive black hole, of many millions solar masses, at their cores. Gigantic explosions of stars within individual galaxies -- supernovae and Gamma-Ray bursts -- have been found to radiate as much light as billions of suns. Such explosions have been detected in systems as far out as nearly the edge of the accessible universe, where stellar systems are moving away from us at close to the speed of light, and from which the light rays we now see were emitted billions of years ago when the universe was much younger. The Cosmic Microwave Background radiation – a 2.7K degree radiation that is a remnant of the hot Big-Bang some 14 billion years ago – has been measured in detail. This radiation is remarkably uniform. However, on top of this highly uniform distribution, the tiny fluctuations that provided the seeds for galaxy and structure formation in the early universe have been detected and carefully mapped– a discovery of great importance for understanding how the structure we see today formed. While such discoveries are fascinating in their own right, they cast light on the fundamental questions that people have been asking since the dawn of mankind about the hidden nature of our universe.

We explore these properties of the universe in our department of Astrophysical Sciences. The undergraduate program in Astrophysics is flexible and is open to a broad

range of student interests -- from those interested in continuing their science education in Astrophysics graduate schools to those interested in fields such as science policy, science education, space-science program, astro-biology, as well as students who plan to go into data science, high-tech industry, finance, law, and medicine. For those who are fascinated by the prospectof contributing to the search for the universe's hidden secrets, the rewards of our Astrophysics program are great.

The Astrophysics Program: Overview

Our program consists of two components, course work and independent research projects under the close supervision of a faculty member. The course work is designed to give a solid background in the relevant areas of Physics, Astrophysics, and Math and to survey several of the currently most active areas of Astrophysics research. We place a particularly strong emphasis on the independent research component, which allows students to carry out cutting-edge research in Astrophysics and to gain a working experience of what it is like to do professional Astronomical research. The goal for the independent research work is for the students to learn how to carry out original research projects that contribute to our knowledge about the Universe. This independent work has numerous extended goals, including for students to learn the scientific method, learn how to conduct cutting-edge research, learn quantitative thinking and problem solving, develop originality in the conduct of research, and learn data-analysis and computational skills as well as independent thinking and intimate understanding of the scientific topic they investigate.

A measure of our success is that a substantial fraction of our graduating seniors have co-authored one or more scientific papers published in the astronomical literature as a result of their junior paper or senior thesis work. Another measure of our program's overall effectiveness and, perhaps more importantly, of the quality of the students at Princeton, is the remarkable success our students have achieved in their graduate school applications and jobs they follow. Our graduates go to graduate schools such as Berkeley, Cal Tech, Chicago, Cornell, Harvard, Johns Hopkins, Santa Cruz, Yale, and other top schools. Many of our students are winners of honorific fellowships. Needless to say, our program is a rigorous one, intended to challenge and serve the first-class students that Princeton regularly attracts.

In addition to the scientific excellence of the department, its relatively small size allows for an informal atmosphere and a highly accessible faculty, both of which are greatly enjoyed by our majors. Our program provides outstanding personal mentoring to the students, a family-like atmosphere, and is flexible and adaptive to the student needs and future plans.

Opportunities for Hands on Research

Princeton is part of the Sloan Digital Sky Survey, the largest survey ever done of the universe. The SDSS is a multi- institution collaboration to map the universe in three-dimensions by obtaining digital images of the entire northern high-latitude sky and

measuring redshifts of one million galaxies. Princeton students and faculty have used the Sloan Survey to make exciting fundamental discoveries -- such as the discovery of the most distant quasars known in the universe and the coolest known stars. Undergraduate majors are working on the scientific analysis from this unique and exciting survey and participate in its discoveries.

Princeton has partnered with the Japanese and Taiwanese astronomical communities to use the Hyper-Suprime Camera (HSC) on the 8.2-meter Subaru Telescope in Hawaii to carry out comprehensive surveys of the sky. This project, which is currently operating, will be the deepest wide survey of galaxies until the Rubin Large Synoptic Survey Telescope comes on line. Princeton faculty and students are using the HSC data to trace the evolution of galaxy properties with cosmic time, measure the gravitational distortions of galaxies to map the distribution of dark matter, and search for distant quasars.

Princeton is and has been a leading partner in major cosmology experiments, the Wilkinson Microwave Anisotropy Probe (WMAP) and the Atacama Cosmology Telescope (ACT). WMAP measured temperature and polarization of the Cosmic Microwave Background fluctuations across the whole sky. The ACT experiment measures a large patch of the Southernsky with 10 times the resolution of WMAP. Both the physics and astronomy departments are active in research in cosmology. Princeton is also the lead institution for the Southern Cosmology Survey. Undergraduates who are part of this program will have the opportunity to do research in either South Africa or Chile.

Princeton is one of the three main centers of a large international collaboration using the Japanese Subaru 8.2-meter telescope located in Hawaii to study massive young exoplanets and circumstellar disks, both those from which planets form and those which co-exist with older planetary systems, by direct, high-contrast imaging. The other major centers are the National Astronomical Observatory of Japan and the Max-Planck-Institut fur Astronomie (Heidelberg, Germany). This is an extensive observational survey of nearby and young stars to produce views of the circumstellar environments of nearby stars of unprecedented sensitivity, contrast and sharpness.

HATNet is a network of wide-field, fully automated telescopes in Arizona and at Hawaii, monitoring selected areas on the sky to search for transiting extrasolar planets. These planets, by fortuitous alignment, orbit their host stars in such a way that they periodically transit across the face of their stars, causing the star-light to dim. The HATNet telescopes have been very successful in detecting the signatures of transiting exoplanets. To date, we have discovered and confirmed many dozen new planets, and measured the basic properties of these planets with good accuracy (mass, radius, orbital period, temperature, alignment). These discoveries have shown an amazing diversity of remote worlds, planets ranging from the mass of Neptune to 10 times that of Jupiter.

A related project is HATSouth; the world's first network of automated and homogeneous telescopes that is capable of year-round 24-hour monitoring of positions over an entire

hemisphere of the sky. HATSouth employs six telescope units spread over three prime locations with large longitude separation in the southern hemisphere (Chile, Namibia, Australia). HATSouth discovered new planets with an increasing rate of discovery of many additional planets.

Princeton is a major participant in the important Rubin Large Survey of Space ad Time (Rubin LSST survey) that is currently being build. This survey is the next big step beyond the SDSS survey, exploring the universe to much greater depth as well as time-variability (time-domain astronomy). Our students will become active participants in the survey, analyzing a broad range of scientific data from this extensive survey, including galaxy properties and their evolution with time, gravitational lensing, dark matter, dark energy, super-massive black-holes, quasars, stellar astronomy, time-domain astronomy, and more.

For more details see:
https://web.astro.princeton.edu/research

Description of the Undergraduate Program in Astrophysics

I Course Prerequisites & Requirements

II Independent Research (Juniors Projects, Senior Thesis)

I. PREREQUISITES: Students interested in majoring in astrophysics are required to complete the following courses *during their 1st and 2nd year:*

Physics 103 or 105:	Classical Mechanics
Physics 104 or 106:	Electromagnetism
Physics 207:	Advanced Mechanics
Astrophysics 204:	Topics in Modern Astronomy
Mathematics 103 and 104:	Calculus
Mathematics 201 or 203 or 218:	Advanced Multivariable Calculus
Mathematics 202 or 204 or 217:	Linear Algebra

REQUIRED COURSES: Eight upper level courses are required for completing an Astro major.

(a) Students should complete *at least three* out of the following courses:

Astrophysics 301:	General Relativity
Astrophysics 303:	Deciphering the Universe: Research Methods in Astrophysics
Astrophysics 309:	Science and Technology of Nuclear Energy: Fission and Fusion
Astrophysics 401:	Cosmology
Astrophysics 403:	Stars and Star Formation

(b) Students should complete three of the following courses:

Physics 208:	Principles of Quantum Mechanics
Physics 301:	Thermal Physics
Physics 303:	Advanced Dynamics
Physics 304:	Advanced Electromagnetism
Physics 305:	Quantum Mechanics

(c) Students may select among the following - or other - courses to complete theireight required courses:

Physics 312:	Experimental Physics
Physics 403:	Mathematical Methods of Physics
Physics 408:	Modern Classical Dynamics
MAE 305/MAT 391:	Mathematics in Engineering I (ODE's)
MAE 306/MAT 392:	Mathematics in Engineering II (PDE's)
MAT 330:	Complex Analysis with Applications
GEO 361:	Earth's Atmosphere
GEO 320:	Geophysics
GEO 367:	Modeling the Earth System: Climate Change
MAE 341:	Space Flight

And other upper-level science or math courses

(d) Other course selections or replacements allowed with departmental approval.

Recommended Courses in addition to the above:

COS 126, 217, 226:	Computer Science and programming (highly recommended)
Physics 209:	Computational Physics Seminar
ORF 309/MAT 380:	Probability and Stochastic Systems

II. Junior Papers and Senior Thesis

Research/Advising: Junior Papers (Fall and Spring) and Senior Theses in Astrophysics represent original research work done by the student in collaboration with a faculty or research adviser. The work ranges from observational astronomy and data analysis to theoretical and computational astrophysics. All topics in astronomy and astrophysics are covered from planets, stars, and the interstellar medium, to galaxies, quasars, large-scale structure of the universe, dark-matter, dark-energy, black-holes, cosmology, the microwave background, and the early universe. These topics can be carried out both theoretically and observationally. The Astro Majors have a choice on what topic they wish to work for each of their JPs and ST. Typically, each student will discuss possible choices with the Director of the Undergraduate Program, Prof. Neta Bahcall, at the beginning of each term; Prof. Bahcall will advise the students of various possibilities and direct each student to discuss potential projects with a couple of faculty and researchers in the department. The student then selects the topic that most excites them. This is repeated for each of the JPs and for the Senior Thesis.

The department allows students to carry out a JP or a Senior Thesis in another department if relevant and appropriate for the future directions and goals of the student. Some of our students have carried out a JP or a ST in departments or topics such as Physics, MAE,

Philosophy, the WWS, Science Education, and more. A student should discuss such possibilities with the Director of the Undergraduate Program in our department.

Astro Faculty Research Topics: https://web.astro.princeton.edu/people/astronomy-faculty
(by professor's name to bio/astrophysics expertise)

Faculty Research: https://web.astro.princeton.edu/research
(by astrophysics topic to professor's name)

Format: The students summarize their research results in a Junior Paper written each semester, and in a Senior Thesis written at the end of Senior year. The Junior Papers and Senior Thesis publications are similar to scientific papers published in professional journals; i.e., they should contain a concise abstract, a comprehensive introduction that reviews the general topic (more extensive than a typical publication), followed by presentation of the work itself -- the data or theory used, the analysis methods, the results, and the main conclusions. Figures, plots, tables are all expected in the paper.

Formatting Requirements for the Thesis

There are certain guidelines that must be followed when preparing the copies that will be turned in. These guidelines have been developed as a response to certain legal requirements regarding copyrights as well as administrative needs for processing the thesis.
The requirements for preparing the thesis are as follows:

Sample Title Page:

TITLE OF YOUR SENIOR THESIS OR JUNIOR PAPER

Your Full Name

A SENIOR THESIS PRESENTED TO THE FACULTY
OF PRINCETON UNIVERSITY
IN CANDIDACY FOR THE DEGREE
OF BACHELOR OF THE ARTS

RECOMMENDED FOR ACCEPTANCE
BY THE DEPARTMENT OF
ASTROPHYSICAL SCIENCES

Adviser: Your Adviser's Full Name

Date of Submission

Template for Papers/Thesis Title Page:
https://web.astro.princeton.edu/academic/undergraduate-program/resources

The second page should contain the following statements:

I hereby declare that I am the sole author of this thesis.

I authorize Princeton University to lend this thesis to other institutions or individuals for the purpose of scholarly research.

(your signature)
(your name)

I further authorize Princeton University to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

(your signature)
(your name)

Other thesis formatting requirements:

- formatted one and one half spaced or double spaced, with the exception of footnotes and bibliography which should be single-spaced
- font size should be between 10 and 12 point.
- left hand margin should be 1 1/2 inches to allow for binding; all other margins should be 1 inch.

Many of the Astro JPs and STs are eventually published as scientific papers in professional journals. Examples of recent Astrophysics JPs and Senior Theses are provided on our website at:

https://web.astro.princeton.edu/academic-programs/undergraduate-program/jps-senior-theses-senior-thesis-defenses-and-grading

Advising

Each Astrophysics major is assigned a Fall JP adviser, a Spring JP adviser, and a Senior Thesis adviser. The Director of Undergraduate Program provides overall advising for all the students. Each adviser meets regularly with their student, typically on a weekly basis (or more frequently as needed). The adviser discusses with the student the science project, the goals of the research, and how to conduct it (whether observational, data analysis, computational, or theoretical), how to search the scientific literature for references and related publications, how to perform the research, interpret and understand the results, and help the student think about the next steps needed in the research. The research itself is done fully by the student (i.e. Independent Research); the adviser serves in an advising role only. The project is original research; that is, it has not been carried out previously, and there is no answer known ahead of time to the scientific question posed.

The Office of the Dean of the College provides a website "Academic Success at Princeton" listing academic resources designed to enhance approaches to research, writing, and problem-solving: https://www.princeton.edu/academics/advising

Dean of the College sends memo midway through each term regarding instructions for Students in Academic Difficulty. Deans, Directors of Studies, and departmental faculty members work together to encourage and support students regarding time managements, study skills, and availability of tutoring and review sessions.

The McGraw Center for Teaching & Learning: Useful Handouts and Study Strategies

https://mcgraw.princeton.edu/undergraduates/resources-handouts-and-advice

Thesis Submission Deadline and Requirements:

Drafts:

All students are requested to provide drafts of their JPs and STs to their advisers before the deadline (a couple weeks prior to the deadline) in order to receive comments and improve their papers. Format and procedure is decided by the adviser and student.

Final Thesis:

The department needs **one** bound copy of your final thesis for the Lewis Library. A PDF copy is submitted directly by the student to the university archives and to our Astrophysics Academic Administrator.

The department deadlines for both JPs and Senior Thesis are the University deadline. No extension beyond the university deadline can be made without approval by the Dean

Juniors and Seniors:

Please provide Polly Strauss with an electronic copy of yourfinal paper (JP and ST) by the relevant university deadlines.

Timeline

Junior Independent Work and Senior Thesis Submission: by the University deadline
Senior Departmental Examinations: During University Senior Department Exam period

Funding

There are two opportunities to apply for student research funding from The Office of the Dean of the College (ODOC): In the spring of junior year, rising seniors may apply for funding to support senior thesis research to be conducted during the summer; in early fall of senioryear, students may apply for funding for research to be conducted over fall semester, winter break or intercession. For additional information and application process:

https://undergraduateresearch.princeton.edu/funding/thesis-funding

Current juniors are eligible to apply for funding from ODOC; students may access the application through the Student Activity Funding Engine (SAFE).

https://studentfunding.princeton.edu/

Research and Writing Resources

Princeton Writing Program: Junior Independent Work Handbook: https://writing.princeton.edu/sites/writing/files/jphandbook.pdf
Princeton Writing Program: https://mcgraw.princeton.edu/
Princeton Writing Program: https://writing.princeton.edu/
The McGraw Center for Teaching and Learning: https://mcgraw.princeton.edu/
The University Library: https://library.princeton.edu/
Seeley G. Mudd Manuscript Library: https://rbsc.princeton.edu/mudd
The Educational Technology Center: https://mcgrawect.princeton.edu/
Academic Integrity at Princeton: https://odoc.princeton.edu/curriculum/academic-integrity
Astrophysical Sciences Department: other useful information: Academics, Library, Computers, Offices, Astro Calendar: https://web.astro.princeton.edu/events
Center for Career Development: https://careerdevelopment.princeton.edu/
Campus Life: https://campuslife.princeton.edu/

Grading of Junior Independent Research Work and Senior Theses

Advisers of JPs review the work of their student and his/her JP as follows: you provide Prof. Bahcall with a recommended grade for the JP based on the grading guidelines posted on the website and provided below; we then follow with a meeting of all the JP advisers and Prof. Bahcall to review and discuss the recommended grades before obtaining the final JP grade in order to ensure consistency across the department. Senior Theses are reviewed and graded by the Senior Thesis Committee for each Thesis. The Committee follows the grading guidelines established by the department, as listed below.

Grading Guidelines

A+ Exceptional. The student has significantly exceeded the highest expectations for undergraduate work. The student has shown a high degree of originality, independence, and understanding of the research projects and has produced important scientific results. The research write-up and content should be at the level of a refereed journal article, and it is expected that after additional work the JP/ST will be submitted for publication, by the student and adviser.

A Outstanding. The student met the highest standards for the assignment. The student research goes beyond simply "doing a good job". The student research reflects originality and independence, excellent understanding of the topic, and high-level of presentation. At this grade level, an ST should contain important scientific results. A JP should either contain important results or the student demonstrates exceptional development in mastering the tools of original research in astrophysics, as applied to an important problem. In either case, it is generally expected that the student will eventually appear as co-author on a likely refereed publication.

A- Excellent. The student research meets very high standards for the assignment. Between A above and B+ below.

B+ Very good. The student research meets high standards for the assignment. Student did what is expected at a very good level. At this level, student's research will exhibit problems in either science content, understanding, presentation, or independence, and will look like it could have been improved with more work. An ST should contain substantial contributions toward the solution of an important research problem, and a JP should either contain suchcontributions or demonstrate significant development in mastering the tools of original research in astrophysics.

B Good. The student research meets most of the standards for the assignment. The content, presentation,understanding, or independence of the student could stand some significant improvement.

B- The student work is more than Adequate. Shows some reasonable command of the material. The content, presentation, understanding, or independence of the student is more than adequate but less than good. The work may contain some conceptual or other

errors, andthe work may reflect adequate but not good understanding, originality or independence.

C+ Acceptable; The student work meets basic standards for the assignment.

C Acceptable; The student work meets some of the basic standards for the assignment.

C- Acceptable; The student work falls short of meeting basic standards in

several ways

D Minimally acceptable; lowest passing grade

F Fail. Very poor performance.

For students completing JP/ST in other departments the guidelines should be similar in spirit, but should take account of the different nature of the field.

Senior Thesis, Defense, and Departmental Evaluation

Seniors together with their advisers, select one additional reader for their theses; the two faculty (adviser plus one reader) will comprise the thesis committee.

Seniors:

-- please give a copy of your thesis to the two members of your committee;
-- please arrange a thesis defense date with your committee

The dates for the defense are usually within 1-2 weeks after the Thesis deadline. Pleasereserve a room for that time with Polly (for about 1.5 hours).

The **THESIS DEFENSE** is composed of three parts:

A. THESIS: 20 minute presentation by the Senior of the thesis (use PowerPoint or similar presentation). The Thesis grade will be decided by the committee based on the grading guidelines listed above.

B. THESIS DEFENSE: ~20 minutes questions by members of the committee on topics related to the thesis

The grade on the Thesis Defense will be decided by the committee based on the student presentation of the Thesis, the student answers to the questions on the Thesis, their general understanding of the Thesis topic and its execution, and their understanding of the broader Thesis-related topics.

A+ Student demonstrates outstanding knowledge, understanding, and presentation of the Thesis work,results, and the broader scientific topic.

A Student demonstrates excellent/very-good knowledge, understanding and

presentation of the Thesiswork, results, and broader scientific topic.

A- Student demonstrates very good (on above items); some misses in either the knowledge,understanding, or presentation

B+ good; some of the knowledge, understanding, or presentation could have been better

B some lack of knowledge or understanding of the project

B- more substantial lack of knowledge or understanding of the Thesis work and related topics.

C+- poorer understanding

C. ASTROPHYSICS COMPREHENSIVE

This is the third part of the final oral defense for seniors: 20 minutes of questions by the committee on general topics in astronomy and astrophysics. We generally recommend to the students to review F. Shu's introductory book in Astronomy, "The Physical Universe," or a comparable level textbook, as well as their class notes from their upper-level Astro courses.

The grade on this part of the exam does not appear on the student transcript; it is averaged together with the thesis defense into an overall "Senior Departmental Exam."

For this grade, the grading guidelines are equivalent to those listed above for the Thesis Defense, but of course apply to the student's general knowledge of Astrophysics

Advisers: Please provide Prof. Bahcall with three separate grades: Thesis grade; Thesis Defense grade (parts A & B above); and Astrophysics Comprehensive grade (part C above).

Other Useful Information for Astro Majors

Academic

It is imperative that each student verify their university and distribution requirements each term to ensure that all university distribution requirements are satisfied, as well as all the required departmental courses.

No student can graduate without fulfilling all the university distribution requirements.

Each Fall the Astronomy & Physics Departments organize a meeting with all our Seniors to discuss preparation for the Physics GREs, application to grad-schools, and related topics. Please plan to attend.

Library

Please see the Astrophysics Research Guide: and the Lewis Library website for descriptions of the resources and services available to you at Princeton University.

Contact Anya Bartelmann, Astrophysics, Mathematics and Physics Librarian, at abartelm@princeton.edu or 609-258-3150 with any questions. Her office is located on the second floor, Room 210, in the Lewis Science Library and you are welcome to stop by at any time!

Computers

If you should have a computer problem or question, please e-mail:
help@astro.princeton.edu
You will receive a response as soon as possible.

Offices

Rooms 29 and 30 are the Undergraduate offices.

The Astrophysics Calendar

Located on the Astrophysics Website summarizes Astro-related events:
https://web.astro.princeton.edu/events

Refrigerator and Microwave

Both are located outside of Room 33 (lower level) for everyone's use.

E-Mail

Check messages FREQUENTLY for announcements, lectures, and Astro events!E-mail messages to and from undergrads use: ugs@astro.princeton.edu

Other Undergraduate Research Opportunities

Undergraduate Summer Research Program (USRP)

Every summer, our department organizes the **Undergraduate Summer Research Program** (USRP), in which undergraduates carry out research projects under the supervision of faculty and postdoc advisers. Students who are selected for this paid nine-week internship program (similar to an REU program) can participate in projects with a range of levels of difficulty and sophistication; some even co-author research articles for peer-reviewed journals based on their summer research. The topics that undergraduate researchers have tackled in the past have spanned all of experimental, observational, and theoretical astronomy. Participating in the summer program is an excellent introduction to research in astronomy, and for students interested in majoring in astrophysics it is a greatway to learn whether this is something you would like to pursue for a career (many former participants have gone on to graduate school and to careers in astronomy and other sciences). For more information, visit
https://web.astro.princeton.edu/academic/undergraduate-summer-research-program-usrp

The program generally runs from mid- June through mid-August. You will be expected to be on campus during this entire period. As a participant in the program you will receive a stipend to cover on-campus housing and other living expenses.

If you would like to apply for the **Undergraduate Summer Research Program**, please submit an application as described on the USRP website.

The application deadline is typically in mid-February. We will make decisions in March. Please feel free tocontact the program organizers via email.

The Princeton Environmental Institute often sponsors internships over the summer months. For application details, visit the internship website:
https://environment.princeton.edu/undergrads/internships

Certificate Program
Program in Planets and Life

The Department of Astrophysical Sciences participates in the University Certificate Program in Planets and Life. This Program is an interdepartmental, multidisciplinary plan of study designed for students interested in these two fundamental subjects. The goal is for students to gain an understanding of the fundamental astrophysical, chemical, biological, and geological principles and engineering challenges that will guide our search for life in extreme environments on Earth and on other planets. The cooperating departments from which the Program in Planets and Life draws faculty and other resources include Astrophysics, Chemistry, Ecology and Evolutionary Biology, Electrical

Engineering, Geosciences, Mechanical and Aerospace Engineering, Operations Research and Financial Engineering, and the Woodrow Wilson School. For more information, please visit https://astrobiology.princeton.edu/

Departmental Kudos and Reputation

NAS Survey Ranks Princeton Astrophysics #1

The released NAS "Data-Based Assessment of Research-Doctorate Programs (http://www.nap.edu/rdp/) gave its highest rating to the Princeton University Astrophysics Department. Basing its ranking on 20 factors including publications per faculty member, citations per publication, percent faculty with grants and awards per faculty member, the NAS survey has assessed over 5000 programs in 62 fields. In astrophysics, the NAS ranked 34 graduate programs and gave its top ranking (based on its S rating) to Princeton followed by Caltech, Penn State, UC Berkeley and U Chicago.

Princeton was top ranked in research activity, its level of student support, student outcomes, and in the number of awards per faculty member. Princeton astrophysics faculty (including Associate Faculty) includes 10 NAS members, 4 MacArthur Fellows and 2 winners of the Presidential Medal of Science.

What the Astro Students Say.
"Making MAJOR CHOICES"

https://odoc.princeton.edu/advising/choosing-major

Exploration, observation, and analysis of the large-scale universe around us are the object of modern astronomy. For students fascinated by the prospect of contributing to the search for the universe's hidden secrets, the study of astronomy is a rewarding major. The astrophysics program is flexible, moreover, and accommodates students with a broad range of interests. While many of our students plan to continue in graduate school in astrophysics, we offer a flexible choice of courses and research projects for students with other career goals, in areas such as science education, science policy, and space exploration, as well as law, medicine, finance, and teaching. We place a particularly strong emphasis on independent research, and a measure of our success is that a substantial fraction of our graduating seniors have co-written one or more papers published in the astronomical literature as a result of their independent work. In addition to the scientific excellence of the department, its relatively small size allows for an informal atmosphere and a highly accessible faculty, both of which are greatly enjoyed by our majors.

What is astrophysical sciences?

Astrophysics is basically the study of the universe we live in—from the tiniest grains of interstellar dust to galaxy clusters. If you have ever wondered what's out there, how did

the universe start, how big is it, are there other habitable planets, what are stars and galaxies made from, and how do we know all these things, anyways, chances are you will also find this a very interesting field.

What can you learn from it?

You'll learn a whole lot about the universe, as well as about how much we really don't understand at all about it (but hopefully your senior thesis will clear a few things up).

You will learn a whole lot of physics, mathematics, computer programming and general research skills, from taking courses but more importantly from all the research you will be doing.

What is it like being an astrophysical sciences major?

The astrophysics department is rather small and very informal, which makes it a great place to be an undergrad! Normally faculty outnumber undergraduate students, so when choosing a JP or thesis adviser, you simply stop by and chat with professors working on topics you are interested in. Both JPs and your thesis must be original research (no "reading projects" here), and undergrads frequently end up publishing some of their independent work. Seniors normally also present a poster at the American Astronomical Society meeting every year.

All undergrads get a workstation with a computer in one of the undergrad offices in Peyton, both very nice for independent work, and for getting to know and working with your fellow astro majors. Hey, you'll probably get to know most grad students too, and discover that they're nice people (and very useful when you're stuck on your research or homework). There's also tea and cookies every day at 3:30, very informal and another good way to meet the rest of the department.

What are common misconceptions about Astrophysical Sciences majors?

Since it is such a small department, many people aren't even aware that it exists. Well, it does, and it is awesome.

Many also aren't quite sure what the differences between being a physics and astrophysics major are. While we do take most core physics classes (except core lab), you also take at least three upper-level astro classes, and the requirements are somewhat more flexible. The biggest difference is probably that you get to do your independent work in a smaller department, and that all your independent work needs to be research. Some people also have the misconception that astrophysics is a very narrow and therefore limiting field—what on earth can you do with it, except more astrophysics? Well, while many people do go to grad school, we also have people doing science policy, teaching, journalism, consulting, finance and pretty much everything you can think of. The skills you will learn will be applicable to most disciplines, and firms tend to love astro majors.

What kind of internships and international experiences have majors had?

The astro department has a very good undergraduate research summer program, which is also a great way to get to know the department. Many people also do summer research programs elsewhere, in the States or abroad (recent examples including South Africa and Germany). It is not necessary to stay summer after junior year to start thesis research, but it is possible if you want a head start.

And of course, people who don't plan on continuing in research choose their summer internships accordingly, so we also have people doing finance, consulting, journalism and pretty much anything else over summer.

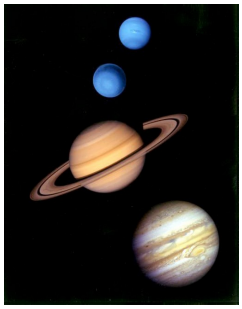
Spending a semester abroad is absolutely possible, but requires a bit of planning ahead if you want to go junior or senior year.

How will Astrophysical Sciences majors save the world?

First of all, we know that in a few billion years, the sun will run out of hydrogen in its core, expand into a red giant, and that will be the end of the Earth—sorry, there's no saving us from that. However, hopefully by then we will have discovered some new planet to live on and a way to get there. Meanwhile, we'll try our best to detect any asteroids, cosmic explosions or other things that might be bad for the world at the moment.

Why would anyone want to date an Astrophysical Sciences major?

We know where all the good spots for stargazing are :)



History of the Department of Astrophysical Sciences

https://web.astro.princeton.edu/about-us/history

Student Research Topics

For a list of student papers providing insight to the broad range of topics that are researched: https://web.astro.princeton.edu/academic/undergraduate-program/undergrad-research

If you have any questions, please contact us or visit our office.

Prof. Neta Bahcall Director of Undergraduate Program	137 Peyton Hall	609-258-6065	neta@astro.princeton.edu
Polly Strauss Academic Programs Administrator	4 Peyton Hall	609-258-3803	pstrauss@princeton.edu

May 17, 2023