ASTRONOMY–PHYSICS, BS

Astronomy, the oldest of the sciences, originated in the human urge to understand the mysterious lights we see in the sky above us — the Sun, the Moon, the planets, and the stars. Over the centuries, new tools have become available to study these cosmic icons — telescopes that allow us to see further and fainter, detectors that are sensitive to electromagnetic signals at non-visible wavelengths, and satellites that can observe from outside the confines of the Earth's atmosphere. These tools have answered many questions, but raised even more. How did the Universe begin, and how did the stars and galaxies within it form? How will it end? Are there habitable planets around other stars — and has life emerged on these planets?

CHOOSE TO BE AN ASTRONOMY-PHYSICS MAJOR

WHY STUDY ASTRONOMY?

- Because it's fascinating: Astronomy speaks directly to our natural urge to better understand our place in the cosmos.
- Because it's challenging: Astronomy studies objects that are distant beyond simple conception.
- Because it's adaptable: Astronomy utilizes a broad set of transferable skills, from a foundation in logical and quantitative reasoning through to data analysis, programming, and visualization.

The UW–Madison Astronomy–Physics program builds on a foundation of classical and modern physics, to embark on a comprehensive study of the observable Universe at scales extending from planets and stars, through to galaxies and the cosmic web.

A MAJOR IN ASTRONOMY-PHYSICS CAN...

- Prepare you for graduate studies for master's or doctoral degrees in experimental or theoretical Astronomy, Astrophysics or Physics.
- Prepare you for employment in industrial or governmental laboratories.
- Provide a broad background for further work in other sciences, such as materials sciences, aerospace, computer science, geophysics, meteorology, radiology, medicine, biophysics, engineering, and environmental studies.
- Provide a science-oriented liberal education. This training can be useful in some areas of business administration, public policy, law, or other fields where a basic knowledge of science is useful.
- Provide part of the preparation you need to teach Astronomy and Physics. To teach these subjects in high school, you will also take education courses to become certified. You will need a doctoral degree to become a college or university professor.

Students who intend to continue astronomy in a graduate program are strongly encouraged to get involved in research early. To learn about research opportunities in the department, please meet with faculty advisors. Please consider applying for Research Experiences for Undergraduates (REU's) and if interested in department research, visit our webpage (https://www.astro.wisc.edu/undergraduate-program/current-students/) and reach out to individual faculty. On our webpage you will find our Undergraduate Student Handbook as well as some of the current research projects.

OTHER PROGRAMS

PHYSICS

Students interested in the Physics major should contact the Physics Department (http://guide.wisc.edu/undergraduate/letters-science/physics/).

EDUCATION–ASTRONOMY

A student working toward the Bachelor of Science–Education degree may major or minor in Astronomy-Physics. Interested students should contact the School of Education (http://guide.wisc.edu/undergraduate/education/).

MEDICAL PHYSICS

A suggested curriculum for students interested in graduate study in medical physics is available on the medical physics webpage (https://www.medphysics.wisc.edu/graduate-program/admissions/#requirements).

HOW TO GET IN

HOW TO GET IN

Students who wish to declare the Astronomy-Physics may do so after arriving at UW-Madison (students cannot declare this major as part of their UW-Madison admissions process).

Students are encouraged to declare their major as early as their first year. For pre-major and major advising, students should contact the undergraduate advisor or faculty advisors.

Astronomy-Physics Majors should get started on one of the Introductory Physics sequences as early as possible.

Introductory Physics sequences are:

Code	Title	Credits
Sequence 1: PHYSICS 247, 248, and 249		
Sequence 2: PHYSICS 201, 202, and 205		
Sequence 3: PHYSICS 207, 208, and 241		

REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext) section of the *Guide*.

General Education	• Breadth—Humanities/Literature/Arts: 6 credits • Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits • Breadth—Social Studies: 3 credits • Communication Part A & Part B * • Ethnic Studies * • Quantitative Reasoning Part A & Part B *

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

COLLEGE OF LETTERS & SCIENCE DEGREE REQUIREMENTS: BACHELOR OF SCIENCE (BS)

Students pursuing a Bachelor of Science degree in the College of Letters & Science must complete all of the requirements below. The College of Letters & Science allows this major to be paired with either the Bachelor of Arts or the Bachelor of Science degree requirements.

BACHELOR OF SCIENCE DEGREE REQUIREMENTS

Mathematics	Complete two courses of 3+ credits at the Intermediate or Advanced level in MATH, COMP SCI, or STAT subjects. A maximum of one course in each of COMP SCI and STAT subjects counts toward this requirement.
Language	Complete the third unit of a language other than English.
L&S Breadth	Complete: • 12 credits of Humanities, which must include at least 6 credits of Literature; and • 12 credits of Social Science; and • 12 credits of Natural Science, which must include 6 credits of Biological Science and 6 credits of Physical Science.
Liberal Arts and Science Coursework	Complete at least 108 credits.
Depth of Intermediate/Advanced Coursework	Complete at least 60 credits at the Intermediate or Advanced level.
Major	Declare and complete at least one major.
Total Credits	Complete at least 120 credits.
UW-Madison Experience	Complete both: • 30 credits in residence, overall, and • 30 credits in residence after the 86th credit.
Quality of Work	• 2.000 in all coursework at UW–Madison • 2.000 in Intermediate/Advanced level coursework at UW–Madison

NON–L&S STUDENTS PURSUING AN L&S MAJOR

Non–L&S students who have permission from their school/college to pursue an additional major within L&S only need to fulfill the major requirements. They do not need to complete the L&S Degree Requirements above.

REQUIREMENTS FOR THE MAJOR

The major requires a minimum of 34 credits in the field of specialization, with at least 6 of these credits in ASTRON and at least 28 credits in PHYSICS.

COURSE REQUIREMENTS FOR THE MAJOR ARE:

Code	Title	Credits
Astronomy [1]		
Complete at least two of the following:		*6*
ASTRON 310	Stellar Astrophysics [2]	
ASTRON 320	The Interstellar Medium	
ASTRON 330	Galaxies [2]	
ASTRON 335	Cosmology [2]	
ASTRON 340	Solar System Astrophysics	
ASTRON 500	Techniques of Modern Observational Astrophysics [2]	
Physics		
Complete one of the following sequences for Introductory Physics: [3]		*28*
Sequence 1:		
PHYSICS 247 & PHYSICS 248 & PHYSICS 249	A Modern Introduction to Physics and A Modern Introduction to Physics and A Modern Introduction to Physics	
Sequence 2:		
PHYSICS 201 & PHYSICS 202 & PHYSICS 205	General Physics and General Physics and Modern Physics for Engineers	
Sequence 3:		
PHYSICS 207 & PHYSICS 208 & PHYSICS 241	General Physics and General Physics and Introduction to Modern Physics	
Mechanics, Electromagnetic Fields, Thermal Physics (complete all):		
PHYSICS 311	Mechanics	
PHYSICS 322	Electromagnetic Fields	
PHYSICS 415	Thermal Physics	
Atomic Quantum Physics (complete either):		
PHYSICS 448 & PHYSICS 449	Atomic and Quantum Physics and Atomic and Quantum Physics	
or		
PHYSICS 531	Introduction to Quantum Mechanics	
Complete one 300-level or higher laboratory course:		
ASTRON 465	Observational Astronomy and Data Analysis	

PHYSICS 307	Intermediate Laboratory-Mechanics and Modern Physics	
Additional PHYSICS to reach minimum of 28 credits		
Total Credits		**34**

RESIDENCE AND QUALITY OF WORK

- 2.000 GPA in all ASTRON, all PHYSICS, and all major courses
- 2.000 GPA on 15 upper-level major credits in residence[4]
- 15 credits in ASTRON and PHYSICS, taken on campus

HONORS IN THE MAJOR

Students may declare Honors in the Major in consultation with the Astronomy–Physics undergraduate advisor(s). Please plan your Senior Honors Thesis research project a year in advance.

HONORS IN THE MAJOR REQUIREMENTS

To earn Honors in the Major, students must satisfy both the requirements for the major (above) and the following additional requirements:

- Earn a 3.300 University GPA
- Earn a 3.500 GPA for all ASTRON and PHYSICS courses, and all courses accepted in the major, at the 300 level or higher
- Complete the following coursework:
  - Four 300-level or higher ASTRON courses, with a 3.500 GPA (not including ASTRON 681 and ASTRON 682)
  - A two-semester Senior Honors Thesis in ASTRON 681 and ASTRON 682, with a grade of AB or better (for a total of 6 credits).

FOOTNOTES

1 ASTRON 103 and ASTRON 104 are not required for majors.
2 ASTRON 310 is a prerequisite for ASTRON 330, ASTRON 335, and ASTRON 500.
3 E M A 201, E M A 202, and M E 240 count toward the 28 credits of PHYSICS requirement. E M A 201 & E M A 202, or E M A 201 & M E 240 count as a first semester, introductory course (e.g., PHYSICS 247, PHYSICS 201, PHYSICS 207).
4 ASTRON 300-699 and PHYSICS 300-699 are upper-level in the major.

UNIVERSITY DEGREE REQUIREMENTS

Total Degree	To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.
Residency	Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. “In residence” credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.
Quality of Work	Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

LEARNING OUTCOMES

LEARNING OUTCOMES

1. Learn how astronomical observations are made and data are analyzed.
2. Become familiar with theories and observations of planets, stars, interstellar gas, galaxies, and structure of the Universe (cosmology).
3. Learn how to read and critically evaluate scientific literature.
4. Learn the basics of oral and written scientific communication.
5. Be trained in principles and standards of professional and ethical conduct.
6. Develop the skills to carry out a small independent research project. Learn to define the scope of the project, conduct an effective literature search, perform computations, and analyze data.

FOUR-YEAR PLAN

FOUR-YEAR PLAN

This Four-Year Plan is only one way a student may complete an L&S degree with this major. Many factors can affect student degree planning, including placement scores, credit for transferred courses, credits earned by examination, and individual scholarly interests. In addition, many students have commitments (e.g., athletics, honors, research, student organizations, study abroad, work and volunteer experiences) that necessitate they adjust their plans accordingly. Informed students engage in their own unique Wisconsin Experience by consulting their academic advisors, Guide, DARS, and Course Search & Enroll for assistance making and adjusting their plan.

First Year

Fall	Credits	Spring	Credits
MATH 221 (QR-B)	5	MATH 222	4
Biological Science Breadth	3	Biological Science Breadth	3
Humanities Breadth	3	Social Science Breadth	3
Foreign Language (if needed)	4	Foreign Language (if needed)	4
		Communication A	2
	15		**16**

Second Year

Fall	Credits	Spring	Credits
PHYSICS 247, 201, or 207	5	PHYSICS 248, 202, or 208	5
MATH 234	4	Literature Breadth	3
ASTRON 200	3	Social Science Breadth	4
Foreign Language (if needed)	4	MATH 320[1]	3
	16		**15**

Third Year

Fall	Credits	Spring	Credits
PHYSICS 249, 205, or 241	4	PHYSICS 311	3
ASTRON 310	3	ASTRON 320 (or another ASTRON 300 level course)	3
MATH 321[2]	3	MATH 322[2]	3
Communication B	3	PHYSICS 322	3
		Literature Breadth	3
	13		**15**

Fourth Year

Fall	Credits	Spring	Credits
PHYSICS 448	3	Social Science Breadth	3
ASTRON 465	3	PHYSICS 449	3
Social Science Breadth	3	PHYSICS 415	3
Ethnic Studies	3	Humanities Breadth	3
Elective	3	Astronomy 300 Level OR Elective	3
	15		**15**

Total Credits 120

[1] Alternatively, students may wish to consider MATH 319 and MATH 340.
[2] Students are encouraged to consider MATH 321 and MATH 322 for additional preparation prior to coursework completed in the fourth year of this plan.

ADVISING AND CAREERS

ADVISING AND CAREERS

We encourage students to meet major advisors as early as possible. The undergraduate advisor, Evan Heintz (via Starfish), can assist students with curriculum and course scheduling, career planning, academic concerns, and overall performance and strategies.

To declare the astronomy–physics major, **first** meet with the Undergraduate Advisor, Evan Heintz (eheintz@wisc.edu), who will then put you in contact with the Faculty Advisors: Professor Ke Zhang (ke.zhang@wisc.edu (townsend@astro.wisc.edu)) or Professor Snezana Stanimirovic, (sstanimi@astro.wisc.edu).

ADVISING FOR SOAR STUDENTS

Email eheintz@wisc.edu if you have any questions. You may also use Starfish to schedule an appointment with him.

The Department of Astronomy encourages our majors to begin working on their career exploration and preparation soon after arriving on campus. We partner with SuccessWorks at the College of Letters & Science. L&S graduates are in high demand by employers and graduate programs. It is important to us that our students are career ready at the time of graduation, and we are committed to your success.

A good starting point to begin exploring possible careers is to enroll in PHYSICS 301 Physics Today. This course, offered in the spring semester, includes a weekly talk where a topic of local research is discussed by one of the physics faculty, astronomy faculty, or SuccessWorks.

RECOMMENDED ADDITIONAL COURSES

ASTRONOMY

It is recommended that students take ASTRON 200 at some point during the introductory physics sequence. This course serves as a good introductory basis for all areas of astronomy and will serve you well in your upper-level coursework. ASTRON 103/ASTRON 104 are not recommended for students planning to major in Astronomy-Physics.

MATHEMATICS

Specific math courses are listed as prerequisites for your Physics and Astronomy courses. We also recommend a few other math courses to best prepare you for your upper-level coursework.

MATH 221 Calculus and Analytic Geometry 1: A prerequisite for ASTRON 200, PHYSICS 247, PHYSICS 207, and PHYSICS 201.

MATH 222 Calculus and Analytic Geometry 2: A prerequisite for PHYSICS 247 but can be taken concurrently.

MATH 234 Calculus--Functions of Several Variables: A prerequisite for PHYSICS 248 but can be taken concurrently. If you are not taking the PHYSICS 247/PHYSICS 248/PHYSICS 249 intro sequence, you will still need this course for PHYSICS 311 and PHYSICS 322.

MATH 319 Techniques in Ordinary Differential Equations: Techniques for solving and approximating solutions to ordinary differential equations.

MATH 340 Elementary Matrix and Linear Algebra: An introduction to linear algebra. This course is a bridge between concrete and abstract math. You are strongly advised to take MATH 319 and MATH 340, or MATH 320 before PHYSICS 311 and PHYSICS 322.

MATH 320 Linear Algebra and Differential Equations: This course combines topics from MATH 319 and MATH 340. It is adequate for the rest of the undergraduate curriculum but is not recommended for students planning to continue to graduate school. There is an accelerated honors section that thoroughly covers all of the material in MATH 319 and MATH 340. It is more challenging but is a good way to fit in both topics if you are unable to take MATH 319/MATH 340 before you take PHYSICS 311 or PHYSICS 322.

MATH 321 Applied Mathematical Analysis: Techniques for solving problems in the physical sciences, engineering, and applied mathematics, using advanced calculus and analytic function theory. For students interested in more abstract math, taking MATH 521 would be equivalent. It is recommended that MATH 321 be taken before PHYSICS 322 but especially before you take either PHYSICS 448 /PHYSICS 531. Note that this course is a significant time commitment.

A typical math sequence is: MATH 221, MATH 222, MATH 234, MATH 319, MATH 340, MATH 321.

Please consult with an advisor when choosing your Mathematics courses. We do not recommend the honors sequence (MATH 375/MATH 376) unless you are considering majoring in Math as well.

COMPUTER AND DATA SCIENCE

Computers are fundamental to astronomical research. The most useful languages are Python followed by C or C++. The computer sciences

department offers introductory courses. The Division of Information Technology (DoIT) also offers short courses to introduce programming.

COMP SCI 220 Data Science Programming I is a good starting point since Python is a commonly used language in Astronomy research. Students may then wish to continue to COMP SCI 320 Data Science Programming II.

Students interested in data science and machine learning are also recommended to take PHYSICS 361 Machine Learning in Physics.

CHEMISTRY

A college course in physical or organic chemistry is useful for astronomy students. Physical chemistry is particularly valuable for those interested in the interstellar medium, comets, and planets.

STATISTICS

A background in statistics is valuable, particularly for students interested in observational astronomy. STAT/MATH 309 Introduction to Probability and Mathematical Statistics I/STAT/MATH 310 Introduction to Probability and Mathematical Statistics II are suggested.

L&S CAREER RESOURCES

Every L&S major opens a world of possibilities. SuccessWorks (https://successworks.wisc.edu/) at the College of Letters & Science helps students turn the academic skills learned in their major, certificates, and other coursework into fulfilling lives after graduation, whether that means jobs, public service, graduate school or other career pursuits.

In addition to providing basic support like resume reviews and interview practice, SuccessWorks offers ways to explore interests and build career skills from their very first semester/term at UW all the way through graduation and beyond.

Students can explore careers in one-on-one advising, try out different career paths, complete internships, prepare for the job search and/or graduate school applications, and connect with supportive alumni and even employers in the fields that inspire them.

- SuccessWorks (https://careers.ls.wisc.edu/)
- Set up a career advising appointment (https://successworks.wisc.edu/make-an-appointment/)
- Enroll in a Career Course (https://successworks.wisc.edu/career-courses/) - a great idea for first- and second-year students:
  - INTER-LS 210 L&S Career Development: Taking Initiative (1 credit)
  - INTER-LS 215 Communicating About Careers (3 credits, fulfills Comm B General Education Requirement)
- Learn about internships and internship funding (https://successworks.wisc.edu/finding-a-job-or-internship/)
  - INTER-LS 260 Internship in the Liberal Arts and Sciences
- Activate your Handshake account (https://successworks.wisc.edu/handshake/) to apply for jobs and internships from 200,000+ employers recruiting UW-Madison students
- Learn about the impact SuccessWorks has on students' lives (https://successworks.wisc.edu/about/mission/)

PEOPLE

PEOPLE

FACULTY

Amy Barger (Chair)
Thomas Beatty
Juliette Becker
Matt Bershady
Elena D'Onghia
Kate Grier
Sebastian Heinz
Alex Lazarian
Michael Maseda
Bob Mathieu
Snezana Stanimirovic
Zoe Todd
Rich Townsend
Christy Tremonti
Susanna Widicus Weaver
Eric Wilcots
Ke Zhang
Ellen Zweibel

STAFF

Undergraduate Advisor: Evan Heintz
Department Administrator: Steve Anderson
Graduate Program Manager: Heather Sauer
Research Administrator: Sophia Didier
Building Manager and Purchasing: Rick Williams

See preliminary and career advising (https://www.astro.wisc.edu/undergraduate-program/current-students/#preliminary-and-career-advising) for academic advising information.

WISCONSIN EXPERIENCE

WISCONSIN EXPERIENCE

THE ASTRONOMY CLUB

The Astronomy Club is a student organization for people interested in astronomy and related fields.

What does the Astronomy Club do?

The Astronomy Club organizes events such as seminars, tours, trips, and socials for its members. In addition to social events, they organize various events including a research symposium, REU and internship informational sessions, trips to observatories and labs, and even can help you start out doing some of your own astronomy research.

Why should you join the Astronomy Club?

By joining the Astronomy Club, you'll be meeting people who are just as enthusiastic as you are about the universe! Astronomy Club is a great way to find a community of people who can help you navigate through your time here at UW–Madison, whether you major in Astronomy-Physics or not.

To Join

Email the club officers at astronomyclubofficers@gmail.com to notify them of your interest. Then, just pay your annual dues to join.

RESOURCES AND SCHOLARSHIPS

Through the Physics Department, Astronomy-Physics majors may be eligible to receive a number of awards for undergraduate students each year. Many of these awards have been made possible through very generous donations by alumni and friends of the Department.

A list of all the undergraduate awards can be found on the physics website (https://www.physics.wisc.edu/department/awards/apply/).

APPLICATION PROCESS

Eligibility

- Must be enrolled as a full-time student at UW–Madison in both semesters of the Academic Year
- Must be an Astronomy-Physics (or Physics) major.

Applicants will be judged by the Student Awards Committee. You may apply for a specific award, but the Committee will consider all eligible applications for relevant awards. The Committee will review your transcript.

The call for applications is often sent out near the end of the fall semester with the deadline for applications often falling slightly after the beginning of the spring semester. The awards decisions will be made by the Awards Committee soon thereafter. Awardees will be notified and asked to attend the Physics Awards Banquet to be held at the end of the spring semester.

To Apply

Once the call for applications has been sent out, each applicant is to submit the following (in PDF) by the deadline via WiSH (https://wisc.academicworks.com/):

- Resume/CV
- Statement of current research/teaching activity and future plans as a physics major (one page)
- Letter of recommendation from a faculty or staff member (one page)
- Online application system will automatically prompt the letter writer to submit a letter
- If indicated below, a statement of need (one page)

FOR MORE INFORMATION

Please visit the Department of Physics Awards webpage (https://www.physics.wisc.edu/awards/) or contact the Department of Physics at info@physics.wisc.edu.