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, such as telescopes that allow us to see farther, detectors that are sensitive to electromagnetic signals at nonvisible wavelengths, and satellites that can observe from outside the confines of the Earth's atmosphere. These tools have answered many questions, and 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 THE ASTRONOMY—PHYSICS MAJOR BECAUSE:

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

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

RELATED PROGRAMS

L&S Physics major (https://guide.wisc.edu/undergraduate/letters-science/physics/physics-ba/) in the Guide

Medical Physics

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

HOW TO GET IN

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Requirements	Details
How to get in	No application required. All students who meet the requirements listed below are eligible to declare. For information on how to declare, visit Advising & Careers.
Courses required to get in	None
GPA requirements to get in	None
Credits required to get in	None
Other	None

Students declared in the Physics certificate may not be declared in the Astronomy-Physics major at the same time. Students who do wish to declare this major must first cancel their declaration in the Physics certificate.

Astronomy-Physics Majors should get started on one of the Introductory Physics sequences as early as possible. Context that informs a student's selection of an appropriate Introductory Physics sequence is available on the major's Advising and Careers page. Students can also consult with the major's advisor before enrolling in one of these sequences.

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 (https://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 39 credits in the field of specialization, with at least 12 of these credits in ASTRON and at least 25 credits in PHYSICS.

COURSE REQUIREMENTS FOR THE MAJOR ARE:

Code	Title	Credits
Astronomy		
Introductory Course [1]		
ASTRON 200	The Physical Universe	3
Complete at least three of the following:		*9*
ASTRON 310	Stellar Astrophysics	
ASTRON 320	The Interstellar Medium	
ASTRON 330	Galaxies	
ASTRON 335	Cosmology	
ASTRON 340	Solar System Astrophysics	
ASTRON 500	Techniques of Modern Observational Astrophysics	
ASTRON 540	Exoplanets	
ASTRON 620	Seminar in Astrophysical Topics	
Physics		
First Introductory Course (complete one): [2]		*5*
PHYSICS 247	A Modern Introduction to Physics (recommended)	
PHYSICS 201	General Physics	
PHYSICS 207	General Physics	
E M A 201 & E M A 202	Statics and Dynamics	
Second Introductory Course (complete one):		*5*
PHYSICS 248	A Modern Introduction to Physics (recommended)	
PHYSICS 202	General Physics	
PHYSICS 208	General Physics	
Third Introductory Course (complete one):		*3-4*
PHYSICS 249	A Modern Introduction to Physics (recommended)	
PHYSICS 205	Modern Physics for Engineers	
PHYSICS/ E C E 235	Introduction to Solid State Electronics	
PHYSICS 241	Introduction to Modern Physics	
Mechanics, Electromagnetic Fields, & Thermal Physics (complete all):		
PHYSICS 311	Mechanics	3
PHYSICS 322	Electromagnetic Fields	3
PHYSICS 415	Thermal Physics	3
Atomic & Quantum Physics (complete either):		
PHYSICS 448	Atomic and Quantum Physics	3
or PHYSICS 531	Introduction to Quantum Mechanics	
Complete one laboratory course:		*2-3*
ASTRON 465	Observational Astronomy and Data Analysis	
PHYSICS 307	Intermediate Laboratory-Mechanics and Modern Physics	
Total Credits		**39**

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 recommended for majors. Students intending to major should wait to take ASTRON 200 after completing their first introductory physics course or MATH 222.

[2] PHYSICS 247/PHYSICS 248/PHYSICS 249 is the introductory course sequence recommended for prospective astronomy-physics majors, PHYSICS 201/PHYSICS 202/PHYSICS 241 is recommended for engineers, and PHYSICS 207/PHYSICS 208/PHYSICS 241 is intended for life sciences and chemistry majors. Both PHYSICS 201/PHYSICS 202/PHYSICS 241 and PHYSICS 207/PHYSICS 208/PHYSICS 241 are suitable alternatives for physics majors. Although the department recommends following one of these sequences, students are allowed to mix them, with the exception that transfers into the PHYSICS 247/PHYSICS 248/PHYSICS 249 sequence are not permitted.

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

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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

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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
COMP SCI 220	4	Biological Science Breadth	3
Communication A	2	Humanities Breadth	3
Foreign Language (if needed)	4	Foreign Language (if needed)	4
	15		**14**

Second Year

Fall	Credits	Spring	Credits
PHYSICS 247	5	PHYSICS 248	5
MATH 234	4	PHYSICS 301	1
ASTRON 200	3	MATH 319[1]	3
Foreign Language (if needed)	4	MATH 340[1]	3
		Social Science Breadth	3
	16		**15**

Third Year

Fall	Credits	Spring	Credits
ASTRON 300+ Course	3	ASTRON 300+ Course	3
PHYSICS 249	4	PHYSICS 322	3
PHYSICS 311	3	MATH 321	3
Biological Science Breadth	3	Literature Breadth	3
Social Science Breadth	3	Communication B	3
	16		**15**

Fourth Year

Fall	Credits	Spring	Credits
ASTRON 465	3	ASTRON 300+ Course	3
PHYSICS 448	3	MATH 322	3
PHYSICS 415	3	Social Science Breadth	3
Social Science Breadth	3	Humanities Breadth	3

Ethnic Studies	3 Literature Breadth	3
	15	**15**

Total Credits 121

[1] Alternatively, students may wish to consider MATH 320 .

ADVISING AND CAREERS

ADVISING AND CAREERS

DECLARE OR CANCEL THE MAJOR

Follow the process described in the Department of Astronomy website. (https://www.astro.wisc.edu/undergraduate-program/prospective/)

We encourage students to meet major advisors as early as possible. The undergraduate advisor, Evan Heintz (via Starfish (https://wisc.starfishsolutions.com/starfish-ops/dl/instructor/serviceCatalog.html?bookmark=connection/38989/schedule)), can assist students with curriculum and course scheduling, career planning, academic concerns, and overall performance and strategies.

Astronomy-Physics Majors should begin an Introductory Physics sequences as early as possible. See the major's Requirements section for the options. The sequence of PHYSICS 247 + PHYSICS 248 + PHYSICS 249 is recommended. However, students who transfer in courses from one of the other sequences (most commonly the PHYSICS 207 sequence), may usually continue with other major requirements rather than restarting with PHYSICS 247. Please contact Evan Heintz, the academic advisor, to confirm which courses are best for you.

ADVISING FOR ADMITTED STUDENTS

Assistance choosing courses is available for students enrolling during Student Orientation, Advising, and Registration (SOAR (https://soar.wisc.edu)): contact Evan Heintz, eheintz@wisc.edu.

UNDERGRADUATE RESEARCH

If you are declared in the Astronomy-Physics major and are interested in pursuing a research position with a faculty member or scientist, please schedule an appointment (via Starfish (https://wisc.starfishsolutions.com/starfish-ops/dl/instructor/serviceCatalog.html?bookmark=connection/38989/schedule)) with the undergraduate advisor, Evan Heintz, who will discuss your interests and aid you in finding a position within the department.

CAREER EXPLORATION

A good starting point for exploring careers is PHYSICS 301 Physics Today. This course, offered in Spring semesters, includes a weekly talk where a research topic is discussed by one of the Physics or Astronomy faculty.

SuccessWorks has also created the extremely helpful "What Can You Do with Your Major" Skills & Outcomes Sheet (https://successworks.wisc.edu/what-you-can-do-with-your-major/). Check out the specific Astronomy-Physics sheet to explore the major's transferable skills, alumni job titles, frequent employers of the major and words of advice from alumni who have found success following their passions.

RECOMMENDED ADDITIONAL COURSES

Astronomy

Students are required to take ASTRON 200 The Physical Universe for the major. This course serves as a good introduction for all areas of astronomy. Due to this requirement, ASTRON 103 The Evolving Universe: Stars, Galaxies, and Cosmology and ASTRON 104 Our Exploration of the Solar System are not recommended for students planning to major in Astronomy-Physics.

Mathematics

Please consult with the Astronomy academic advisor before choosing your Mathematics courses.

Specific math courses are requisites for the major's Physics and Astronomy courses. We also recommend additional math courses to best prepare you for upper-level coursework.

A typical math sequence is: MATH 221 Calculus and Analytic Geometry 1, MATH 222 Calculus and Analytic Geometry 2, MATH 234 Calculus--Functions of Several Variables, MATH 340 Elementary Matrix and Linear Algebra, MATH 319 Techniques in Ordinary Differential Equations, MATH 321 Applied Mathematical Analysis 1: Vector and Complex Calculus, MATH 322 Applied Mathematical Analysis 2: Partial Differential Equations.

- MATH 221 Calculus and Analytic Geometry 1: A requisite for PHYSICS 247 A Modern Introduction to Physics, PHYSICS 207 General Physics, and PHYSICS 201 General Physics.

- MATH 222 Calculus and Analytic Geometry 2: A requisite for ASTRON 200 The Physical Universe. Also, a requisite for PHYSICS 247 A Modern Introduction to Physics but can be taken concurrently.

- MATH 234 Calculus--Functions of Several Variables: A requisite for PHYSICS 248 A Modern Introduction to Physics but can be taken concurrently. If you are not taking the PHYSICS 247 A Modern Introduction to Physics + PHYSICS 248 A Modern Introduction to Physics + PHYSICS 249 A Modern Introduction to Physics introductory sequence, you will still need this course for PHYSICS 311 Mechanics and PHYSICS 322 Electromagnetic Fields.

- MATH 319 Techniques in Ordinary Differential Equations and MATH 340 Elementary Matrix and Linear Algebra: You are strongly advised to take these courses before PHYSICS 311 Mechanics and PHYSICS 322 Electromagnetic Fields.

- MATH 320 Linear Algebra and Differential Equations: This course combines topics from MATH 319 Techniques in Ordinary Differential Equations and MATH 340 Elementary Matrix and Linear Algebra. It is adequate for the undergraduate major's curriculum but is not recommended for students planning for 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 Mechanics or PHYSICS 322 Electromagnetic Fields.

- MATH 321 Applied Mathematical Analysis 1: Vector and Complex Calculus: For students interested in more abstract math, taking MATH 521 Analysis I would be equivalent. It is recommended that MATH 321 be taken before PHYSICS 322 Electromagnetic Fields but especially before you take either PHYSICS 448 Atomic and Quantum Physics or PHYSICS 531 Introduction to Quantum Mechanics. Students may want to check with the academic advisor

before enrolling in this course to confirm they have enough time and attention in a specific term.

- MATH 322 Applied Mathematical Analysis 2: Partial Differential Equations : MATH 321 Applied Mathematical Analysis 1: Vector and Complex Calculus and MATH 322 are recommended for those planning for graduate school in Astronomy or Physics.

Computer and Data Science

Computers are fundamental to astronomical research. The most useful language is Python, followed by C or C++. COMP SCI 220 Data Science Programming I is a good starting point for learning Python.

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.

WHAT YOU LEARN IN THIS MAJOR WILL:

- 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 education, useful in some areas of business administration, public policy, law, or other fields where a basic knowledge of science is useful; and
- provide part of the preparation you need to teach astronomy or 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. Please consider applying for Research Experiences for Undergraduates (REUs) and if interested in department research, visit our website (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.

SUCCESSWORKS

SuccessWorks (https://successworks.wisc.edu/) at the College of Letters & Science helps you turn the academic skills learned in your classes into a fulfilling life, guiding you every step of the way to securing jobs, internships, or admission to graduate school.

Through one-on-one career advising, events, and resources, you can explore career options, build valuable internship and research experience, and connect with supportive alumni and employers who open doors of opportunity.

- What you can do with your major (https://successworks.wisc.edu/what-you-can-do-with-your-major/) (Major Skills & Outcomes Sheets)
- Make a career advising appointment (https://successworks.wisc.edu/make-an-appointment/)
- Learn about internships and internship funding (https://successworks.wisc.edu/finding-a-job-or-internship/)
- Try "Jobs, Internships, & How to Get Them," (https://successworks.wisc.edu/canvas/) an interactive guide in Canvas for enrolled UW–Madison students

WISCONSIN EXPERIENCE

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THE ASTRONOMY CLUB

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

In addition to social events, the club organizes a research symposium, Research Experiences for Undergraduates (https://www.astro.wisc.edu/undergraduate-program/uw-madison-reu-program/) and internship information sessions, and trips to observatories and labs. Club members can also help you start doing some of your own astronomy research.

By joining the Astronomy Club, you will meet 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 at UW–Madison.

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

RESOURCES AND SCHOLARSHIPS

Students majoring in Astronomy–Physics may be eligible for scholarships (https://www.physics.wisc.edu/department/awards/apply/) made possible through very generous donations by alumni and friends of the Department of Physics.