ASTRONOMY - BACHELOR OF ARTS (BA)

The APS Department is one of the few programs to combine both astrophysics and planetary science. As a result, we provide a unified view of solar and space sciences, planetary systems (our Solar System and others), stellar and galactic astronomy, and cosmology. We also offer hands-on experience with telescopes, optics, instrumentation, computer image processing, and computer modeling. These skills are useful for students wishing to pursue graduate degrees or careers in aerospace, technical or computer industries.

The University of Colorado is recognized as a top university in the exploration and study of space. Our faculty members carry out forefront research in a wide range of disciplines, from theoretical cosmology to finding planets around other stars, from observing cosmic microwave background in Antarctica to building space probes to explore Mars' atmosphere. We offer many types of research opportunities for undergraduates including research-based courses, student positions that support research programs, and individual research projects with faculty. Students can apply for funding from the Undergraduate Research Opportunities Program. The Honors Program (https://www.colorado.edu/aps/undergraduate-students/honors-program) encourages students to write research theses to qualify for Latin Honors upon graduation.

We encourage all students to explore and share their enthusiasm for science and we support a wide range of extra-curricular activities. These include student groups, the Learning Assistant program, research activities, and public outreach. The Sommers-Bausch Observatory (http://www.colorado.edu/sbo) and FiskePlanetarium (http://www.colorado.edu/fiske) offer opportunities for undergraduate students to become involved.

We offer students the ability to graduate with honors. Students must maintain a minimum GPA and write and defend an honors thesis. More information can be obtained from the APS department office and/or the Honors Council Representative (Ann-Marie Madigan (https://www.colorado.edu/aps/ann-marie-madigan)). More general information about the honors thesis is on CU Boulder’s Honors Program page (http://www.colorado.edu/honors).

Program Tracks

Students pursuing an astronomy degree can choose to add the astrophysics/physics track. For more detailed information, visit the department website (https://www.colorado.edu/aps/undergraduate-students/degree-requirements).

Students may declare either track when beginning their coursework, or wait until completion of their foundational courses in astronomy, physics, and mathematics (usually after the first 2-3 semesters). Students are mentored in groups during these first semesters, but meet individually with an APS faculty member every semester thereafter to discuss their academic progress and post-graduation plans.

General Astronomy Track

The astronomy degree highlights the science of astronomy, observation and technology. As a major on this track, students receive core training in astronomy, mathematics, physics, and computational and instrumental technology. These skills prepare students for professions in space sciences and a range of other careers in education, science, and technology. The astronomy degree is also designed to provide opportunities for students to explore a minor or second major in a complementary area of study.

Astrophysics/Physics Track

The astrophysics/physics addition shares the same foundational astronomy, math, and physics course sequences as the astronomy degree for the first two semesters, but then focuses on more advanced work in these topics. This track is jointly administered with the Department of Physics and requires substantial upper-division work in this field. Upon graduation, students should have solid theoretical and applied training for careers or graduate studies in the space sciences.

Requirements

The degree requirements are listed for the astronomy major and the astronomy-astrophysics/physics track. APS students will need to take the listed courses specific to their track in order to complete their astronomy degree.

General Astronomy Track

This is appropriate for someone aiming for a career in K–12 education, science journalism, science policy, information technology, science management, or technical work who does not expect to pursue a graduate degree.

Students must complete a minimum of 32 credit hours in astronomy (this must include at least 18 upper-division credit hours) and a minimum of 9 credit hours in physics.

Through the required coursework for this track of the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the lab component, and the QRMS component of the Gen Ed Skills Requirement. If ASTR 2000 (https://catalog.colorado.edu/search/?P=ASTR%202000) is selected, a student could also complete the Global Perspective component of the Gen Ed Diversity Requirement.

For more information, view the Astronomy Degree Requirements Flowchart (https://www.colorado.edu/aps/sites/default/files/block/astronomy_flowchart_0.jpg).

### Required Courses and Credits

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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</table>

### Required Courses

- **ASTR 1030 & ASTR 1040** Accelerated Introductory Astronomy 1 and Accelerated Introductory Astronomy 2 8
- **PHYS 1115** General Physics 1 for Majors 4
- **PHYS 1125** General Physics 2 for Majors 4
- **PHYS 1140** Experimental Physics 1 1
- **Select one of the following:** 3
  - **PHYS 2130** General Physics 3
  - **ASTR 2100** Fundamental Concepts in Astrophysics
  - **PHYS 2170** Foundations of Modern Physics
- **Select a minimum of two of the following:** 6
  - **ASTR 2000** Ancient Astronomies of the World
Astronomy - Bachelor of Arts (BA)

ASTR 2010  Modern Cosmology-Origin and Structure of the Universe
ASTR 2020  Space Astronomy and Exploration
ASTR 2030  Black Holes
ASTR 2040  The Search for Life in the Universe
ASTR 2500  Gateway to Space
ASTR 2600  Introduction to Scientific Programming

Select one of the following upper-division course sequences:  

<table>
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<tr>
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<tbody>
<tr>
<td>ASTR 3720 &amp; ASTR 3750</td>
<td>Planets and Their Atmospheres and Planets, Moons, and Rings</td>
</tr>
<tr>
<td>ASTR 3730 &amp; ASTR 3830</td>
<td>Astrophysics 1 - Stellar and Interstellar and Astrophysics 2 - Galactic and Extragalactic</td>
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</table>

Major Electives
Select four additional courses from the following or from those sequence courses not used for the upper-division course requirement above:

- ASTR 3510  Observations and Instrumentation 1
- ASTR 3520  Observations and Instrumentation 2
- ASTR 3560  Astronomical Instrumentation Laboratory
- ASTR 3710  Formation & Dynamics of Planetary Systems
- ASTR 3740  Cosmology and Relativity
- ASTR 3760  Solar and Space Physics
- ASTR 3800  Introduction to Scientific Data Analysis and Computing
- ASTR 4330  Cosmochemistry
- ASTR 4800  Space Science: Practice and Policy
- ASTR 5760  Astrophysical Instrumentation
- ATOC 4720  Atmospheric Dynamics

Total Credit Hours 44-47

Required Courses and Credits

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<tr>
<td>ASTR 1030 &amp; ASTR 1040</td>
<td>Accelerated Introductory Astronomy 1 &amp; Accelerated Introductory Astronomy 2</td>
</tr>
<tr>
<td>PHYS 1115 &amp; PHYS 1125 &amp; PHYS 1140</td>
<td>General Physics 1 for Majors and General Physics 2 for Majors and Experimental Physics 1</td>
</tr>
<tr>
<td>PHYS 2170 &amp; PHYS 2150</td>
<td>Foundations of Modern Physics and Experimental Physics 2</td>
</tr>
<tr>
<td>PHYS 2210</td>
<td>Classical Mechanics and Mathematical Methods 1</td>
</tr>
</tbody>
</table>

GEOL Sequence

- GEOL 1010  Exploring Earth
- GEOL 1030  and Introduction to Geology Laboratory 1
- GEOL 1020  Dodos, Dinosaurs, and Deinococcus: The History of a Habitable Planet

ATOC Sequence

- ATOC 1060  Our Changing Environment: El Nino, Ozone, and Climate

Total Credit Hours 15-20

1 Or ASTR 1010 and ASTR 1020 with permission from Lead APS Faculty Mentor.

Astrophysics/Physics Track

The astrophysics/physics track is jointly supervised by the APS and Physics Departments.

For students aiming for a graduate program in astronomy or planetary sciences. Similar to Physics Plan 2 (Astrophysics), with additional astrophysics instrumentation labs and different electives.

Students must complete a minimum of 23 credits in astronomy and a minimum of 28 credits in physics (this must include at least 15 upper-division credits in astronomy and 12 in physics).

Through the required coursework for this track of the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the lab component, and the QRMS component of the Gen Ed Skills Requirement.

For more information, view the Astrophysics Option Flowchart (https://www.colorado.edu/aps/sites/default/files/block/astrophysics_flowchart.jpg).

Required Ancillary Coursework

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<tbody>
<tr>
<td>APPM 1350 &amp; APPM 1360</td>
<td>Calculus 1 for Engineers and Calculus 2 for Engineers</td>
</tr>
<tr>
<td>MATH 1300 &amp; MATH 2300</td>
<td>Calculus 1 and Calculus 2</td>
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</tbody>
</table>

Required Ancillary Science Sequence with Lab

Select one other science sequence with lab, such as:

**CHEM Sequence**
- CHEM 1113  General Chemistry 1
- CHEM 1114  and Laboratory in General Chemistry 1
- CHEM 1133  General Chemistry 2
- CHEM 1134  and Laboratory in General Chemistry 2

**EBIO Sequence**
- EBIO 1210  General Biology 1
- EBIO 1230  and General Biology Laboratory 1
- EBIO 1220  General Biology 2
- EBIO 1240  and General Biology Laboratory 2

**PHYS 3310** Principles of Electricity and Magnetism 1
**PHYS 3320** Principles of Electricity and Magnetism 2
**PHYS 3321** Classical Mechanics and Mathematical Methods 2
**PHYS 3322** Quantum Mechanics 1
Select one of the following two astronomy sequences (6-hour minimum):

- ASTR 3720 & ASTR 3750: Planets and Their Atmospheres and Planets, Moons, and Rings
- ASTR 3730 & ASTR 3830: Astrophysics 1 - Stellar and Interstellar and Astrophysics 2 - Galactic and Extragalactic

Astronomy Electives
Select three additional courses from the following or from those sequence courses not used above (9-hour minimum):

- ASTR 3510: Observations and Instrumentation 1
- ASTR 3520: Observations and Instrumentation 2
- ASTR 3560: Astronomical Instrumentation Laboratory
- ASTR 3710: Formation & Dynamics of Planetary Systems
- ASTR 3740: Cosmology and Relativity
- ASTR 3760: Solar and Space Physics
- ASTR 3800: Introduction to Scientific Data Analysis and Computing
- ASTR 4330: Cosmochemistry
- ATOC 4720: Atmospheric Dynamics

Any ASTR 5000- or 6000-level course with instructor’s permission

Total Credit Hours 51

Four-Year Plans of Study
Astronomy Major

Year One
Fall Semester
ASTR 1030 Accelerated Introductory Astronomy 1 4
APPM 1350 Calculus 1 for Engineers 4-5
or MATH 1300 or Calculus 1
PHYS 1115 General Physics 1 for Majors 4
or PHYS 1110 or General Physics 1
Gen Ed Skills course/Elective/MAPS /FYSM 3

Credit Hours 15-16

Spring Semester
ASTR 1040 Accelerated Introductory Astronomy 2 4
APPM 1360 Calculus 2 for Engineers 4-5
or MATH 1300 or Calculus 2
PHYS 1125 General Physics 2 for Majors 4
or PHYS 1120 or General Physics 2
PHYS 1140 Experimental Physics 1 1
Gen Ed Distribution course /Elective/MAPS 3

Credit Hours 16-17

Year Two
Fall Semester
ASTR 2600 Introduction to Scientific Programming 3
or ASTR 2100 Foundations of Modern Physics 3
((recommended, but not required) or an Elective)
or Fundamental Concepts in Astrophysics

ASTR 3800 Introduction to Scientific Data Analysis and Computing 3
or Upper Division ASTR-Elective (Or Upper Division ASTR-Elective)

Credit Hours 14-16

Spring Semester
ASTR 2100 Fundamental Concepts in Astrophysics (if 3
or ASTR 3400 Phys 2170 or 2130 not taken)
or Research Methods in Astronomy

ASTR 3800 Introduction to Scientific Data Analysis and Computing (Or Upper Division ASTR-Elective) 3

Ancillary Science Sequence + LAB (Chem 1113 & CHEM 1114 or EBIO 1210 & EBIO 1230 or GEOL 1010 & GEOL 1030, or ATOC 1050 & ATOC 1070) 4-5

Credit Hours 15-16

Recommended Physics Electives

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>PHYS 4150</td>
<td>Plasma Physics</td>
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<tr>
<td>PHYS 4230</td>
<td>Thermodynamics and Statistical Mechanics</td>
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</tr>
<tr>
<td>PHYS 4410</td>
<td>Quantum Mechanics 2</td>
<td></td>
</tr>
<tr>
<td>PHYS 4420</td>
<td>Nuclear and Particle Physics</td>
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<tr>
<td>PHYS 4510</td>
<td>Optics</td>
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</table>

Total Credit Hours 16-19

1 Or equivalent PHYS 1110 + PHYS 1120 + PHYS 1140 sequence.
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Year Three

Fall Semester
ASTR 3720  Planets and Their Atmospheres (part one of required sequence) 3
or ASTR 3730  or Astrophysics 1 - Stellar and Interstellar
ASTR Upper division or Elective/Minor 3
Gen Ed Skills course/Maps/Elective/Minor 3
Gen Ed Distribution Course 3
Elective 3
Credit Hours 15

Spring Semester
ASTR 3750  Planets, Moons, and Rings (part two of required sequence) 3
or ASTR 3830  or Astrophysics 2 - Galactic and Extragalactic
ASTR Upper-Division Elective 3
Upper Division Elective/Minor 3
Gen Ed Distribution course 3
Gen Ed Distribution course 3
Credit Hours 15

Year Four

Fall Semester
ASTR Upper-division Elective 3
ASTR Upper-Division Elective 3
Gen Ed Distribution course - Upper Division 3
Upper-Division Elective / Minor/ Research/ Independent Study (Independent Study does not count for Upper Division ASTR credit) 3
Upper-Division Elective / Minor 3
Credit Hours 15

Spring Semester
ASTR Upper-Division Elective 3
Gen Ed Distribution course - Upper Division 3
Upper-Division Elective / Minor/ Research/ Independent Study (Independent Study does not count for Upper Division ASTR credit) 3
Upper-Division Elective / Minor 3
Credit Hours 15

Total Credit Hours 120-125

Astrophysics/Physics Track
Course  Title  Credit Hours

Year One
Fall Semester
ASTR 1030  Accelerated Introductory Astronomy 1 4
PHYS 1115  General Physics 1 for Majors 4
APPM 1350  Calculus 1 for Engineers 4-5
or MATH 1300  or Calculus 1
Gen Ed Skills course / MAPS/ FYSM 3
Credit Hours 15-16

Year Two
Fall Semester
APPM 2350  Calculus 3 for Engineers 4
PHYS 2170  Foundations of Modern Physics 3
PHYS 2150  Experimental Physics 2 1
Gen Ed Distribution course (example: Social Sciences) 3
Elective 3
Credit Hours 16-17

Spring Semester
PHYS 2210  Classical Mechanics and Mathematical Methods 1 3
APPM 2600  Introduction to Scientific Programming (recommended, not required) 3
APPM 2360  Introduction to Differential Equations with Linear Algebra 4
Gen Ed Distribution/Diversity course (example: Social Sciences/US Perspective) 3
Elective 3
Credit Hours 14

Year Three
Fall Semester
ASTR 3730  or ASTR 3710  Astrophysics 1 - Stellar and Interstellar or Formation & Dynamics of Planetary Systems 3
ASTR 3400  Research Methods in Astronomy (Or Upper Division ASTR-Elective) 3
PHYS 3210  Classical Mechanics and Mathematical Methods 2 3
PHYS 3310  Principles of Electricity and Magnetism 1 3
Gen Ed Distribution course 3
Credit Hours 15

Spring Semester
ASTR 3830  or ASTR 3720  Astrophysics 2 - Galactic and Extragalactic or Planets and Their Atmospheres 3
PHYS 3220  Quantum Mechanics 1 3
PHYS 3320  Principles of Electricity and Magnetism 2 3
Gen Ed Skills Course (Upper Division Writing) 3
Gen Ed Upper Division course / Elective 3
Credit Hours 15

Year Four
Fall Semester
ASTR Upper-division Elective 3
PHYS 4230  Thermodynamics and Statistical Mechanics (recommended, not required) 3
Gen Ed Course or Upper Division Elective 3
<table>
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<th>Course Description</th>
<th>Credits</th>
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<td>Upper-Division Elective or ASTR Upper-Division Elective</td>
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<td>Gen Ed Distribution course</td>
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**Spring Semester**

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<tr>
<td>PHYS 4410</td>
<td>Quantum Mechanics 2 (recommended, not required)</td>
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<td>ASTR Upper-division Elective or ASTR Independent Study or Research (would not count for ASTR Upper Division Credit)</td>
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<tr>
<td>ASTR Upper-division Elective</td>
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<tr>
<td>Gen Ed Distribution course</td>
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