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-Bauch Observatory (http://www.colorado.edu/sbo/) and Fiske Planetarium (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. In either track all required major courses and all required ancillary courses must be passed with a C- or better and cannot be taken pass/fail. No more than 45 credits in ASTR may be applied to overall graduation requirements. Students must have a grade point average of at least 2.000 in the major in order to graduate.

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%2020000) 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/astonomy_flowchart_0.jpg).

Required Courses and Credits

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>ASTR 1030 &amp; ASTR 1040</td>
<td>Accelerated Introductory Astronomy 1 and Accelerated Introductory Astronomy 2</td>
<td>8</td>
</tr>
<tr>
<td>PHYS 1115 &amp; PHYS 1110</td>
<td>General Physics 1 for Majors General Physics 1</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 1125 &amp; PHYS 1120</td>
<td>General Physics 2 for Majors General Physics 2</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 1140</td>
<td>Experimental Physics 1</td>
<td>1</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYS 2130</td>
<td>Introduction to Quantum Mechanics and Its Applications</td>
<td>3</td>
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</tbody>
</table>
Astronomy - Bachelor of Arts (BA)

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
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: 6
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

Major Electives
Select four additional courses from the following or from those sequence courses not used for the upper-division sequence requirement above: 12-15
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

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

Required Ancillary Coursework

Required Ancillary Calculus Coursework
Select one of the following sequences: 8-10
APPM 1350 | Calculus 1 for Engineers
& APPM 1360 | and Calculus 2 for Engineers
MATH 1300 | Calculus 1
& MATH 2300 | and Calculus 2

Required Ancillary Science Sequence with Lab
Select one other science sequence with lab, such as: 2 7-10
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

GEOL Sequence
GEOL 1010 | Exploring Earth
& GEOL 1030 | and Introduction to Geology Laboratory 1
GEOL 1020 | Dodos, Dinos, and Deinococcus: The History of a Habitable Planet

ATOC Sequence
ATOC 1050 | Weather and the Atmosphere
& ATOC 1070 | and Weather and the Atmosphere Laboratory
ATOC 1060 | Our Changing Environment: El Nino, Ozone, and Climate

Total Credit Hours 15-20

Astrophysics/Physics Track

The astrophysics/physics track is jointly supervised by the APS and Physics Departments. Students in this track are not eligible to pursue a physics minor.

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 Courses and Credits

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
</table>
| Lower-Division Coursework
The following courses are required:
ASTR 1030 | Accelerated Introductory Astronomy 1 | 8 |
& ASTR 1040 | and Accelerated Introductory Astronomy 2 |
PHYS 1115 | General Physics 1 for Majors | 9 |
& PHYS 1125 | and General Physics 2 for Majors |
& PHYS 1140 | and Experimental Physics 1 |
PHYS 2170 | Foundations of Modern Physics | 4 |
& PHYS 2150 | and Experimental Physics 2 |
PHYS 2210 | Classical Mechanics and Mathematical Methods 1 | 3 |
Upper-Division Coursework
The following physics courses are required:
- PHYS 3310 Principles of Electricity and Magnetism 1 (3)
- PHYS 3320 Principles of Electricity and Magnetism 2 (3)
- PHYS 3210 Classical Mechanics and Mathematical Methods 2 (3)
- PHYS 3220 Quantum Mechanics 1 (3)
Select one of the following two astronomy sequences (6-hour minimum):
- ASTR 3720 & ASTR 3750 Planets and Their Atmospheres and Planets, Moons, and Rings (6)
- 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 (3)
- ASTR 3520 Observations and Instrumentation 2 (3)
- ASTR 3560 Astronomical Instrumentation Laboratory (1)
- ASTR 3710 Formation & Dynamics of Planetary Systems (3)
- ASTR 3740 Cosmology and Relativity (3)
- ASTR 3760 Solar and Space Physics (3)
- ASTR 3800 Introduction to Scientific Data Analysis and Computing (3)
- ASTR 4330 Cosmochemistry (3)
- ATOC 4720 Atmospheric Dynamics (3)
Any ASTR 5000- or 6000-level course with instructor’s permission (3)

Total Credit Hours 51

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

Required Ancillary Calculus Coursework
Select one of the following sequence of courses:
- APPM 1350 or MATH 1300 Calculus 1 for Engineers (4-5)
- APPM 1360 or MATH 2300 Calculus 2 for Engineers (4-5)
- PHYS 1115 or PHYS 1110 General Physics 1 for Majors (4-5)
- General Ed Distribution course/Elective/MAPS/FYSM (3)

Total Credit Hours 15-19

Four-Year Plans of Study
Through the required coursework for either track in the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the Lab requirement, and the QRMS component of the Gen Ed Skills Requirement. For more information, view the Astronomy Degree Requirements Flowchart (https://www.colorado.edu/aps/sites/default/files/block/astronomy_flowchart_0.jpg).

Astronomy Major

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

Total Credit Hours 15-16

Spring Semester
- ASTR 1040 Accelerated Introductory Astronomy 2 (4)
- APPM 1360 or MATH 2300 Calculus 2 for Engineers (4-5)
- PHYS 1125 or PHYS 1120 General Physics 2 for Majors (4)
- PHYS 1140 General Physics 1 (4)

Total Credit Hours 16-17

Year Two
Fall Semester
- ASTR 2600 Introduction to Scientific Programming (3)
- PHYS 2170 or ASTR 2100 Foundations of Modern Physics (3)
- PHYS 2150 Experimental Physics 2 (1)
- APPM 2350 or ASTR 2100 Calculus 3 for Engineers (4)

Total Credit Hours 15-17

Spring Semester
- ASTR 2100 or ASTR 3400 Fundamental Concepts in Astrophysics (3)

Total Credit Hours 15-16
### Astrophysics/Physics Track

#### Year One

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<th>Credit Hours</th>
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<tr>
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<td>PHYS 1115</td>
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<td>APPM 1350 or MATH 1300</td>
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<td>APPM 1360 or MATH 2300</td>
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<td>PHYS 1125</td>
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#### Credit Hours: 15-16

#### Year Two

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<td>PHYS 2170</td>
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<td>PHYS 2210</td>
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<td>ASTR 2600</td>
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<tr>
<td></td>
<td>APPM 2360</td>
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<td>Gen Ed Distribution/Diversity course (example: Social Sciences/US Perspective)</td>
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#### Credit Hours: 16-17

#### Year Three

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<td>ASTR 3400</td>
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<tr>
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<td>PHYS 3210</td>
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#### Credit Hours: 15

#### Year Four

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<tr>
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<tr>
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<td>PHYS 3210</td>
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#### Credit Hours: 15

#### Total Credit Hours: 121-125
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<tr>
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<tr>
<td>PHYS 3320</td>
<td>Principles of Electricity and Magnetism 2</td>
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<td>Gen Ed Skills Course (Upper Division Writing)</td>
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<td>Gen Ed Upper Division course / Elective</td>
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**Year Four**

**Fall Semester**

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<td>ASTR Upper-division Elective</td>
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<tr>
<td>PHYS 4230</td>
<td>Thermodynamics and Statistical Mechanics (recommended, not required)</td>
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<td>Gen Ed Course or Upper Division Elective</td>
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<td>Upper-Division Elective or ASTR Independent Study or Research (would not count for ASTR Upper Division Credit)</td>
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<td>Upper-Division Elective or ASTR Upper-Division Elective</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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<tr>
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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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<td>ASTR Upper-division Elective</td>
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<td>Upper-Division Elective</td>
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<td>Gen Ed Distribution course</td>
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**Total Credit Hours** | **121-123**