Bachelor of Science in Astronomy

Why study physics and astronomy?

Our goal is to understand the physical universe. The questions addressed by our department’s research and education missions range from the applied, such as an improved understanding of the materials that can be used for solar cell energy production, to foundational questions about the nature of mass and space and how the Universe was formed and subsequently evolved, and how astrophysical phenomena affected the Earth and its evolution. We study the properties of systems ranging in size from smaller than an atom to larger than a galaxy on timescales ranging from billions of a second to the age of the universe. Our courses and laboratory/research experiences help students hone their problem solving and analytical skills and thereby become broadly trained critical thinkers. While about half of our majors move on to graduate studies in STEM, many find employment in the private sector in diverse situations ranging from financial analysts to physicians. Graduates of all our degree programs can be found in key positions regionally, nationally, and internationally. In this way, our department is at the forefront of telling the academic story of the University of Kansas to people around the state and around the world.

Undergraduate programs in astronomy

Astronomy degrees are offered through the Department of Physics and Astronomy. The astronomy curriculum offers undergraduates a survey of modern astronomy and an introduction to physical science, gives science and engineering students an introduction to astronomy and astrophysics, and prepares students majoring in astronomy for graduate study in astronomy or related fields.

Courses for Nonmajors

ASTR 191 surveys a wide range of contemporary astronomy topics. ASTR 394 is open to students with previous coursework in astronomy, biology, or geology; ASTR 391 offers an introduction to physical astronomy at a calculus-based level.

Undergraduate Admission

Admission to KU

All students applying for admission must send high school and college transcripts to the Office of Admissions. Prospective first-year students should be aware that KU has qualified admission requirements that all new first-year students must meet to be admitted. Consult the Office of Admissions (http://admissions.ku.edu/) for application deadlines and specific admission requirements.

Visit the International Support Services (http://www.iss.ku.edu/) for information about international admissions.

Students considering transferring to KU may see how their college-level course work will transfer on the Office of Admissions (http://credittransfer.ku.edu/) website.

Advising

Students considering a major in astronomy should confer early with a departmental representative about the selection of courses. The B.A. degree is appropriate for students who want a general education in astronomy as part of a broadly structured liberal education. The B.S. is a more specialized program with a substantial emphasis on physics content as well as astronomy. It provides preparation for a professional career or graduate work in astronomy, astrophysics, or related fields. A total of 120 credit hours is required for graduation.

First- and Second-Year Preparation

All major programs in physics and astronomy share requirements in basic physics and mathematics including PHSX 150, a seminar course for majors. Completion of MATH 125 and MATH 126 in the first year allows students to start calculus-based physics foundation courses (PHSX 211 and PHSX 216 or PHSX 213, followed by PHSX 212 and PHSX 236 or PHSX 214) by the second semester. Majors are encouraged to take PHSX 213 and PHSX 214, the honors versions of PHSX 211/PHSX 216 and PHSX 212/PHSX 236. Students should take these courses and ASTR 391 in their first two years. B.S. astronomy majors normally complete additional course work in mathematics (MATH 127, MATH 290, and MATH 320), as well as PHSX 313 and PHSX 316, in the second year.

Requirements for the B.S. Degree in Astronomy

All students pursuing the Bachelor of Science in Astronomy must complete the KU Core requirements in addition to the degree and major requirements. For details regarding the KU Core requirements, please see the KU Core section of the catalog.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 125</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 145</td>
<td>Calculus I, Honors</td>
<td></td>
</tr>
<tr>
<td>MATH 126</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 146</td>
<td>Calculus II, Honors</td>
<td></td>
</tr>
<tr>
<td>PHSX 150</td>
<td>Seminar in Physics, Astronomy and Engineering Physics</td>
<td>0.5</td>
</tr>
<tr>
<td>PHSX 211</td>
<td>General Physics I</td>
<td>5</td>
</tr>
<tr>
<td>&amp; PHSX 216</td>
<td>General Physics I Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHSX 213</td>
<td>General Physics I Honors</td>
<td>5</td>
</tr>
<tr>
<td>PHSX 212</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PHSX 236</td>
<td>General Physics II Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHSX 214</td>
<td>General Physics II Honors</td>
<td>4</td>
</tr>
<tr>
<td>Foundations of Chemistry I</td>
<td>Satisfied by one of the following:</td>
<td></td>
</tr>
</tbody>
</table>

The following code requirements must be completed in the first two years:

- **General science requirements**
  - Majors must complete courses as specified in each of the following areas. Majors are advised to take honors courses when eligible. These hours do not contribute to the minimum number of hours required for the major.
  - Calculus I. Satisfied by one of the following:
    - MATH 125
    - MATH 145
  - Calculus II. Satisfied by one of the following:
    - MATH 126
    - MATH 146
  - General Physics I. Satisfied by one of the following:
    - PHSX 150
    - PHSX 211 & PHSX 216
    - PHSX 213
  - General Physics II. Satisfied by one of the following:
    - PHSX 212 & PHSX 236
    - PHSX 214
  - Foundations of Chemistry I. Satisfied by one of the following:
CHEM 130  General Chemistry I  5  

or CHEM 150  Chemistry for Engineers  

or CHEM 170  Chemistry for the Chemical Sciences I  

or CHEM 190  Foundations of Chemistry I, Honors  

& CHEM 191  and Foundations of Chemistry I Laboratory, Honors

**Advanced Mathematics Core Knowledge and Skills**

- Vector Calculus. Satisfied by the following:  
  - MATH 127  Calculus III  4  
  - or MATH 147  Calculus III, Honors

- Elementary Linear Algebra. Satisfied by the following:  
  - MATH 290  Elementary Linear Algebra  2  
  - or MATH 291  Elementary Linear Algebra, Honors

- Elementary Differential Equations. Satisfied by the following:  
  - MATH 320  Elementary Differential Equations  3  
  - or MATH 220  Applied Differential Equations  
  - or MATH 221  Applied Differential Equations, Honors

- Math Elective. Satisfied by one of the following:  
  - PHSX 518  Mathematical Physics  
  - PHSX 718  Mathematical Methods in Physical Sciences  
  - MATH 526  Applied Mathematical Statistics I  
  - MATH 530  Mathematical Models  
  - MATH 558  Introductory Modern Algebra  
  - MATH 581  Numerical Methods  
  - MATH 590  Linear Algebra  
  - MATH 628  Mathematical Theory of Statistics  
  - MATH 646  Complex Variable and Applications  
  - MATH 647  Applied Partial Differential Equations  
  - MATH 648  Calculus of Variations and Integral Equations  
  - MATH 660  Geometry I  
  - MATH 661  Geometry II  
  - any 700-level MATH lecture course.

**Astronomy Requirements for Major**

- Majors must complete the following seven courses:  
  - ASTR 391  Physical Astronomy, Honors  3  
  - ASTR 591  Stellar Astronomy  3  
  - ASTR 592  Galactic and Extragalactic Astronomy  3  
  - ASTR 596  Observational Astrophysics  2  
  - ASTR 691  Astrophysics I  3  
  - ASTR 692  Astrophysics II  3  
  - ASTR 503  Undergraduate Research  1-4

**Physics Core Knowledge and Skills**

- Majors must complete courses as indicated in the following areas:  
  - General Physics III. Satisfied by the following:  
    - PHSX 313  General Physics III  3  
  - Intermediate Physics Lab. Satisfied by the following:  
    - PHSX 316  Intermediate Physics Laboratory I  1  
  - Introductory Quantum Mechanics. Satisfied by the following:  
    - PHSX 611  Introductory Quantum Mechanics  3  
  - Physical Measurements or Electronic Circuit Measurement and Design. Satisfied by one of the following:  
    - PHSX 536  Electronic Circuit Measurement and Design  4  
    - PHSX 616  Physical Measurements  4

- Mechanics I. Satisfied by the following:  
  - PHSX 521  Mechanics I  3  

- Electricity and Magnetism. Satisfied by the following:  
  - PHSX 531  Electricity and Magnetism  3  

- Thermal Physics. Satisfied by the following:  
  - PHSX 671  Thermal Physics  3  

- Physics Elective. Satisfied by any PHSX lecture or laboratory course numbered 500 or higher (PHSX 693 recommended) (with the exception of PHSX 594), including:  
  - ASTR 792  Topics in Advanced Astrophysics  
  - ASTR 795  Space Plasma Physics  
  - or PHSX 795  Space Plasma Physics  
  - PHSX 693  Gravitation and Cosmology (recommended)

**Major Hours & Major GPA**

While completing all required courses (above), majors must also meet each of the following hour and grade-point average minimum standards:

- **Major Hours**
  - Satisfied by 30 hours of major courses.

- **Major Hours in Residence**
  - Satisfied by a minimum of 15 hours of KU resident credit in the major.

- **Major Junior/Senior (300+) Hours**
  - Satisfied by a minimum of 12 hours from junior/senior courses (300+) in the major.

- **Major Junior/Senior (300+) Graduation GPA**
  - Satisfied by a minimum of a 2.0 KU GPA in junior/senior courses (300+) in the major. GPA calculations include all junior/senior courses in the field of study including F’s and repeated courses. See the Semester/Cumulative GPA Calculator (http://clas.ku.edu/undergrad/tools/gpa/).

Below is a sample 4-year plan for students pursuing the BS in Astronomy. To view the list of courses approved to fulfill KU Core Goals, please visit the KU Core website (http://kucore.ku.edu/courses/).

This degree plan assumes students will have completed MATH 104, or its equivalent, prior to the freshman year, fall semester.

**Freshman**

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall Hours</th>
<th>Spring Hours</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 125 (Goal 1.2 Quantitative Literacy, Major Requirement)</td>
<td>4</td>
<td>ASTR 391 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 150 (Major Requirement)</td>
<td>0.5</td>
<td>MATH 126 (Major Requirement)</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 130 or 170 (Goal 3 Natural Science, Major Requirement)</td>
<td>5</td>
<td>PHSX 211</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Critical Thinking, Major Requirement</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Goal 2.1 Written Communication (1 of 2)</td>
<td>3</td>
<td>EECS 138 or 168 (Major Requirement)</td>
<td>3-4</td>
</tr>
<tr>
<td>Goal 3 Social Science</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Hours**

- Fall: 15.5
- Spring: 15-16
### Bachelor of Science in Astronomy

**Sophomore**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 591 (Major Requirement)&lt;sup&gt;2,4&lt;/sup&gt;</td>
<td>3</td>
<td>ASTR 592 (Major Requirement)&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 212 &amp; PHSX 236 (Goal 3 Natural Science, Major Requirement)&lt;sup&gt;5&lt;/sup&gt;</td>
<td>4</td>
<td>PHSX 313 (Goal 3 Natural Science, Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 127 (Pre-requisite for Major Requirement)</td>
<td>4</td>
<td>PHSX 316 (Major Requirement)</td>
<td>1</td>
</tr>
<tr>
<td>MATH 290 (Major Requirement)</td>
<td>2</td>
<td>MATH 320 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>Goal 2.1 Written Communication (2 of 2)</td>
<td>3 Goal 3 Arts and Humanities</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ASTR 503 (Major Requirement)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 16

**Junior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 596 (Goal 6 Integration &amp; Creativity, Major Requirement)&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>3</td>
<td>ASTR 692 (Major Requirement)&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 691 (Major Requirement)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3</td>
<td>PHSX 611 (Major Requirement)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 521 (Major Requirement)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3</td>
<td>PHSX 616 or 536 (Major Requirement)</td>
<td>4</td>
</tr>
<tr>
<td>PHSX Math Elective 300+ (Major Requirement)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3 Goal 4.1 US Diversity</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Goal 2.2 Communication</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15 13

**Senior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHSX 531 (Major Requirement)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHSX 671 (Major Requirement)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>3</td>
<td>PHSX Elective 500+ (Major Requirement)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>Goal 4.2 Global Awareness</td>
<td>3 Goal 5 Social Responsibility and Ethics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ASTR Elective</td>
<td>3</td>
<td>Second Area of Study/Degree/Junior-Senior Hours&lt;sup&gt;7&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>ASTR Elective</td>
<td>3</td>
<td>Second Area of Study/Degree/Junior-Senior Hours&lt;sup&gt;7&lt;/sup&gt;</td>
<td>3</td>
</tr>
</tbody>
</table>

15 15

**Total Hours 120.5-121.5**

1. Refer to the Degree Requirements tab for a list of courses that can fulfill this major requirement.
2. Offered odd-numbered years.
3. Offered even-numbered years.
4. PHSX 150, PHSX 521, ASTR 591, ASTR 596, ASTR 691, PHSX 531, and PHSX 671 are Fall only courses. PHSX 611, ASTR 592, and ASTR 692 are Spring only courses.
5. Majors are encouraged to take PHSX 213.
6. Majors are encouraged to take PHSX 214.
7. Hour requirements (incl. 45 jr/sr hrs) are typically met through KU core, degree, major, second area of study and/or elective hours. Students completing the BGS with a major must choose a secondary area of study. Individual degree mapping is done in partnership with your advisor.
8. Course offering using the python programming language recommended.

Please note:

All students in the College of Liberal Arts and Sciences are required to complete 120 total hours of which 45 hours must be at the Jr/Sr (300+) level.

The same course cannot be used to fulfill more than one KU Core Goal. However, overlap of a KU Core course with a major or degree-specific requirement is allowed. Overlapping is recommended to allow more opportunities to explore other majors and/or minors.

### Departmental Honors in Physics and Astronomy

Qualified students earning either a B.A. or a B.S. degree in the College of Liberal Arts and Sciences with a major in astronomy or physics may graduate with Honors in Physics & Astronomy by fulfilling the following requirements: (1) By the end of the candidate's final semester, achieve a minimum GPA of 3.5 in the major, in all courses taken in residence and elsewhere; and (2) Complete at least 24 semester hours of astronomy and physics courses numbered 500 or above, including undergraduate research represented by two hours of credit in ASTR 501, ASTR 503, PHSX 501 or PHSX 503. A grade of B or better must be earned in one of the following: ASTR 501, ASTR 503, PHSX 501 or PHSX 503. All of our department’s honors requirements include student research, for which results shall be presented in either: (1) a written research summary, read by 3 faculty members in physics and astronomy or related fields or authorship on a peer-reviewed manuscript; or (2) a research-based oral presentation at an appropriate venue (e.g., Undergraduate Research symposium, a presentation in an advanced department seminar class, a discipline specific meeting); or (3) presentation of a poster at an appropriate venue. Students intending to graduate with honors in physics and astronomy must file a Declaration of Intent Form with the Departmental Honors Coordinator, preferably during their junior year but no later than enrollment for the final undergraduate semester.