Bachelor of Science in Astronomy

Why study 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 billionths 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
Astronomy programs 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 while ASTR 293 discusses a shorter list of astrophysically extreme objects in greater detail; both courses require eligibility for MATH 101. ASTR 394 is open to students with previous coursework in astronomy, geology or biology; 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. Unless they are college transfer students with at least 24 hours of credit, prospective students must send ACT or SAT scores 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 Office of International Student and Scholar 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.

Admission to the College of Liberal Arts and Sciences
Admission to the College is a different process from admission to a major field. Some CLAS departments have admission requirements. See individual department/program sections for departmental admission requirements.

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.

General science requirements (43.5-44.5)
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.

Computing and Programming. Satisfied by one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>EECS 138</td>
<td>Introduction to Computing: _____</td>
<td>3-4</td>
</tr>
<tr>
<td>or EECS 168</td>
<td>Programming I</td>
<td></td>
</tr>
<tr>
<td>or EECS 169</td>
<td>Programming I: Honors</td>
<td></td>
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<tr>
<td>Calculus I. Satisfied by one of the following:</td>
<td></td>
<td></td>
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<tr>
<td>MATH 125</td>
<td>Calculus I</td>
<td>4</td>
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<tr>
<td>or MATH 145</td>
<td>Calculus I, Honors</td>
<td></td>
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<tr>
<td>Calculus II. Satisfied by one of the following:</td>
<td></td>
<td></td>
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<tr>
<td>MATH 126</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 146</td>
<td>Calculus II, Honors</td>
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</tr>
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</table>

Seminar in Physics, Astronomy, & Engineering Physics. Satisfied by the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHSX 150</td>
<td>Seminar in Physics, Astronomy and Engineering Physics</td>
<td>0.5</td>
</tr>
</tbody>
</table>
General Physics I. Satisfied by one of the following: 5
PHSX 211 General Physics I 5
& PHSX 216 General Physics I Laboratory 5
PHSX 213 General Physics I Honors 5

General Physics II. Satisfied by one of the following: 4
PHSX 212 General Physics II 4
& PHSX 236 General Physics II Laboratory 4

PHSX 214 General Physics II Honors 4

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 (12)**

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

Math Elective. Satisfied by one of the following:
PHSX 510 Mathematical Physics
PHSX 518 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 except MATH 701 and MATH 715.

**Astronomy Requirements for Major (18-21)**

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 (27)**

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 511 Introductory Quantum Mechanics 3

Physical Measurements or Electronic Circuit Measurement and Design. Satisfied by one of the following:
PHSX 156 Physical Measurements 4
PHSX 536 Electronic Circuit Measurement and Design 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 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>Hours Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Goal 2.1 Written</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Communication (First Course, 2 Crs Required)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Goal 2.2 Oral</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CHEM 130 (Goal 1.2)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Quantitative Literacy or Goal 3</td>
<td>4</td>
<td></td>
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<tr>
<td>Natural Science, Major Requirement</td>
<td>4</td>
<td></td>
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**Bachelor of Science in Astronomy**
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<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EECS 138 or 168 (Major Requirement)</td>
<td>3-4</td>
<td>Goal 3 Social Science</td>
<td>3</td>
</tr>
<tr>
<td>MATH 127 (Pre-requisite for Major Requirement)</td>
<td>4</td>
<td>Goal 4.1 US Diversity</td>
<td>3</td>
</tr>
<tr>
<td>MATH 223 (Major Requirement)</td>
<td>3</td>
<td>MATH 320 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 290 (Major Requirement)</td>
<td>2</td>
<td>ASTR 391 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 212 (Goal 3 Natural Science, Major Requirement)</td>
<td>3</td>
<td>PHSX 313 (Goal 3 Natural Science, Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 236 (Major Requirement)</td>
<td>1</td>
<td>PHSX 316 (Major Requirement)</td>
<td>1</td>
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<tr>
<td>Junior</td>
<td>Hours</td>
<td>Spring</td>
<td>Hours</td>
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<tr>
<td>Fall</td>
<td></td>
<td></td>
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<tr>
<td>ASTR 591 (Major Requirement)</td>
<td>3</td>
<td>Goal 4.2 Global Awareness</td>
<td>3</td>
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<tr>
<td>ASTR 596 (Major Requirement)</td>
<td>2</td>
<td>ASTR 592 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 521 (Major Requirement)</td>
<td>3</td>
<td>PHSX 511 (Major Requirement)</td>
<td>3</td>
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<tr>
<td>PHSX 516 or 536 (Major Requirement)</td>
<td>4</td>
<td>Elective (Total Hours)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX Math Elective 300+ (Major Requirement)</td>
<td>3</td>
<td>Elective (Total Hours)</td>
<td>3</td>
</tr>
<tr>
<td>Senior</td>
<td>Hours</td>
<td>Spring</td>
<td>Hours</td>
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<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Goal 5 Social Responsibility &amp; Ethics</td>
<td>3-4</td>
<td>ASTR 503 (Goal 6 Integration &amp; Creativity, Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 691 (Major Requirement)</td>
<td>3</td>
<td>ASTR 692 (Major Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PHSX 531 (Major Requirement)</td>
<td>3</td>
<td>PHSX Elective 500+ (Major Requirement)</td>
<td>3</td>
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<tr>
<td>PHSX 671 (Major Requirement)</td>
<td>3</td>
<td>Elective (Total Hours)</td>
<td>3</td>
</tr>
<tr>
<td>Elective (Total Hours)</td>
<td>3</td>
<td>Elective (Total Hours)</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours: 120.5-122.5

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.

ASTR 391, PHSX 511, ASTR 592, and ASTR 692 are Spring only courses.

5 PHSX 213 may be taken in place of the combination of PHSX 211 and PHSX 216.

6 PHSX 214 may be taken in place of the combination of PHSX 212 and PHSX 236.

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 3.25 overall and 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 597, ASTR 503, PHSX 501 or PHSX 503. A grade of B or better must be earned in one of the following: ASTR 597, ASTR 503, PHSX 501 or PHSX 503. In addition, all our all of our department's honors requirements include student research, for which results shall be presented in at least one of the following forms: (1) a written research summary, read by 3 faculty members in physics and astronomy or related fields or authorship on a peer-reviewed manuscript; (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. A student who plans to graduate with honors in physics and astronomy must file a Declaration of Intent Form with the Departmental Honors Coordinator, preferably during his/her junior year but in any case no later than enrollment for the final undergraduate semester.