Class Schedule - Spring 2019

Astronomy

Astronomy
Chair of Department: Leslie Looney
Department Office: 103 Astronomy Building, 1002 West Green, Urbana
Phone: 333-3090
www.astro.illinois.edu

ASTR 100  Introduction to Astronomy  credit: 3 hours.
Introduces the student to the basic concepts of modern astronomy. Covers topics including the night sky; the solar system and its
origin; the nature and evolution of stars; stellar remnants, including white dwarfs, neutron stars, and black holes; extrasolar planetary
systems; galaxies and quasars; dark matter and dark energy; the Big Bang and the fate of the universe; and life in the universe. Credit
is not given for ASTR 100 if credit in any of ASTR 121, ASTR 122, ASTR 210, or equivalent has been earned. Students with credit in
PHYS 211 are encouraged to take ASTR 210.

Students interested in ASTR 100 should also consider ASTR 121 or ASTR 122 which covers the same materials and topics but in two
semesters instead of one. ASTR 121 and ASTR 122 include two lectures each week and one weekly small discussion meeting for more
individual attention. ASTR 121 and ASTR 122 are independent offerings and can be taken in any order. While ASTR 100, ASTR 121
and ASTR 122 are for non-science majors, problem solving with basic algebra is required. Science and astronomy majors should take
ASTR 210.

This course satisfies the General Education Criteria for a:
Nat Sci & Tech - Phys Sciences

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<tr>
<th>CRN</th>
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<th>Time</th>
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<th>Instructor</th>
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<td>100 - Materials Science &amp; Eng Bld</td>
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Nat Sci & Tech - Phys Sciences course.

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<tr>
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Nat Sci & Tech - Phys Sciences course.
"This section has one or more proctored exams, which may carry additional fees. Proctoring options include fee-based ProctorU and
approved proctoring centers, as well as testing options on the Urbana-Champaign campus, which carry no fees."

ASTR 121  Solar System and Worlds Beyond  credit: 3 hours.
Introductory survey of the Solar System; structure and motions of the Earth and Moon; planetary motions; natures and characteristics
of the planets and smaller solar system bodies; planetary moons and rings; meteors, meteoroids, and meteorites; properties of the
Sun; origin and evolution of the Solar System; discovery of extrasolar planetary systems; architecture of extrasolar planetary systems
and comparison to our solar system; habitable extrasolar planets. Emphasis will be placed on problem-solving and scientific methods.
Credit is not given for ASTR 121 if credit in either ASTR 100 or ASTR 210 has been earned. Students with credit in PHYS 211 are
couraged to take ASTR 210.

ASTR 121 and ASTR 122 cover the same topics as ASTR 100, but the material and topics are covered in much more depth over two
semesters instead of one. ASTR 121 and ASTR 122 are independent offerings and can be taken in any order. While ASTR 121 and
ASTR 122 are for non-science majors, problem solving with basic algebra is required. Science and astronomy majors should take
ASTR 210. Students must register for one discussion and one lecture section.

This course satisfies the General Education Criteria for a:
Quantitative Reasoning II
Nat Sci & Tech - Phys Sciences

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page 1 - Astronomy, Spring 2019
ASTR 122  Stars and Galaxies  credit: 3 hours.
Introduction to celestial objects and phenomena beyond the Solar System, and their governing basic physical principles; galaxies, quasars, and structure of the universe; dark matter and dark energy; the Big Bang and the fate of the universe; the Milky Way; the interstellar medium and the birth of stars: stellar distances, motions, radiation, structure, evolution, and remnants, including neutron stars and black holes. Emphasis will be placed on problem-solving and scientific methods. Credit is not given for ASTR 122 if credit in either ASTR 100 or ASTR 210 has been earned. Students with credit in PHYS 211 are encouraged to take ASTR 210.

ASTR 121 and ASTR 122 cover the same topics as ASTR 100, but the material and topics are covered in much more depth over two semesters instead of one. ASTR 121 and ASTR 122 are independent offerings and can be taken in any order. While ASTR 121 and ASTR 122 are for non-science majors, problems solving with basic algebra is required. Science and astronomy majors should take ASTR 210.

This course satisfies the General Education Criteria for a:
Quantitative Reasoning II
Nat Sci & Tech - Phys Sciences
ASTR 150  **Killer Skies: Astro-Disasters**  credit: 3 hours.

Exploration of the most dangerous topics in the Universe, such as meteors, supernovae, gamma-ray bursts, magnetars, rogue black holes, colliding galaxies, quasars, and the end of the Universe, to name just a few.

This course satisfies the General Education Criteria for a:
Nat Sci & Tech - Phys Sciences
Credit Hours: 3 hours
Nat Sci & Tech - Phys Sciences course.
Exploration of the most dangerous topics in the Universe, such as meteors, supernovae, gamma-ray bursts, magnetars, rogue black holes, colliding galaxies, quasars, and the end of the Universe, to name just a few.

**ASTR 210  Introduction to Astrophysics**  credit: 3 hours.
Survey of modern astronomy for students with background in physics. Topics include: the solar system; nature and evolution of stars; white dwarfs, neutron stars, and black holes; galaxies, quasars and dark matter; large scale structure of the universe; the Big Bang; and Inflation. Emphasis will be on the physical principles underlying the astronomical phenomena. Prerequisite: PHYS 211.
This course satisfies the General Education Criteria for a:
Nat Sci & Tech - Phys Sciences

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<td>103 - Transportation Building</td>
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Nat Sci & Tech - Phys Sciences course.

**ASTR 310  Computing in Astronomy**  credit: 3 hours.
An introduction to the use of computers in astrophysics research. Topics covered include a basic introduction to computing hardware concepts, Unix shell commands, programming in Python, data structures, astronomical libraries, modern software engineering concepts and tools, plotting and visualization of data, and fundamental numerical algorithms. Applications and examples drawn from astrophysics are stressed throughout. Prerequisite: PHYS 211; MATH 220; Credit or concurrent registration in ASTR 210.

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Credit Hours: 3 hours

**ASTR 330  Extraterrestrial Life**  credit: 3 hours.
Scientific discussion of the search for extraterrestrial life. Topics include: cosmic evolution (protons to heavy elements to molecules); terrestrial evolution (chemical, biological, and cultural); high technology searches for extraterrestrial life in the solar system (Mars, Venus, outer planets); and beyond the solar system (Drake equation and current SETI projects).

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Camp Honors/Chanc Schol course.
Restricted to Chancellor's Scholar-CHPHonors students.
Section CH for Chancellor's Scholars only; others may only enroll with consent of the Campus Honors Program and the Instructor. This will meet in Observatory 124.

**ASTR 390  Individual Study**  credit: 0 TO 4 hours.
Individual study at an advanced undergraduate level. May be repeated in separate terms to a maximum of 8 hours. Prerequisite: Consent of advisor and of faculty member who supervises the work.
To register for ASTR 390, use the ASTR 390 CRN (available from the departmental undergraduate records office) specific to the instructor with whom you have arranged to study. (You cannot register under the general CRN 10396.)

### ASTR 401  Scientific Writing for Astronomy  credit: 2 hours.

Development of journal-style writing skills. Papers written in accordance with the Astrophysical Journal Manual of Style on topics approved by the instructor. Emphasis on developing adequate and critical coverage of the topic, brevity compatible with clarity, and effective presentation. Proper referencing, footnotes, and bibliography are covered. 2 undergraduate hours. No graduate credit. Prerequisite: Completion of campus Composition I general education requirement. Concurrent enrollment in a designated 400-level astronomy course. Not intended for graduate students.

This course satisfies the General Education Criteria for a:
Advanced Composition

### ASTR 405  Planetary Systems  credit: 3 hours.

This course traces, from a physical perspective, the evolution of planetary systems from star formation in molecular clouds to the emergence of habitable worlds. Topics include the properties of HII regions and molecular clouds, gravitational collapse and disk formation, formation of planetesimals and planets, dynamics of the solar system, physics of planetary atmospheres, properties of individual planets and their rings and satellites, detection and characterization of extra-solar planets, and searches for life in the Solar System and beyond. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 212 or consent of instructor. Recommended: ASTR 210, PHYS 213.

### ASTR 414  Astronomical Techniques  credit: 4 hours.

Introduction to techniques used in modern optical and radio astronomy with emphasis on the physical and mathematical understanding of the detection of electromagnetic radiation; includes such topics as fundamental properties of radio and optical telescopes and the
detectors that are used with telescopes. Lectures and laboratory. 4 undergraduate hours. 4 graduate hours. Prerequisite: MATH 241 or equivalent; PHYS 212; or consent of instructor. Recommended: ASTR 210, PHYS 213, PHYS 214.

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Credit Hours: 4 hours

**ASTR 490  Senior Thesis**  credit: 3 hours.
Research with thesis, under the direction of a faculty member in astronomy. This course is recommended for all students who plan to do research and graduate study, and it is a prerequisite for graduation with highest distinction in astronomy. In the term preceding their initial enrollment, those interested in taking the course should consult with an academic advisor as well as the potential research advisor. A thesis must be presented for credit to be received. 3 undergraduate hours. No graduate credit. Prerequisite: Two 400-level Astronomy courses and consent of academic advisor and of faculty member who supervises the work. Intended for Astronomy majors of senior standing.

This course satisfies the General Education Criteria for a:
Advanced Composition

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Advanced Composition course. Departmental Approval Required

**ASTR 496  Seminar in Astronomy**  credit: 1 TO 4 hours.
Lectures on topics of current interest in astronomy and astrophysics; for advanced undergraduates and graduates. See Class Schedule for current topics. 1 to 4 undergraduate hours. 1 to 4 graduate hours. Approved for both letter and S/U grading. May be repeated. Prerequisite: Consent of instructor.

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Credit Hours: 3 hours
Instructor Approval Required
NPA: Nuclear and Particle Astrophysics. This course is targeted to advanced undergraduate students, with no nuclear or particle physics prerequisites. Need instructors approval. We will develop and apply basic nuclear and particle physics to trace highlights in the history of cosmic matter from the big bang to the present, using all available cosmic messengers. Planned topics include: Early universe thermodynamics, relic particles, and dark matter. Primordial nucleosynthesis predictions, observations, implications, and future tests. Stellar burning phases and nucleosynthesis. Supernovae and explosive nucleosynthesis. Solar, geophysical, atmospheric, supernova, jet-driven, and cosmological neutrinos. Neutron capture processes: theory, astrophysical sites, and observations. Gamma-ray bursts and kilonovae. Ultra-high energy cosmic rays. Cosmic-ray nucleosynthesis and $\gamma$-ray production. The first stars. Galactic and cosmic chemical evolution. The emphasis will be on physical arguments and quantitative estimates to understand observations.

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Credit Hours: 1 hours
Section S: Survey of Current Research
This course is for first year graduate students and advanced undergraduates interested in the research work of faculty members in Astronomy and Astrophysics. Students will meet with a different faculty member for one hour each week informally to learn about his or her scientific research work. ASTR 496 Section S is primarily meant for students who are interested in pursuing a research project with a faculty member, and the course provides good preparation for summer research assistantships. S/U grading only.

ASTR 506 Galaxies credit: 4 hours.
Survey of the different constituents of the Universe, including galaxies, active galaxies, galaxy clusters, and intergalactic gas. Particular emphasis will be placed on observable properties of the Milky Way and other galaxies, as well as relating such observations to the understanding of the dynamics and evolution of galaxies. Prerequisite: ASTR 406 or consent of instructor.

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ASTR 516 General Relativity II credit: 4 hours.
Same as PHYS 516. See PHYS 516.

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Restricted to Graduate - Urbana-Champaign.

ASTR 590 Individual Study credit: 2 TO 16 hours.
Individual study or non-thesis research. May be repeated. Prerequisite: Consent of adviser and of faculty member who supervises the work.

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Instructor Approval Required

ASTR 596 Seminar in Special Topics credit: 0 TO 16 hours.
Approved for both letter and S/U grading. May be repeated. Prerequisite: Consent of instructor.

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Credit Hours: 4 hours
Astronomy has always been driven by data. Yet only in recent years has it truly become a big data field. With automatic surveys recording the sky at unprecedented speed, the sheer volume of astronomical data introduces new challenges and opportunities. Modern Astronomy pushes the boundaries of data analysis and artificial intelligence, providing a great domain for computer science
This course will survey exemplary results, highlight main challenges, and focus on recent methodological advancements in machine learning and data analysis driven by astronomical applications.

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Credit Hours: 4 hours
Nuclear and Particle Astrophysics The course is targeted to beginning graduate students, with no nuclear or particle physics prerequisites. We will develop and apply basic nuclear and particle physics to trace highlights in the history of cosmic matter from the big bang to the present, using all available cosmic messengers. Planned topics include: Early universe thermodynamics, relic particles, and dark matter. Primordial nucleosynthesis predictions, observations, implications, and future tests. Stellar burning phases and nucleosynthesis. Supernovae and explosive nucleosynthesis. Solar, geophysical, atmospheric, supernova, jet-driven, and cosmological neutrinos. Neutron capture processes: theory, astrophysical sites, and observations. Gamma-ray bursts and kilonovae. Ultra-high energy cosmic rays. Cosmic-ray nucleosynthesis and $\gamma$-ray production. The first stars. Galactic and cosmic chemical evolution. The emphasis will be on physical arguments and quantitative estimates to understand observations.

ASTR 599  **Thesis Research**  credit: 0 TO 16 hours.
Approved for S/U grading only. May be repeated.

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Instructor Approval Required