

# Astrophysics Major Info Session

May 16, 2017

# B.A. and B.S.

- *Bachelor of Arts* in Astrophysics consists of 15 courses beginning with the Physics Introductory sequence.
- *Bachelor of Science* in Astrophysics consists of 18 courses beginning with *either* the Physics *or* Chem Introductory sequences.

# Program Overview

## Year 1

- Completion of introductory sequences in Physics or Chem and Math
- Finish first year with ASTR 13300 Introduction to Astrophysics in the Spring Quarter

## Year 2

- Continue foundational program in Physics or Chem and complete Core requirements
- Begin research preparation starting with Computer Science, Statistics and A&A courses ASTR 21100 Computational Techniques in Astrophysics and ASTR 21200 Observational Techniques in Astrophysics

# Program Overview

## Year 3

- Begin Core astrophysics courses ASTR 25400 Radiation Processes, ASTR 24100 The Physics of Stars and ASTR 23900 The Physics of Galaxies or ASTR 24300 Cosmological Physics
- Complete research preparation: Statistics course (if not taken earlier) and ASTR 29700 Participation in Research

## Year 4

- Advanced courses in Physics or Chem
- Electives
- Honors Track for eligible students

# Summary of Requirements

15 required courses for the B.A. in Astrophysics	18 required courses for the B.S. in Astrophysics (with Physics courses)	18 required courses for the B.S. in Astrophysics (with Chem courses)
ASTR 13300 Intro to Astrophysics	ASTR 13300 Intro to Astrophysics	ASTR 13300 Intro to Astrophysics
ASTR 21100 Computational Techniques	ASTR 21100 Computational Techniques	ASTR 21100 Computational Techniques
ASTR 21200 Observational Techniques	ASTR 21200 Observational Techniques	ASTR 21200 Observational Techniques
ASTR 24100 The Physics of Stars	ASTR 24100 The Physics of Stars	ASTR 24100 The Physics of Stars
ASTR 23900 or 24300	ASTR 23900 or 24300	ASTR 23900 or 24300
ASTR 25400 Radiation Processes	ASTR 25400 Radiation Processes	ASTR 25400 Radiation Processes
ASTR 29700 Participation in Research	ASTR 29700 Participation in Research	ASTR 29700 Participation in Research
		PHYS 13100 Mechanics; E&M I
		PHYS 13200 Mechanics; E&M II
PHYS 13300 Waves, Optics, and Heat	PHYS 13300 Waves, Optics, and Heat	PHYS 13300 Waves, Optics, and Heat
PHYS 22000 Intro Math Meth in Physics	PHYS 22000 Intro Math Meth in Physics	PHYS 22000 Intro Math Meth in Physics
PHYS 22100 Math Methods in Physics	PHYS 22100 Math Methods in Physics	PHYS 22100 Math Methods in Physics
PHYS 15400 Modern Physics	PHYS 15400 Modern Physics	
	PHYS 23400 Quantum Mechanics I	
	PHYS 19700 Statistical/Thermal Phys	
CMSC 12100 Intro to Computer Science	CMSC 12100 Intro to Computer Science	CMSC 12100 Intro to Computer Science
STAT 2XXXX Stat Models/Applications	STAT 2XXXX Stat Models/Applications	STAT 2XXXX Stat Models/Applications
		CHEM 11300 Comp Gen Chem III
		CHEM 26100 Quantum Mechanics
		CHEM 26200 Thermodynamics
Two electives	Three electives	One elective

# Electives

Astro	CompSci	Physics		GeoSci	Math	Stats
ASTR 25800 Extrasolar Planets	CMSC 15200 Introduction to Computer Science II	PHYS 18500 Intermediate Mechanics	PHYS 22600 Electronics	GEOS 212000 Physics of the Earth	MATH 20250 Abstract Linear Algebra or higher	STAT 22200 Linear Models and Experimental Design
ASTR 28200 Current Topics in Astrophysics	CMSC 15400 Introduction to Computer Systems	PHYS 19700 Statistical and Thermal Physics	PHYS 26000 Fluid Dynamics	GEOS 22000 Origin & Evolution of the Solar System		STAT 22400 Applied Regression Analysis
ASTR 30300 Stars	CMSC 28510 Introduction to Scientific Computing	PHYS 23400 Quantum Mechanics I	PHYS 26400 Spacetime and Black Holes	GEOS 22000 Geochron		STAT 24500 Statistical Theory and Methods II
ASTR 30300 Interstellar Medium	CMSC 23500 Introduction to Database Systems	PHYS 23500 Quantum Mechanics II		GEOS 22040 From Dust to Planetesimals		STAT 24500 Statistical Theory and Methods II
ASTR 33000 Computational Astrophysics	CMSC 23900 Data Visualization	PHYS 22500 Int. Electricity & Magnetism I		GEOS 22050 From Planetesimals to Planets		STAT 25100 Introduction to Mathematical Probability
ASTR 40200 Particle Astrophysics		PHYS 22700 Intermediate Electricity & Magnetism II		GEOS 22060 What Makes a Planet Habitable?		STAT 25300 Introduction to Probability Models

# Yes, there will be labs.

- **Astr 21100**
  - This course will introduce basic computational techniques most often used in astronomical research, such as interpolation, transforms, smoothing, numerical differentiation and integration, integration of ordinary differential equations, and Monte Carlo methods; and elements of basic computer algorithms, data structures, and parallel programming using Python as the main course programming language. Practical examples where these numerical techniques are applied will be addressed using real-world astronomical problems and results of recent papers with emphasis on implementing the algorithms from scratch.
- **Astr 21200**
  - This course will prepare students in methods that will be used in their independent research by introducing observation and analysis techniques in a field of astrophysics chosen by the instructor. Students learn basics of astronomical instrumentation and apply that knowledge in a practical context, such as using an on-campus telescope or telescopes controlled robotically from campus. The process of data reduction and calibration will be illustrated, leading to the extraction of scientifically meaningful results.
- **Astr 24100**
  - This course develops the physical theory of the internal structure of stars and how their structure changes with time. The material illustrates how to build model stars based on these physical principles, and covers observational constraints on these models, such as the neutrino flux from the core of the Sun. Topics include supernovae and the end states of stars - white dwarfs, neutron stars, and black holes.

# Research and Honors

- The ASTR 29700 Participation in Research course will facilitate entry into a faculty-led research group.
- Meaningful involvement in research, using powerful tools including the Magellan Telescopes (and in the coming decade, the Giant Magellan Telescope), will be a prominent feature of the Major.
- Students with a GPA of 3.5 in the Major and 3.0 overall, and have an approved research project that will be supervised by a faculty member, are eligible for the Honors Track. A goal of the Honors Track is to mentor students through the process of preparing research and submitting it for publication. Along the way, students present their research groups, including A&A faculty.



# Course Availability (soon)

- Of the 7 required courses in the A&A, these will be available in the 2017-2018 academic year:
  - ASTR 25400 Radiation Processes in Astrophysics
  - ASTR 24100 The Physics of Stars
  - ASTR 23900 The Physics of Galaxies and ASTR 24300 Cosmological Physics
  - ASTR 21200 Observational Techniques in Astrophysics
  - ASTR 29700 Participation in Research (by arrangement)
- The remaining 2 courses will be rolled out in the 2018-2019 academic year:
  - ASTR 13300 Introduction to Astrophysics
  - ASTR 21100 Computational Techniques in Astrophysics

# Course Availability (later)

Autumn Quarter	Winter Quarter	Spring Quarter
ASTR 25400 Radiation Processes in Astrophysics	ASTR 24100 Physics of Stars	ASTR 13300 Introduction to Astrophysics
ASTR 24300 Cosmological Physics	ASTR 21100 Computational Techniques in Astrophysics	ASTR 21200 Observational Techniques in Astrophysics
		ASTR 23900 The Physics of Galaxies
		ASTR 29700 Participation in Research

In addition, electives in A&A will be offered periodically: ASTR 28200 Current Topics in Astrophysics and ASTR 25800 Extrasolar Planets.

# Sample Program

B.S. in Astrophysics (18 courses)		
YEAR 1		
Autumn	Winter	Spring
PHYS 13100 Mechanics/Electricity and Magnetism	PHYS 13200 Mechanics/Electricity and Magnetism	<b>ASTR 13300 Introduction to Astrophysics</b>
MATH 15100 Calculus I	MATH 15200 Calculus II	PHYS 22000 Introduction to Mathematical Methods in Physics
		PHYS 13300 Waves, Optics, and Heat
YEAR 2		
CMSC 12100 Computer Science with Applications I	<b>ASTR 21100 Computational Techniques in Astrophysics</b>	<b>ASTR 21200 Observational Techniques in Astrophysics</b>
PHYS 15400 Modern Physics		PHYS 23400 Quantum Mechanics I
PHYS 22100 Mathematical Methods in Physics		
YEAR 3		
<b>ASTR 25400 Radiation Processes in Astrophysics</b>	<b>ASTR 24100 Physics of Stars</b>	<b>ASTR 29700 Participation in Research</b>
STAT 22000 Statistical Methods and Applications	Elective	<b>ASTR 23900 The Physics of Galaxies <i>or</i> ASTR 24300 Cosmological Physics</b>
YEAR 4		
PHYS 19700 Statistical and Thermal Physics	Elective	Elective

# Sample Program

B.A. in Astrophysics (15 courses)		
YEAR 1		
Autumn	Winter	Spring
PHYS 13100 Mechanics/Electricity and Magnetism	PHYS 13200 Mechanics/Electricity and Magnetism	<b>ASTR 13300 Introduction to Astrophysics</b>
MATH 15100 Calculus I	MATH 15200 Calculus II	PHYS 22000 Introduction to Mathematical Methods in Physics
		PHYS 13300 Waves, Optics, and Heat
YEAR 2		
CMSC 12100 Computer Science with Applications I	<b>ASTR 21100 Computational Techniques in Astrophysics</b>	<b>ASTR 21200 Observational Techniques in Astrophysics</b>
PHYS 15400 Modern Physics		<del>PHYS 23400 Quantum Mechanics I</del>
PHYS 22100 Mathematical Methods in Physics		
YEAR 3		
<b>ASTR 25400 Radiation Processes in Astrophysics</b>	<b>ASTR 24100 Physics of Stars</b>	<b>ASTR 29700 Participation in Research</b>
STAT 22000 Statistical Methods and Applications	Elective	<b>ASTR 23900 The Physics of Galaxies or ASTR 24300 Cosmological Physics</b>
YEAR 4		
<del>PHYS 19700 Statistical and Thermal Physics</del>	Elective	<del>Elective</del>

# Sample Program

B.S. in Astrophysics (18 courses) CHEM INTRO SEQUENCE		
YEAR 1		
Autumn	Winter	Spring
CHEM 10100 Introductory General Chemistry I	CHEM 10200 Introductory General Chemistry II	CHEM 11300 Comprehensive General Chemistry III
MATH 15100 Calculus I	MATH 15200 Calculus II	<b>ASTR 13300 Introduction to Astrophysics</b>
YEAR 2		
CMSC 12100 Computer Science with Applications I	<b>ASTR 21100 Computational Techniques in Astrophysics</b>	<b>ASTR 21200 Observational Techniques in Astrophysics</b>
PHYS 13100 Mechanics/Electricity and Magnetism	PHYS 13200 Mechanics/Electricity and Magnetism	PHYS 13300 Waves, Optics, and Heat
		PHYS 22000 Introduction to Mathematical Methods in Physics
YEAR 3		
<b>ASTR 25400 Radiation Processes in Astrophysics</b>	<b>ASTR 24100 Physics of Stars</b>	<b>ASTR 29700 Participation in Research</b>
PHYS 22100 Mathematical Methods in Physics	STAT 23400 Statistical Models and Methods	<b>ASTR 23900 The Physics of Galaxies or ASTR 24300 Cosmological Physics</b>
YEAR 4		
CHEM 26100 Quantum Mechanics	CHEM 26200 Thermodynamics	Elective

# If you are rising second-year ...

- In Autumn Quarter 2017 take CMSC 12100 Computer Science with Applications I
- In Spring 2018 take ASTR 21200 Observational Techniques in Astrophysics

# If you are a rising third-year ...

- In Autumn 2017 take ASTR 25400 Radiation Measurements in Astrophysics
- In Winter 2018 take ASTR 24100 The Physics of Stars
- In the 2017-2018 Academic Year, you can take ASTR 23900 The Physics of Galaxies in Autumn Quarter or ASTR 24300 Cosmological Physics in Spring Quarter

# For further information

- Sign up for the Astro Major list host
- Contact Julia Brazas

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