

# PHYSICS AND ASTRONOMY

## THE WIESS SCHOOL OF NATURAL SCIENCES

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## DEGREES OFFERED: BA, BS, MST, MS, PHD

The Department of Physics and Astronomy offers undergraduate and graduate programs for a wide range of interests. The bachelor of arts degrees in physics and astronomy are suitable for students who wish to obtain a broad liberal education with a concentration in physical science. The bachelor of science degrees in physics, astrophysics, and chemical physics provide preparation for employment or further study in physics and related fields. Students in the professional nonthesis, MST program obtain training in science teaching.

Research facilities and thesis supervision are available for MS and PhD students in atomic, molecular, and optical physics; biophysics; condensed matter and surface physics; earth systems science; nuclear and particle physics; observational astronomy; solar system physics; space plasma physics; and theoretical physics and astrophysics.

## UNDERGRADUATE DEGREES

For general university requirements, see Graduation Requirements (Undergraduate Students section, pages 2–5). Major requirements consist of a common core of basic physics and mathematics courses, with additional course work specific to each degree program. Students may obtain credit for some courses by advanced placement, and the department's undergraduate committee can modify requirements to meet the needs of students with special backgrounds.

## DEGREE REQUIREMENTS FOR BS IN PHYSICS

### **All options must complete**

PHYS 101 or 111 *Mechanics* (with lab)  
 PHYS 102 or 112 *Electricity and Magnetism* (with lab)  
 PHYS 201 *Waves and Optics*  
 PHYS 202 *Modern Physics*  
 PHYS 231 *Elementary Physics Laboratory II*  
 PHYS 301 *Intermediate Mechanics*  
 PHYS 311 *Introduction to Quantum Physics I*  
 PHYS 425 *Statistical and Thermal Physics*  
 PHYS 491 and 492 *Undergraduate Research*  
 PHYS 493 and 494 *Undergraduate Research Seminar*  
 (The undergraduate research course and seminar must be taken concurrently.)  
 MATH 101 and 102 *Single Variable Calculus I and II*  
 MATH 211 *Ordinary Differential Equations and Linear Algebra*  
 MATH 212 *Multivariable Calculus*  
 (MATH 221 and 222 *Honors Calculus III and IV* may substitute for MATH 211 and 212)

### **Additional courses for the BS in physics with general physics option**

PHYS 302 *Intermediate Electrodynamics*  
 PHYS 312 *Introduction to Quantum Physics II*  
 PHYS 331/332 *Junior Physics Laboratory I and II*  
 PHYS 411 *Introduction to Nuclear and Particle Physics*  
 PHYS 412 *Solid State Physics*

MATH 381 *Introduction to Partial Differential Equations* and MATH 382 *Complex Analysis* or CAAM 335 *Matrix Analysis* and CAAM 336 *Differential Equations in Science and Engineering*  
 CHEM 121 and 122 *General Chemistry* (with lab) or CHEM 151 and 152 *Honors Chemistry* (with lab)

### **Additional courses for the BS in physics with applied physics option**

PHYS 302 *Intermediate Electrodynamics* or ELEC 306 *Electromagnetic Fields and Devices*  
 PHYS 312 *Introduction to Quantum Physics II* or ELEC 361 *Quantum Mechanics for Engineers*  
 Two of: PHYS 331/332 *Junior Physics Laboratory I and II*, ELEC 342 *Electronic Circuits*, and ELEC 465 *Physical Electronics Practicum*  
 PHYS 412 *Solid State Physics* or approved substitute in applied physics  
 ELEC 242 *Fundamentals of Electrical Engineering II* or ELEC 243 *Introduction to Electronics*  
 ELEC 305 *Introduction to Physical Electronics*  
 MATH 381 *Introduction to Partial Differential Equations* or CAAM 336 *Differential Equations in Science and Engineering*  
 CHEM 121 and 122 *General Chemistry* (with lab) or CHEM 151 and 152 *Honors Chemistry* (with lab)  
**Additional courses for the BS in physics with biological physics option**  
 PHYS 302 *Intermediate Electrodynamics*

PHYS 312 *Introduction to Quantum Physics II*

PHYS 355 *Introduction to Biological Physics*

BIOS 201 *Introductory Biology*

BIOS 211 *Introduction to Experimental Biosciences*

BIOS 301 *Biochemistry* or BIOS 341 *Cell Biology*

CHEM 121 and 122 *General Chemistry* (with lab) or CHEM 151 and 152 *Honors Chemistry* (with lab)

CHEM 211 *Organic Chemistry*

MATH 381 *Introduction to Partial Differential Equations* or CAAM 336 *Differential Equations in Science and Engineering*

***Additional courses for the BS in physics with computational physics option***

PHYS 302 *Intermediate Electrodynamics*

PHYS 312 *Introduction to Quantum Physics II*

PHYS 416 *Computational Physics*

MATH 381 *Introduction to Partial Differential Equations* and MATH 382 *Complex Analysis* or CAAM 335 *Matrix Analysis* and CAAM 336 *Differential Equations in Science and Engineering*

CAAM 210 *Introduction to Engineering Computation*

CAAM 353 *Computational Numerical Analysis*

CAAM 420 *Computational Science I*

One of: CAAM 452 *Numerical Methods for Partial Differential Equations*, CAAM 453 *Numerical Analysis*, CAAM 520 *Computational Science II*

CHEM 121 *General Chemistry* (with lab) or CHEM 151 *Honors Chemistry* (with lab)

**DEGREE REQUIREMENTS FOR BS IN ASTROPHYSICS**

PHYS 101 or 111 *Mechanics* (with lab)

PHYS 102 or 112 *Electricity and Magnetism* (with lab)

PHYS 201 *Waves and Optics*

PHYS 202 *Modern Physics*

PHYS 231 *Elementary Physics Laboratory II*

PHYS 301 *Intermediate Mechanics*

PHYS 302 *Intermediate Electrodynamics*

PHYS 311 *Introduction to Quantum Physics I*

PHYS 425 *Statistical and Thermal Physics*

PHYS 491 and PHYS 492 *Undergraduate Research*

PHYS 493 and PHYS 494 *Undergraduate Research Seminar*

(The undergraduate research course and seminar must be taken concurrently.)

ASTR 230 *Astronomy Laboratory*

ASTR 350 and ASTR 360 *Introduction to Astrophysics*

Two credits of ASTR 400 *Undergraduate Research Seminar*

Three courses from: ASTR 450 *Experimental Space Science*, ASTR 451 *Solar and Stellar Astrophysics*, ASTR 452 *Galaxies and Cosmology*, ASTR 470 *Solar System Physics*,

PHYS 312 *Introduction to Quantum Physics II*, PHYS 480 *Introduction to Plasma Physics*

MATH 101/102 *Single Variable Calculus I and II*

MATH 211 *Ordinary Differential Equations and Linear Algebra*

MATH 212 *Multivariable Calculus*

(MATH 221/222 *Honors Calculus III and IV* may substitute for MATH 211/ MATH 212)

CAAM 336 *Differential Equations in Science and Engineering*

NSCI 230 *Computation in Natural Sciences* or CAAM 210 *Introduction to Engineering Computation*

CHEM 121 *General Chemistry*

**DEGREE REQUIREMENTS FOR BA IN PHYSICS**

PHYS 101 or 111 *Mechanics* (with lab)

PHYS 102 or 112 *Electricity and Magnetism* (with lab)

PHYS 201 *Waves and Optics*

PHYS 202 *Modern Physics*

PHYS 231 *Elementary Physics Laboratory II*

PHYS 301 *Intermediate Mechanics*

PHYS 302 *Intermediate Electrodynamics*

PHYS 311 *Introduction to Quantum Physics I*

PHYS 331 *Junior Physics Laboratory I*

PHYS 425 *Statistical and Thermal Physics*

One additional PHYS or ASTR course (3 credit hours) at 400 level

MATH 101 and 102 *Single Variable Calculus I and II*

MATH 211 *Ordinary Differential Equations and Linear Algebra*

MATH 212 *Multivariable Calculus*

(MATH 221 and 222 *Honors Calculus III and IV* may substitute for MATH 211 and 212)

NSCI 230 *Computation in Natural Sciences* or CAAM 210 *Introduction to Engineering Computation* or one MATH or CAAM course at or above 300 level

### DEGREE REQUIREMENTS FOR BA IN ASTRONOMY

PHYS 101 or 111 *Mechanics* (with lab)

PHYS 102 or 112 *Electricity and Magnetism* (with lab)

PHYS 201 *Waves and Optics*

PHYS 202 *Modern Physics*

PHYS 231 *Elementary Physics Laboratory II*

PHYS 301 *Intermediate Mechanics*

PHYS 302 *Intermediate Electrodynamics*

PHYS 425 *Statistical and Thermal Physics* or CHEM 310 *Physical Chemistry*

ASTR 230 *Astronomy Laboratory*

ASTR 350 and ASTR 360 *Introduction to Astrophysics*

Two credits of ASTR 400 *Undergraduate Research Seminar*

One of: ASTR 450 *Experimental Space Science*, ASTR 451 *Solar and Stellar Astrophysics*, ASTR 452 *Galaxies and Cosmology*, ASTR 470 *Solar System Physics*, PHYS 480 *Introduction to Plasma Physics*

MATH 101/102 *Single Variable Calculus I and II*

MATH 211 *Ordinary Differential Equations and Linear Algebra*

MATH 212 *Multivariable Calculus*

(MATH 221/222 *Honors Calculus III and IV* may substitute for MATH 211/ MATH 212)

One of: PHYS 331 *Junior Physics Laboratory I*, NSCI 230 *Computation in Natural Sciences*, or CAAM 210 *Introduction to Engineering Computation*

### DEGREE REQUIREMENTS FOR BS IN CHEMICAL PHYSICS

PHYS 101 or 111 *Mechanics* (with lab)

PHYS 102 or 112 *Electricity and Magnetism* (with lab)

PHYS 201 *Waves and Optics*

PHYS 202 *Modern Physics*

PHYS 231 *Elementary Physics Laboratory II*

PHYS 301 *Intermediate Mechanics*

PHYS 302 *Intermediate Electrodynamics*

PHYS 311 *Introduction to Quantum Physics I*

CHEM 121/122 *General Chemistry* or CHEM 151/152 *Honors Chemistry* (with lab)

CHEM 211 *Organic Chemistry* or CHEM 251 *Honors Organic Chemistry*

CHEM 310 *Physical Chemistry*

CHEM 360 *Inorganic Chemistry*

One of: PHYS 312 *Introduction to Quantum Physics II*, CHEM 415 *Chemical Kinetics and Dynamics*, or CHEM 430 *Quantum Chemistry*

One of: CHEM 420 *Classical and Statistical Thermodynamics*, or PHYS 425 *Statistical and Thermal Physics*

Six credit hours from: CHEM 215 *Organic Chemistry Laboratory*, CHEM 351 or 352 *Introductory Module in Experimental Chemistry*, CHEM 372–395, CHEM 435 *Methods of Computational Quantum Chemistry*, and PHYS 331 or 332 *Junior Physics Laboratory I or II*; up to two hours of CHEM 491 *Research for Undergraduates* or PHYS 491/492 *Undergraduate Research* may be counted toward this requirement.

MATH 101/102 *Single Variable Calculus I and II*

MATH 211 *Ordinary Differential Equations and Linear Algebra*

MATH 212 *Multivariable Calculus*

(MATH 221/222 *Honors Calculus III and IV* may substitute for MATH 211/ MATH 212)

Six credit hours from MATH or CAAM courses at or above 300 level

### ADVANCED DEGREES

For general university requirements, see Graduate Degrees (Graduate Students section, pages 3–4). More detailed information on courses and requirements is available from the Department of Physics and Astronomy.

The master of science teaching requires 30 credit hours of approved course work. The master of science is a research degree, normally undertaken as the first stage of doctoral study. The MS requires at least 30 credit hours of approved graduate-level studies, including a research project performed under the direction of a departmental faculty member. The student must defend the results of the project in a public oral examination and submit an original thesis to the Office of Graduate and Postdoctoral studies.

The nonthesis master of science is a research degree, normally undertaken as the first stage of doctoral study. The MS requires at least 30 credit hours of approved graduate-level studies, including a research project performed under the direction of a departmental faculty member. The student must defend the results of the project in a public oral examination and submit an article, with the student as principal author, to a peer-reviewed journal.

To be eligible for the PhD degree, graduate students must demonstrate to the department their ability to engage in advanced research. This normally is accomplished by successfully completing the work for the MS. Students also must complete 60 credit hours of approved graduate-level study at Rice and produce a research thesis under the direction of a departmental faculty member. At least two years of graduate study are required for the PhD.

**See ASTR and PHYS in the Courses of Instruction section.**