Physics and Astronomy

The Wiess School of Natural Sciences

Chair
F. Barry Dunning

Professors
Billy E. Bonner
Paul A. Cloutier
Marjorie D. Corcoran
Michael W. Deem
Rui-Rui Du
Ian M. Duck
Reginald J. Dufour
Arthur A. Few Jr.
James P. Hannon
Thomas W. Hill
Huey W. Huang
Randall G. Hulet
Neal Lane
Eugene H. Levy
Edison P. Liang
Hannu E. Miettinen
Gordon S. Mutchler
Peter Nordlander
Carl Rau
Patricia H. Reiff
JabBus B. Roberts Jr.
Qimiao Si
Paul M. Stevenson

Associate Professors
David Alexander
Anthony A. Chan
Stanley A. Dodds
Patrick M. Hartigan
Thomas C. Killian
Douglas A. Natelson
B. Paul Padley
Frank R. Toffoletto

Assistant Professors
Matthew G. Baring
Carlos J. Bolech
Giovanni Fossati
Jason H. Hafner
Christopher Johns-Krull
Ching-Hwa Kiang
Emilia Morosan
Uwe Oberlack
Han Pu

Adjunct Professors
Markus Aschwanden
James L. Burch
Franklin R. Chang-Diaz
James H. Newman
Carolyn Sumners
David T. Young

Adjunct Associate Professors
Hui Li
Gary A. Morris
Alexander J. Rimberg

Instructors
Sarah B. Nagel
Leonard E. Suess

Senior Faculty Fellows
William J. Llope
Ian A. Smith
Pablo P. Yepes

Faculty Fellow
Stanislav Sazykin

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 Degree Requirements

For general university requirements, see Graduation Requirements (pages 14–15). 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.

All physics majors must complete the following courses:

- 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

Additional courses for the BS degree in physics:

- PHYS 302 Intermediate Electrodynamics
- PHYS 311/312 Introduction to Quantum Physics I and II
- PHYS 331/332 Junior Physics Laboratory I and II
- PHYS 411 Introduction to Nuclear and Particle Physics
- PHYS 412 Solid-state Physics
- PHYS 425 Statistical and Thermal Physics
- PHYS 491/492 Undergraduate Research

Additional courses for the BS degree in physics with option in applied physics:

- PHYS 302 Intermediate Electrodynamics or ELEC 306 Electromagnetic Fields and Devices
- PHYS 311 Introduction to Quantum Physics I
- PHYS 312 Introduction to Quantum Physics II or ELEC 361 Electronic Materials and Quantum Devices
- 2 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
- PHYS 425 Statistical and Thermal Physics
- PHYS 491/492 Undergraduate Research

PHYS 301 Intermediate Mechanics
- 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)

PHYS 493/494 Undergraduate Research Seminar
- (The undergraduate research course and seminar must be taken concurrently.)
- 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 121/122 General Chemistry with Laboratory or CHEM 151/152 Honors Chemistry with Laboratory

PHYS 493/494 Undergraduate Research Seminar
- (The undergraduate research course and seminar must be taken concurrently.)
- 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 121/122 General Chemistry with Laboratory or CHEM 151/152 Honors Chemistry with Laboratory
Additional courses for the BS degree in physics with option in biophysics:
PHYS 302 Intermediate Electrodynamics
PHYS 311/312 Introduction to Quantum Physics I and II
PHYS 425 Statistical and Thermal Physics
BIOS 201/202 Introductory Biology

Additional courses for the BS degree in physics with option in computational physics:
PHYS 302 Intermediate Electrodynamics
PHYS 311/312 Introduction to Quantum Physics I and II
PHYS 416 Computational Physics
PHYS 425 Statistical and Thermal Physics
PHYS 491/492 Undergraduate Research
PHYS 493/494 Undergraduate Research Seminar
(The undergraduate research course and seminar must be taken concurrently.)
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

Additional courses for the BS degree in astrophysics:
PHYS 302 Intermediate Electrodynamics
PHYS 311 Introduction to Quantum Physics I
PHYS 425 Statistical and Thermal Physics
ASTR 230 Astronomy Laboratory
ASTR 350/360 Introduction to Astrophysics—Stars, Galaxies, and Cosmology
3 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
PHYS 491/492 Undergraduate Research
PHYS 493/494 Undergraduate Research Seminar
(The undergraduate research course and seminar must be taken concurrently.)
NSCI 230 Computation in Natural Science or CAAM 210 Introduction to Engineering Computation
CAAM 336 Differential Equations in Science and Engineering
CHEM 121 General Chemistry with Laboratory

Additional courses for the BA degree in physics:
PHYS 302 Intermediate Electrodynamics
PHYS 311 Introduction to Quantum Physics I
PHYS 331 Junior Physics Laboratory I
PHYS 425 Statistical and Thermal Physics
BIOS 301 Biochemistry
CHEM 121/122 General Chemistry with Laboratory
or CHEM 151/152 Honors Chemistry with Laboratory
CHEM 211/212 Organic Chemistry
CHEM 215 Organic Chemistry Laboratory
CAAM 210 Introduction to Engineering Computation
CAAM 353 Computational Numerical Analysis
CAAM 420 Computational Science I
1 of: CAAM 452 Numerical Methods for Partial Differential Equations, CAAM 453 Numerical Analysis, CAAM 520 Computational Science II
CHEM 121 General Chemistry with Laboratory
or CHEM 151 Honors Chemistry with Laboratory

1 additional PHYS or ASTR course (3 credit hours) at 400 level
NSCI 230 Computation in Natural Science or CAAM 210 Introduction to Engineering Computation or 1 MATH or CAAM course (3 credit hours) at or above 300 level
Additional courses for the BA degree in astronomy:

- PHYS 302 *Intermediate Electrodynamics*
- 1 of: PHYS 331 *Junior Physics Laboratory I*, NSCI 230 *Computation in Natural Science* or CAM 210 *Introduction to Engineering Computation*
- PHYS 425 *Statistical and Thermal Physics* or CHEM 311 *Physical Chemistry*

Additional courses for the BS degree in chemical physics:

- CHEM 121/122 *General Chemistry* or CHEM 151/152 *Honors Chemistry* with Laboratory
- CHEM 211 *Organic Chemistry*
- CHEM 212 *Organic Chemistry* or CHEM 360 *Inorganic Chemistry*
- CHEM 311/312 *Physical Chemistry*
- PHYS 302 *Intermediate Electrodynamics*
- 2 of: PHYS 311 or 312 *Introduction to Quantum Physics I or II*, CHEM 415 *Chemical Kinetics and Dynamics*, and CHEM 430 *Quantum Chemistry*
- 6 credit hours from: CHEM 215 *Organic Chemistry Laboratory*, CHEM 351 or 352

**Requirements for Advanced Degrees**

For general university requirements, see Graduate Degrees (pages 57–58). 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 thesis performed under the direction of a departmental faculty member.

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.

ASTR 230 *Astronomy Laboratory*

ASTR 350/360 *Introduction to Astrophysics—Stars, Galaxies, and Cosmology*

ASTR 470 *Solar System Physics*

1 of: ASTR 430 *Teaching Astronomy Laboratory*, ASTR 450 *Experimental Space Science*, or PHYS 443 *Atmospheric Science*

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 2 hours of CHEM 491 *Research for Undergraduates* or PHYS 491/492 *Undergraduate Research* may be counted toward this requirement.

6 credit hours from: NSCI 230 *Computation in Natural Science*, CAM 210, *Introduction to Engineering Computation*, and MATH, or CAM courses at or above 300 level