Physics and Astronomy

The Wiess School of Natural Sciences

Chair
F. Barry Dunning

Professors
Stephen D. Baker
Billy E. Bonner
Paul A. Cloutier
Marjorie D. Corcoran
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
Jabus B. Roberts, Jr.
Richard E. Smalley
Paul M. Stevenson
Richard A. Wolf

Professors Emeriti
Thomas L. Estle
John W. Freeman
William E. Gordon, *Distinguished*
F. Curtis Michel
Ronald F. Stebbings
G. King Walters

Associate Professors
Anthony A. Chan
Stanley A. Dodds
Patrick M. Hartigan
Qimiao Si

Assistant Professors
Matthew G. Baring
Jason H. Hafner
Thomas C. Killian
Christopher Johns-Krull
Douglas A. Natelson
Uwe Oberlack
Alexander J. Rimberg
B. Paul Padley
Frank R. Toffoletto

Adjunct Professors
David C. Black
James L. Burch
Franklin R. Chang-Diaz
Carolyn Sumners
J. David Winningham

Adjunct Associate Professors
James H. Newman
Tomasz F. Stepinski

Instructors
Nathan Harshman
Gary A. Morris

Distinguished Faculty Fellow
Edward B. Platner

Senior Faculty Fellows
William J. Llope
Pablo P. Yepes

Faculty Fellows
Bernard G. Lindsay
Ian A. Smith

Degrees Offered: B.A., B.S., M.Astron., M.Sp.Sc., M.S.T., M.S., Ph.D.

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 in 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, in astrophysics, and in chemical physics provide preparation for employment or further study in physics and related fields. Students in the professional, nonthesis master's programs obtain advanced training in astronomy, space science, or science teaching. Research facilities and thesis supervision are available for M.S. and Ph.D. 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 16–18). 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*
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)

Additional courses for the B.S. 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*
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 lab)
or CHEM 151/152 *Honors Chemistry* (with lab)

Additional courses for the B.S. 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 327 *Digital Logic Design Laboratory*, 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 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 B.S. 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*
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*

Additional courses for the B.S. degree in astrophysics:
PHYS 302 *Intermediate Electrodynamics*
PHYS 311 *Introduction to Quantum Physics I*
PHYS 425 *Statistical and Thermal Physics*
ASTR 100 *Exploring the Cosmos*
ASTR 230 *Astronomy Laboratory*
ASTR 350/360 *Introduction to Astrophysics—Stars, Galaxies, and Cosmology*
1 topical group, consisting of PHYS 443 *Atmospheric Science*, PHYS 480 *Introduction to Plasma Physics*, and ASTR 470 *Solar System Physics*
or ASTR 430 *Teaching Astronomy Laboratory*, ASTR 450 *Experimental Space Science*, and ELEC 361 *Electronic Materials and Quantum Devices*
or PHYS 312 *Introduction to Quantum Physics II*, PHYS 480 *Introduction to Plasma Physics*, and ASTR 451 *Solar and Stellar Astrophysics)*
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 211 *Introduction to Engineering Computation*
CAAM 336 *Differential Equations in Science and Engineering*
CHEM 121 *General Chemistry with Laboratory*

Additional courses for the B.A. 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*
1 additional PHYS or ASTR course (3 credit hours) at 400 level
NSCI 230 *Computation in Natural Science*
or CAAM 210 or 211 Introduction *to Engineering Computation*
or 1 MATH
or CAAM course (3 credit hours) at or above 300 level

Additional courses for the B.A. degree in astronomy:
PHYS 331 *Junior Physics Laboratory I*
or NSCI 230 *Computation in Natural Science*
PHYS 425 *Statistical and Thermal Physics*
or CHEM 311 *Physical Chemistry*
ASTR 100 *Exploring the Cosmos*
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*

Additional courses for the B.S. degree in chemical physics:
CHEM 121/122 *General Chemistry with Laboratory*
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 *Introductory Module in Experimental Chemistry*, CHEM 373–391, CHEM 435 *Advanced Module in Chemistry*, and PHYS 331, or 332 *Junior Physics Laboratory I* or *II*

6 credit hours from: NSCI 230 *Computation in Natural Science*, CAAM 210, or 211 *Introduction to Engineering Computation*, and MATH, or CAAM courses at or above 300 level

Requirements for Advanced Degrees

For general university requirements, see Graduate Degrees (pages 60–65). More detailed information on courses and requirements is available from the Department of Physics and Astronomy.

The master of astronomy and master of space science require 30 credit hours of approved course work, including at least 9 credit hours of research participation. The master of science teaching requires 30 credit hours of approved course work, which may include up to 12 hours of research participation or practicum training.

The master of science is a research degree, normally undertaken as the first stage of doctoral study. The M.S. 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 Ph.D. degree, graduate students must demonstrate to the department their ability to engage in advanced research. This is normally accomplished by successfully completing the work for the M.S. Students must also 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 Ph.D.

See ASTR (pages 265–267), and PHYS (pages 490–494) in the Courses of Instruction section.