

PHYSICS AND ASTRONOMY

THE WIESS SCHOOL OF NATURAL SCIENCES

CHAIR

F. Barry Dunning

PROFESSORS

Billy E. Bonner
 Anthony A. Choy
 Marjorie D. Corcoran
 Michael W. Deem
 Rui-Rui Du
 Reginald J. Dufour
 James P. Hannon
 Patrick M. Hartigan
 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.
 Qimiao Si
 Paul M. Stevenson

PROFESSORS EMERITI

Stephen D. Baker
 Paul A. Cloutier
 Ian M. Duck
 Arthur A. Few, Jr.
 John W. Freeman
 F. Curtis Michel
 Ronald F. Stebbings
 G. King Walters
 Richard A. Wolf

ASSOCIATE PROFESSORS

David Alexander
 Matthew G. Baring

Stanley A. Dodds
 Thomas C. Killian
 Douglas Natelson
 B. Paul Padley
 Frank R. Toffoletto

ASSISTANT PROFESSORS

Carlos J. Bolech
 Karl M. Ecklund
 Giovanni Fossati
 Franciscus J. M. Geurts
 Jason H. Hafner
 Christopher Johns-Krull
 Ching-Hwa Kiang
 Emilia Morosan
 Uwe Oberlack
 Han Pu

ADJUNCT PROFESSORS

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

ADJUNCT ASSOCIATE PROFESSORS

Hui Li
 Alexander J. Rimberg

INSTRUCTORS

Timothy J. Gilheart
 Dario F. Martinez

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 16–19). 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 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*
 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*

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 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 biological physics

PHYS 302 *Intermediate Electrodynamics*
 PHYS 311/312 *Introduction to Quantum Physics I and II*
 PHYS 355 *Introduction to Biological 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.)

BIOS 201 *Introductory Biology*
 BIOS 211 *Introduction to Experimental Biosciences*
 BIOS 301 *Biochemistry*
 or BIOS 341 *Cell Biology*
 CHEM 121/122 *General Chemistry with Laboratory*
 or CHEM 151/152 *Honors Chemistry with Laboratory*
 CHEM 211 *Organic Chemistry*
 MATH 381 *Introduction to Partial Differential Equations*
 or CAAM 336 *Differential Equations in Science and Engineering*

Additional courses for 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*

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*

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*
 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 CAAM 210 *Introduction to Engineering Computation*

PHYS 425 *Statistical and Thermal Physics* or CHEM 311 *Physical Chemistry*

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 BS degree in chemical physics

CHEM 121/122 *General Chemistry* or

CHEM 151/152 *Honors Chemistry with Laboratory*

CHEM 211 *Organic Chemistry* or CHEM 251 *Honors 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 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*, CAAM 210, *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 61–62). 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.