**Physics (PHY)**

### Major and Minor in Physics

**Department of Physics and Astronomy, College of Arts and Sciences**

- **Chairperson:** Peter Koch  
- **Assistant to the Chair:** Pam Burris  
- **Director of Undergraduate Studies:** Deane Peterson  
- **Astronomy Coordinator:** James Lattimer

Minors of particular interest to students majoring in Physics: Astronomy (AST), Computer Science (CSE), Electrical Engineering (ESE), Materials Science (ESM), Mathematics (MAT), Nanotechnology Studies (NTS), Science and Engineering (LSE)

### Faculty

**Alexander Abanov**, Associate Professor, Ph.D., University of Chicago: Theoretical condensed matter physics.

**Philip B. Allen**, Professor, Ph.D., University of California, Berkeley: Theoretical condensed matter physics.

**Meigan Arons**, Professor, Ph.D., University of Illinois Urbana-Champaign: Experimental solid-state physics.

**Dimitri Averin**, Associate Professor, Ph.D., Harvard University: Theoretical condensed matter physics.  
**Gerald E. Brown**, Distinguished Professor, Ph.D., Yale University: Experimental high-energy physics.

**Deane M. Peterson**, Associate Professor, Ph.D., Stony Brook University: Theoretical condensed matter physics.  

**Maria Concepcion Gonzalez-Garcia**, Associate Professor, Ph.D., Universidad de Valencia: Particle physics phenomenology, neutrino physics.  
**Erlend H. Graf**, Associate Professor, Ph.D., Cornell University: Experimental high-energy physics.  
**Paul D. Grannis**, Distinguished Professor Emeritus, Ph.D., University of California, Berkeley: Experimental high-energy physics.

**Michael Gurvitch**, Professor, Ph.D., Stony Brook University: Experimental solid-state physics.

**Thomas Hemmick**, Distinguished Teaching Professor, Ph.D., University of Rochester: Experimental relativistic heavy-ion nuclear physics. Recipient of the State University Chancellor's Award for Excellence in Teaching, 1996.

**John Hobbs**, Associate Professor, Ph.D., University of Chicago: Experimental high-energy physics.

**Barbara Jacak**, Distinguished Professor Emeritus, Ph.D., Michigan State University: Experimental nuclear physics; relativistic heavy ions.

**Chris Jacobsen**, Professor, Ph.D., Stony Brook University: X-ray physics.

**Chang Kee Jung**, Professor, Ph.D., Indiana University: Experimental high-energy physics.

**Peter B. Kahn**, Professor Emeritus, Ph.D., Northwestern University: Theoretical physics; nonlinear dynamics.

**Peter M. Koch**, Professor, Ph.D., Yale University: Experimental atomic physics; quantum chaos; nonlinear dynamics.

**Jin Koda**, Assistant Professor, Ph.D., University of Tokyo: Extragalactic astronomy and atmospheric studies.

**Vladimir Korotin**, Professor, Ph.D., Leningrad University: Exactly solvable models in quantum field theory. Member, Yang Institute for Theoretical Physics.


**Kenneth M. Lanzetta**, Professor, Ph.D., University of Pittsburgh: Observational cosmology.  
**James Lattimer**, Professor, Ph.D., University of Texas: Nuclear astrophysics.  
**Linwood L. Lee, Jr.**, Professor Emeritus, Ph.D., Yale University: Experimental nuclear structure.  
**Konstantin Likharev**, Distinguished Professor, Ph.D., Moscow State University: Solid-state physics.

**James Lukens**, Professor, Ph.D., University of California, San Diego: Experimental solid-state physics.

**Robert L. McCarthy**, Professor, Ph.D., University of California, Berkeley: Experimental elementary particle physics.

**Emily E. Mendez**, Professor, Ph.D., Massachusetts Institute of Technology: Experimental high-energy and relativistic heavy-ion physics.

**Emilio M. Napolitano**, Professor, Ph.D., California Institute of Technology: Experimental solid-state physics.


**Stanimir Metchev**, Assistant Professor, Ph.D., California Institute of Technology: Astronomy of brown dwarfs and exoplanet systems.


**Vijay Patel**, Research Assistant Professor, Ph.D., Stony Brook University: Experimental solid-state physics.

**Gilad Perez**, Assistant Professor, Ph.D., Weizmann Institute: Theoretical high-energy physics. Member, Yang Institute for Theoretical Physics.

**Deane M. Peterson**, Associate Professor, Ph.D., Stanford University: Observational stellar astronomy.

**Leonardo Rastelli**, Associate Professor, Ph.D., Massachusetts Institute of Technology: Theoretical physics. Member, Yang Institute for Theoretical Physics.

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Teaching Assistants
Estimated number: 49

Physics
Physics is the study of the basic physical principles that govern our universe. This study uses the language of mathematics and is applied in all other natural sciences (astronomy, chemistry, biology, geology, etc.) and engineering. The objective of the major in Physics is to teach students those principles, and, in general, how to think scientifically about the physical world.

A basic education in physics is also applicable to many other fields, including astronomy, engineering, computer programming, geology, biophysics, medicine, medical technology, teaching, law, business, etc. Since the basic principles of physics do not go out of style, and will be the basis for many new technologies, the Physics major provides the ability to adapt to new conditions; hence its permanent value. After graduation approximately half of our Physics majors go on to graduate school, either in physics or in a related field (such as those mentioned above). The other half initially take positions in industry, but many of them later return to graduate school.

Astronomy
See the Astronomy entry in the alphabetical listings of Approved Majors, Minors, and Programs for Astronomy courses and major requirements.

Courses Offered in Physics
See the Course Descriptions listing in this Bulletin for complete information.

PHY 104 Opportunities in Physics
PHY 112-E Light, Color, and Vision
PHY 113-E Physics of Sports
PHY 114-E Electromagnetism, Waves and Radiation for Sports Science
PHY 115 Physics of Sports Laboratory
PHY 116 Electromagnetism, Wave and Radiation for Sports Science Laboratory
PHY 119-E Physics for Environmental Studies
PHY 121-E, 123 Physics for the Life Sciences I with Laboratory
PHY 122-E, 124 Physics for Life Sciences II with Laboratory
PHY 125-E Classical Physics A with Laboratory
PHY 126-E Classical Physics B with Laboratory
PHY 127-E Classical Physics C with Laboratory
PHY 131-E, 133 Classical Physics I with Laboratory
PHY 132-E, 134 Classical Physics II with Laboratory
PHY 141-E, 142-E Classical Physics I, II: Honors, with Laboratory
PHY 191, 192 Transitional Study
PHY 200 Physics Today
PHY 237-H Current Topics in World Climate and Atmosphere
PHY 251, 252 Modern Physics with Laboratory
PHY 277 Computation for Physics and Astronomy
PHY 287 Introduction to Research
PHY 291 Transitional Study
PHY 300 Waves and Optics
PHY 301, 302 Electromagnetic Theory I, II
PHY 303 Mechanics
PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
PHY 308 Quantum Physics
PHY 310 Probability and Statistics for Experimental Physics
PHY 311 Connections in Science
PHY 313-H Mystery of Matter
PHY 315-E Hands-On Science with Cosmic Rays: Experimental Research for Non-Physics Majors
PHY 335 Electronics and Instrumentation Laboratory
PHY 382-H The Quantum Moment: Quantum Mechanics in Philosophy, Culture, and Life
PHY 390 Special Topics in Physics
PHY 405 Advanced Quantum Physics
PHY 408 Relativity
PHY 431 Nuclear and Particle Physics
PHY 445 Senior Laboratory
PHY 447 Tutorial in Advanced Topics
PHY 452 Lasers
PHY 472 Solid-State Physics
PHY 475 Undergraduate Teaching Practicum
PHY 487 Research
Requirements for the Major in Physics (PHY)
The major in Physics leads to the Bachelor of Science degree. Each course used to satisfy the major numbered 300 or above must be completed with a grade of C or higher; a maximum of three courses at the 100 or 200 level passed with a grade of C- may be applied to the major.

Completion of the major requires approximately 67 credits.

A. Courses in Physics
PHY 131/133, 132/134 Classical Physics I, II with Laboratories
(See Note 1)
PHY 251/252 Modern Physics with Laboratory
PHY 277 Computation for Physics and Astronomy
PHY 300 Waves and Optics
PHY 301 Electromagnetic Theory
PHY 303 Mechanics
PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
PHY 308 Quantum Physics
PHY 335 Electronics and Instrumentation Laboratory
PHY 445 Senior Laboratory

Notes:
1. The sequence PHY 125, 126, 127 or PHY 141, 142 may substitute for PHY 131/133, 132/134. PHY 127 may be taken before PHY 126.
2. At least four courses numbered 300 or above must be taken at Stony Brook.

B. Courses in Mathematics
1. One of the following sequences:
   MAT 125, 126, 127 Calculus A, B, C
   or MAT 131, 132 Calculus I, II
   or MAT 141, 142 Honors Calculus I, II
   or MAT 171 Accelerated Single Variable Calculus
   or AMS 151, 161 Applied Calculus I, II
2. One of the following:
   MAT 205 Calculus III
   or MAT 203 Calculus III with Applications
   or AMS 261 Applied Calculus III
3. One of the following:
   MAT 305 Calculus IV
   or MAT 303 Calculus IV with Applications
   or AMS 361 Applied Calculus IV: Differential Equations

Note: Equivalency for MAT courses achieved on the Mathematics Placement Examination is accepted as fulfillment of the corresponding requirements, as indicated in the Course Descriptions section of this Bulletin.

C. Courses in Related Fields
Twelve credits of acceptable physics-related courses that complement a Physics major’s education. A list of acceptable courses is posted in the Physics and Astronomy Undergraduate Office.

D. Upper-Division Writing Requirement
Students are certified as satisfying the upper-division writing requirement by completing a writing project within their major. Scientific research is often presented using a terse language, but physicists and astronomers must also write engagingly in funding applications and in communicating their work to others. This is what is expected in writing submitted to meet this requirement. Within the first month of the semester in which the student plans to satisfy the requirement, the student should speak with the course instructor or research supervisor about his or her intent to expand upon a course assignment (for example by adding a discussion of the history and significance of a physics experiment) or research project to meet the upper-division writing requirement. If there are questions over the suitability of the proposed writing project, the student should discuss the proposal with the undergraduate program director. Students should obtain comments on a draft of their text during the course of the semester, and the final text should be submitted to the instructor or research supervisor by the last day of the month of the semester in which the course is offered. Suggestion for the writing requirement is set by the B.S. in Physics, a student must satisfy the following:

1. PHY 487 Research
2. Two other 400-level physics courses
3. Overall grade point average of at least 3.30 in all physics courses numbered 300 or higher.

The Research Program
Students who wish to pursue graduate study in physics should choose a program similar to this suggested example:

Freshman Year
PHY 131/133 Classical Physics I with Laboratory
or PHY 141 Classical Physics I: Honors
PHY 132/134 Classical Physics II with Laboratory
or PHY 142 Classical Physics II: Honors
MAT 131 Calculus I
MAT 132 Calculus II

Sophomore Year
PHY 251/252 Modern Physics with Laboratory
PHY 277 Computation for Physics and Astronomy
PHY 300 Waves and Optics
MAT 205 Calculus III
MAT 305 Calculus IV
CHE 131, 132 General Chemistry
or CHE 141, 142 Honors Chemistry
CHE 133, 134 General Chemistry Laboratory
or CHE 143, 144 Honors Chemistry Laboratory

Junior Year
PHY 301, 302 Electromagnetic Theory
PHY 303 Mechanics
PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
PHY 308 Quantum Physics
PHY 335 Electronics and Instrumentation Laboratory
MAT 211 Linear Algebra
MAT 341 Applied Real Analysis
MAT 342 Applied Complex Analysis
Sample Course Sequence for the Major in Physics

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall Credits</th>
<th>Spring Credits</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>First Year Seminar 101 1&lt;br&gt;PHY 131/133 4&lt;br&gt;MAT 131 4&lt;br&gt;D.E.C. 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 15</td>
<td>First Year Seminar 102 1&lt;br&gt;PHY 132/134 4&lt;br&gt;MAT 132 4&lt;br&gt;D.E.C. 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 15</td>
</tr>
<tr>
<td>Sophomore</td>
<td>PHY 251/252 4&lt;brPHY 277 3&lt;br&gt;MAT 205 3&lt;br&gt;D.E.C. 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 16</td>
<td>PHY 300 4&lt;br&gt;MAT 305 3&lt;br&gt;D.E.C. 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 16</td>
</tr>
<tr>
<td>Junior</td>
<td>PHY 301 3&lt;br&gt;PHY 303 3&lt;br&gt;PHY-related elective 3&lt;br&gt;MAT 211 or 341 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 15</td>
<td>PHY 306 3&lt;br&gt;PHY 308 3&lt;br&gt;MAT 335 3&lt;br&gt;MAT 211 or 342 3&lt;br&gt;Elective 3&lt;br&gt;Total 15</td>
</tr>
<tr>
<td>Senior</td>
<td>PHY 487 3&lt;br&gt;PHY elective 3&lt;br&gt;PHY-related elective 3&lt;br&gt;D.E.C. 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 15</td>
<td>PHY 445 3&lt;br&gt;PHY elective 3&lt;br&gt;PHY-related elective 3&lt;br&gt;PHY-related elective 3&lt;br&gt;D.E.C. 3&lt;br&gt;Total 15</td>
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**Senior Year**
- PHY 405 Advanced Quantum Physics
- PHY 445 Senior Laboratory

At least 3 credits of PHY 487 research, and one other 400 level course.

Note: Of the courses mentioned above, MAT 211, MAT 341, MAT 342, PHY 302, and 400 level courses other than PHY 445 are not required for the B.S. in Physics.

**Specialization in Optics**

Students majoring in Physics may decide to pursue a specialization in Optics. This specialization is listed on the official transcript. The director of the specialization is Professor Harold Metcalf.

Students must complete the following courses with a grade of C or better to satisfy the requirements for the specialization:

**A. Required Departmental Courses (12 credits)**
- PHY 301 Electricity and Magnetism I
- PHY 302 Electricity and Magnetism II
- PHY 308 Quantum Mechanics I
- PHY 452 Lasers

**B. Optics-Related Laboratory Experience**
- PHY 487 Research (at least 3 credits, optics related)

**C. One Additional Elective Course:**
- Either PHY 405 Advanced Quantum Mechanics, or one of many courses in other departments including the College of Engineering and Applied Sciences (CEAS) that could meet the requirements for this additional elective. Advance approval of such courses must be obtained from the Director of Undergraduate Studies. Examples of such courses in the CEAS are: ESE-340, (Communication Theory); ESE-357 (Digital Image Processing); ESE-358 (Computer Vision); ESE-362 (Opto-electronic Devices); ESE-363 (Fiber Optic Communications); and ESM-325 (Diffraction Techniques).
Physics Secondary Teacher Education Program
See the Education and Teacher Certification entry in alphabetical listings of Approved Majors, Minors, and Programs.

Introductory Physics Sequences
The Department of Physics offers four Introductory Physics Sequences. The PHY 121/123, 122/124 sequence is designed specifically for students majoring in biological sciences or pre-clinical programs. Any of the other three sequences (PHY 131/133, 132/134; PHY 141, 142; PHY 125, 126, 127) together with PHY 251/252 constitute a comprehensive introduction to classical and modern physics for those who may major in Physics, other physical sciences, or engineering. These three Introductory Physics Sequences cover the same material, although the pace is different. The two-semester sequence (PHY 131/133, 132/134 or PHY 141, 142) should be taken only by students who are prepared for a pace considerably faster than that of the PHY 125, 126, 127 three-semester sequence. The PHY 141, 142 sequence is designed for students with the strongest interest and preparation in physics and mathematics. The flow chart shows the four basic Introductory Physics Sequences available. (In the PHY 125, 126, 127 sequence, 126 and 127 may be taken in either order.)

The Minor in Physics (PHY)
The minor in Physics is available for students who want their University studies to include significant upper-division work in physics.

All courses offered for the minor must be passed with a letter grade of C or higher. Completion of the minor requires 20 physics credits beyond the Introductory Physics Sequence.

Requirements for the Minor in Physics for students with majors in the College of Arts and Sciences:
1. PHY 251/252 Modern Physics
2. PHY 300 Waves and Optics
3. PHY 301 Electromagnetic Theory
4. PHY 303 Mechanics
5. PHY 335 Electronics and Instrumentation Laboratory
6. One of the following:
   PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics

Requirements for the Minor in Physics for students with majors in the College of Engineering and Applied Sciences:
1. PHY 251/252 Modern Physics
2. One of the following:
   PHY 300 Waves and Optics
   ESE 321 Electromagnetic Waves and Wireless Communication
   ESG 281 An Engineering Introduction to the Solid State
3. One of the following:
   PHY 301 Electromagnetic Theory
   ESE 319 Introduction to Electromagnetic Fields and Waves
4. PHY 303 Mechanics
5. One of the following:
   PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
   ESM 309 Thermodynamics of Solids
   MEC 398 Thermodynamics II
6. One of the following:
   PHY 335 Electronics and Instrumentation Laboratory
   ESE 314 Electronics Laboratory B

CHE 302 Physical Chemistry II