PRINCETON UNIVERSITY

DEPARTMENT OF PHYSICS

Princeton, New Jersey 08544
http://princeton.edu/physics

General University Information
President: Christopher Eisgruber
Dean of Graduate School: Acting Dean Cole M. Crittenden
University website: http://www.princeton.edu
Control: Private
Total Faculty: 1,175
Total number of Students: 7,910
Total number of Graduate Students: 2,666

Department Information
Department Chairman: Prof. Herman Verlinde, Chair
Department Contact: James Olsen, Director of Graduate Studies
Total full-time faculty: 39
Full-Time Graduate Students: 132
First-Year Graduate Students: 29
Female First-Year Students: 7
Total Post Doctorates: 29

Department Address
Washington Road
Jadwin Hall
Princeton, NJ 08544
Phone: (609) 258-4910
E-mail: phydgs@princeton.edu
Website: http://princeton.edu/physics

TUITION
Tuition year 2017–18:
Full-time students: $47,140 annual
Deferred tuition plan:
Health insurance: Yes, 1,900.

Teaching Assistants, Research Assistants, and Fellowships
Number of first-year
Fellowship students: 29
Average stipend per academic year
Teaching Assistant: $31,100
Research Assistant: $28,150
Fellowship student: $28,150

FINANCIAL AID
Loans
Loans are not available for U.S. students.
Loans are not available for international students.
GAPSFAS application required: No
FAFSA application required: No
For further information
Address financial aid inquiries to: Asst. Dean of Financial Affairs, Graduate School, 204 Nassau Hall, Princeton, NJ 08544.
Phone: (609) 258-3030
E-mail: gs@princeton.edu
Financial aid website: http://gradschool.princeton.edu/costs-funding

HOUSING
Availability of on-campus housing
Single students: Yes
Married students: Yes
For further information
Address housing inquiries to: Graduate Housing Department
MacMillan Building, Princeton University, Princeton, NJ 08544.
Phone: (609) 258-4360
E-mail: gradhsg@princeton.edu
Housing aid website: http://gradschool.princeton.edu/admission/admitted-degree-students/additional-requirements/graduate-housing
New Jersey

Princeton U., Phys.

Table A—Faculty, Enrollments, and Degrees Granted

<table>
<thead>
<tr>
<th>Research Specialty</th>
<th>2016-2017 Faculty</th>
<th>2016-2017 Enrollments</th>
<th>Number of Degrees Granted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic, Molecular, &amp; Optical Physics</td>
<td>3</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Biophysics</td>
<td>4</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Computational Physics</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Condensed Matter Physics</td>
<td>8</td>
<td>47</td>
<td>7</td>
</tr>
<tr>
<td>Cosmology &amp; String Theory</td>
<td>5</td>
<td>34</td>
<td>5</td>
</tr>
<tr>
<td>High Energy Physics</td>
<td>15</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>Particles and Fields</td>
<td>2</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>200</td>
<td>23</td>
</tr>
<tr>
<td>Full-time Grad. Stud.</td>
<td>115</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First-year Grad. Stud.</td>
<td>26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRADUATE DEGREE REQUIREMENTS

Master’s: The master’s degree is conferred only after passing a general examination. (Students who want to work toward a master’s degree only will not be admitted.)

Doctorate: The formal course requirements include three core courses to be taken between the beginning of the first year of study and the end of the second year. (This requirement is part of the general examination.) Students taking these courses must achieve a grade of B or higher. In addition, one year of residency is required; general examination and the dissertation are required.

Thesis: Thesis may be written in absentia.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

Theoretical research spans most of the central topics of modern physics. The department has decades-old traditions of excellence and leadership in these core areas of fundamental physics, and it is also rapidly building strength in newer areas, such as theoretical biology. In the newer areas, interaction between physics and other departments is critical, and major university-supported interdisciplinary initiatives provide a strong framework for this cooperation. There is also productive interaction between theorists in the department and those at the nearby Institute for Advanced Studies, although there is no formal connection between these institutions.

The high-energy theory group works on quantum field theory, particle phenomenology and cosmology, string theory and quantum gravity models in various dimensions, and dualities between gauge theories and strings. Some members of the group are also interested in applications of quantum field theory and string theory to problems in statistical mechanics, the theory of turbulence, heavy-ion collisions, and condensed matter physics.

The cosmology theory group uses astrophysical, particle physics, and superstring theory combined with observations to study gravitation and the origin, composition, and evolution of the universe.

The theoretical condensed matter group works on quantum many-body theory of systems involving strong correlations and/or disorder, statistical mechanics, biological systems, and systems far from equilibrium.

The mathematical physics group is concerned with problems in statistical mechanics, atomic and molecular physics, quantum field theory, and, in general, with the mathematical foundations of theoretical physics.

The theoretical biophysicists work on problems in statistical mechanics and information theory that arise in studying nervous systems, gene expression networks, the organization of genomes, and the mechanisms of evolution.

Experiments in high-energy particle physics are directed toward understanding the fundamental interactions and particle structures at extremely small distances. The apparatus is designed and constructed in the physics shops in Jadwin Hall or at the nearby Elementary Particles Laboratory, which contains special facilities for the fabrication of detectors. The experiments are performed at large national and international laboratories, which currently include CERN (Switzerland), Fermilab (Illinois), and SLAC (California). The data are then analyzed at Princeton University.

The nuclear and particle astrophysics group is active in experimental studies of solar neutrinos and dark matter. The goal of the solar neutrino program is to explore neutrino oscillations and solar processes through a measurement of the low-energy 7Be neutrino. Neutrinos will be detected with the Borexino liquid scintillation detector located in the Gran Sasso underground laboratory in Italy.

The dark matter group is designed to detect WIMPs in the galaxy by their collisions with either xenon or argon nuclei in a scintillation-ionization detector made of the rare gas atoms. Experiments are under development to provide a definitive search for rare WIMP collisions by combining the unique scintillation properties of the rare gas atoms with the low background methods developed for the Borexino solar neutrino experiment.

Research in the condensed-matter physics group seeks to understand electronic behavior in novel low-dimensional solids in which interaction and correlation effects are dominant. Problems investigated have included the fractional and integer quantum Hall effects, high-temperature superconductivity, Kondo effect in quantum dots, spin-density-wave states in organic conductors, highly frustrated quantum-spin systems, and novel excitations in low-dimensional magnetic systems.

The research involves close collaborations between experimentalists and theorists, as well as with faculty in the Chemistry and Electrical Engineering Departments.

Experimental groups are also engaged in researching novel patterning techniques using diblock copolymers (with faculty in Chemical Engineering) and techniques for single-molecule detection and separation of biological molecules (with Molecular Biology and the Genomics Center).

In the experimental cosmology group, students often design and build specialized instrumentation to make unique and precise measurements, or analyze cosmological data. In recent years, experimental work has emphasized measurements of the anisotropy and polarization of the cosmic microwave background. Among other projects, Princeton is actively involved in all aspects of the WMAP satellite, is the lead institution for the ACT project, and is a collaborator on the QUIET experiment.

Research in atomic physics is primarily focused on spin-polarized gases, liquids, and solids, on their properties, interactions, and a wide range of applications. Among applications currently being developed are searches for violation of CP symmetry beyond the Standard Model, tests of Lorentz invariance, development of miniature atomic clocks, ultra-sensitive atomic magnetometers, and new biomedical techniques, such as lung imaging and mapping of the magnetic fields generated by the brain.
Biological physics spans a huge range of subjects, from neurobiology to genomics to fundamentals of protein action. Princeton has strengths in nearly all areas of modern biological physics. Many faculty with a strong physics background who are involved in biological physics are not solely in the Physics Department but have joint appointments with other departments or are completely in other departments. There is a strong community spirit to biological physics among these departments despite the vast range of subjects being studied.

For more information, please visit www.princeton.edu/physics.

**Table B—Separately Budgeted Research Expenditures by Source of Support**

<table>
<thead>
<tr>
<th>Source of Support</th>
<th>Departmental Research</th>
<th>Physics-related Research Outside Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal government</td>
<td>$19,220,794</td>
<td>$3,562,907</td>
</tr>
<tr>
<td>State/local government</td>
<td>$1,719,570</td>
<td>$323,062</td>
</tr>
<tr>
<td>Non-profit organizations</td>
<td>$120,761</td>
<td></td>
</tr>
<tr>
<td>Business and industry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$21,061,125</td>
<td>$3,885,969</td>
</tr>
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</table>

**Table C—Separately Budgeted Research Expenditures by Research Specialty**

<table>
<thead>
<tr>
<th>Research Specialty</th>
<th>No. of Grants</th>
<th>Expenditures ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrophysics</td>
<td>32</td>
<td>$3,362,839</td>
</tr>
<tr>
<td>Atomic, Molecular, &amp; Optical Physics</td>
<td>13</td>
<td>$1,046,894</td>
</tr>
<tr>
<td>Biophysics</td>
<td>30</td>
<td>$875,467</td>
</tr>
<tr>
<td>Condensed Matter Physics</td>
<td>54</td>
<td>$6,193,586</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>15</td>
<td>$1,078,887</td>
</tr>
<tr>
<td>Particles and Fields</td>
<td>61</td>
<td>$12,220,003</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>$169,418</td>
</tr>
</tbody>
</table>
| Total                                   | 208           | $24,947,094      

**FACULTY**

**Professor**
- **Aizenman, Michael**, Ph.D., Belfer Graduate School of Science, Yeshiva Univ., 1975. Mathematical physics.
- **Bernevig, Bogdan Andrei**, Ph.D., Stanford University. Condensed matter.
- **Gubser, Steven**, Ph.D., Princeton University, 1998. Particle theory.
- **Page, Lyman**, Ph.D., Massachusetts Institute of Technology, 1989. Cosmology; gravitation; relativity.
- **Stagg, Suzanne**, Ph.D., Princeton University, 1993. Cosmology; gravitation; relativity.
- **Verlinde, Herman**, Ph.D., Utrecht University, 1988. Particle theory.

**Associate Professor**

**Assistant Professor**
- **Bakr, Waseem**, Ph.D., Harvard University, 2011.
- **Lisanti, Mariangela**, Ph.D., Stanford University. *Particles and Fields*.

**Emeritus**


**Professor Emeritus**

Lieb, Elliott, Ph.D., Massachusetts Institute of Technology, 1956. Mathematical physics.

**Affiliate Professor**


Sinai, Yakov, Ph.D., Moscow State University, 1960. Professor Mathematics. *Other.*


Torquato, Salvatore, Ph.D., Stony Brook University, 1980. Chemistry.

**Visiting Professor**


Maldacena, Juan, Ph.D., Princeton University, 1996. Particle theory. Visiting Lecturer with rank of Professor.

Seiberg, Nathan, Ph.D., Tel Aviv University, 1982. Visiting Lecturer with rank of Professor. Particle theory.

Witten, Edward, Ph.D., Princeton University, 1976. Visiting Lecturer with rank of Professor. Theoretical physics.

**Associate Faculty**

Tsui, Dan, Ph.D., University of Chicago, 1967. Electrical engineering and computer science.


**DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF**

**Theoretical**

Condensed Matter Physics. The theoretical condensed matter group works on quantum many-body theory of systems involving strong correlations and/or disorder, statistical mechanics, biological systems, and systems far from equilibrium. For more information, visit www.princeton.edu/physics.

Bernevig, Haldane, Sondhi.

Cosmology & String Theory. Working closely with the experimental group, we use astrophysical, particle physics and string theory combined with observations to study gravitation and the origin and evolution of our universe. In cosmology and astrophysics, Einstein’s General Theory of Relativity (GR) is the foundation for everything from models of the universe to the collision of black holes. Our group is a pioneer in the use of numerical GR to understand such things as the gravitational wave signature of merging black hole and neutron star systems, the properties of spacetime and matter fields approaching the big bang, and elements of string theory. The study of the nature of large-scale structure was pioneered in this group *three* decades ago, and we continue to make leading contributions to theories of the origin of this structure. Crucial elements in the work include the measurements by the experimental group of the *2.725* K thermal background radiation, deep observations of galaxies, and the Sloan Digital Sky Survey that operates out of the *neighboring* Department of Astrophysical Sciences. The origin of the physical universe and the cosmological model that describes its evolution must ultimately be explained by fundamental physics. Our group also studies the relationship between particle or string physics and theories of the very early universe, dark matter, the cosmological constant and quintessence. These studies have profound implications for both fundamental physics and cosmology. Dunkley, Gubser, Klebanov, Pufu, Steinhardt, Verlinde.

High Energy Physics. High Energy Experiment - The goal of high energy physics is the understanding of the elementary particles that are the fundamental constituents of matter. The fabulous success of the Standard Model has given us a framework for interpretation of most particle interactions, but it has also created a foundation from which we can begin to explore a deeper level of issues such as the origin of mass, the preponderance of matter over antimatter in the Universe, the identity of "dark matter," the physics of the Big Bang, and the microscopic structure of space-time. High Energy Theory - The research effort of the high energy theory group covers a wide range of fields, including quantum field theory, string theory, quantum gravity models in various dimensions, the theory of turbulence, particle cosmology, phenomenology of the Standard Model and beyond, and also computer simulations of problems that arise in these areas. Giombi, Gubser, Klebanov, Nappi, Pufu, Steinhardt, Verlinde, Witten.

Mathematical Physics. The mathematical physics group is concerned with problems in statistical mechanics, atomic and molecular physics, quantum field theory, and, in general, with the mathematical foundations of theoretical physics. This includes such subjects as quantum mechanics (both nonrelativistic and relativistic), atomic and molecular physics, disorder effects in condensed matter, the existence and properties of the phases of model ferromagnets, the stability of matter, the theory of symmetry and symmetry breaking in quantum field theory (both in general and in concrete models), and mathematical developments in functional analysis, algebra and modern probability theory, to which such subjects lead. In addition to the physics faculty, students in mathematical physics have contact with the faculty of the mathematics department. Aizenman, Lieb.

Experimental

Atomic, Molecular, & Optical Physics. Research in atomic physics is primarily focused on spin-polarized gases, liquids, and solids, on their properties, interactions, and a wide range of applications. Among applications currently being developed are searches for violation of CP symmetry beyond the standard model, tests of Lorentz invariance, development of miniature atomic clocks, ultra-sensitive atomic magnetometers, and new biomedical techniques, such as lung imaging and mapping of the magnetic fields generated by the brain. For more information, please visit www.princeton.edu/physics. Bakr, Romalis.

Biophysics. Biological physics spans a huge range of subjects, from neurobiology to genomics to fundamentals of protein action. Princeton has strengths in nearly all areas of modern biological physics. Many faculty with a strong physics background who are involved in biological physics are not solely in the Physics Department but have joint appointments with other departments or are completely in other departments. There is a strong community spirit to biological physics among these departments despite the vast range of subjects being studied. For more information, please visit www.princeton.edu/physics. Gregor, Leifer.

Condensed Matter Physics. Research in the condensed matter physics group seeks to understand electronic behavior in novel low-dimensional solids in which interaction and correlation effects are dominant. Problems investigated have included the fractional and integer quantum Hall effects, high-temperature superconductivity, Kondo effect in quantum dots, spin-density-wave states in organic conductors, highly frustrated quantum-spin systems, and novel excitations in low-dimensional magnetic systems. The research involves close collaborations between experimentalists and theorists, as well as with faculty in the Chemistry and Electrical Engineering Departments. Experimental groups are also engaged in researching novel patterning techniques using diblock copolymers (with faculty in Chemical Engineering) and techniques for single-molecule detection and separation of biological molecules (with Molecular Biology and the Genomics Center). For more information, please visit www.princeton.edu/physics. Hasan, Ong, Petta, Yazdani.

Cosmology & String Theory. Research on cosmology takes place in a number of places in the Princeton community. The experimental and observational cosmology group in the Physics Department is involved in measurements of the cosmic microwave background (CMB), surveys of large scale cosmic structure, and observations of galactic clusters. The CMB is the afterglow of the hot early stages of the expansion of our universe. In the angular distribution of its temperature and polarization is encoded the history of the evolution of the universe and the values of the cosmological parameters. Measurements have reached the stage where we now have a "standard model of cosmology" and we are exploring the details of the model. These are exciting times. Efforts are underway to find gravitational radiation from the Big Bang, to determine the sum of the neutrino masses, to map out the earliest cosmic structures, and to find the parameters of the fields that produced the Big Bang. Through comparisons with optical surveys we measure how the universe evolved and test theories of gravity. With a new balloon-born optical telescope, we will measure the masses of dozens of galaxy clusters through their gravitational lensing effect... Groth, Jones, Page, Staggs.

Nuclear Physics. The nuclear and particle astrophysics group is active in experimental studies of solar neutrinos and dark matter. The goal of the solar neutrino program is to explore neutrino oscillations and solar processes through a measurement of the low-energy 7Be neutrino. Neutrinos will be detected with the Borexino liquid scintillation detector located in the Gran Sasso underground laboratory in Italy. For more information, please visit www.princeton.edu/physics. Lisanti.

Particles and Fields. Experiments in high-energy particle physics are directed toward understanding the fundamental interactions and particle structures at extremely small distances. The apparatus is designed and constructed in the physics shops in Jadwin Hall or at the Elementary Particles Laboratory a block away, which contains special facilities for the fabrication of detectors. The experiments are performed at large national and international laboratories, which currently include CERN (Switzerland), Fermilab (Illinois), KEK (Japan), and SLAC (California). The data are then analyzed at Princeton. For more information, please visit www.princeton.edu/physics. Olsen, Piroue, Tully.

View additional information about this department at www.gradschoolshopper.com