



# **UNIVERSITY OF CALIFORNIA**

## **PHYSICS GRADUATE STUDY AT BERKELEY**

### **INTRODUCTION**

---

#### **THE BERKELEY CAMPUS**

South Hall, the oaks along Strawberry Creek, and the eucalyptus grove link the Berkeley campus to its beginning over a century ago. While the campus has grown considerably since then, it has retained much of the tranquil beauty of its rural past and is now a park-like oasis in an urban setting. Students study, work, and relax among Neoclassical buildings, wooded glens, and hills spread across 1,232 scenic acres overlooking the San Francisco Bay.

The campus is centered in the city of Berkeley (population 115,403), which has a long history as one of America's most lively, culturally diverse and politically adventurous cities. The surrounding San Francisco Bay Area offers recreation, entertainment and natural beauty without rival, much of which is accessible by BART (Bay Area Rapid Transit), and all of which is within easy reach. San Francisco is just over the bridge; the wine country and Point Reyes National Seashore are a short drive north; the Monterey Peninsula and Big Sur, a short drive south; and Lake Tahoe, the Sierra Nevada mountains, and Yosemite National Park are close enough for weekend skiing and backpacking trips.

Apart from its scenic beauty, Berkeley is also renowned for its academic excellence. Its faculty includes 22 Nobel laureates, 139 members of the National Academy of Sciences, 97 members of the National Academy of Engineering, and more Guggenheim Fellows and Presidential Young Investigators than there are at any other university in the country. In a recent national study, Berkeley was the only college or university that had every one of its departments ranked among the top five in the country. By any standard, Berkeley ranks as one of the world's leading intellectual centers, renowned for the size and quality of its libraries and laboratories, the scope of its research and publications, and the distinction of its faculty and students.

#### **THE DEPARTMENT OF PHYSICS**

A short distance east of the Campanile (the landmark bell tower of the Berkeley campus), old LeConte, new LeConte and Birge Halls house much of the teaching and research activity of the Department. Larger scale accelerator experiments and plasma physics research activities are situated on "The Hill" at the Lawrence Berkeley National Laboratory (LBNL). Research is also conducted at Stanford Linear Accelerator Center, Fermi National Accelerator Laboratory, Lick Observatory and at various research centers throughout the world.

Within the LeConte-Birge complex are classrooms and student laboratories where about 3,000 students attend lecture, discussion and experimental laboratory classes. The teaching faculty consists of approximately sixty full and part time professors. They are assisted by about 120 Graduate Student Instructors who meet with undergraduate students in smaller weekly sections. Physics is taught to freshman and sophomore students in three academic plans: 1) engineers and physical scientists, 2) medical and biological scientists, and 3) non-science majors. Most junior and senior physics courses, as well as graduate courses, are taken by physics majors along with students from other sciences and engineering. While lower division courses range in size from 20-330, upper division courses from 10 to 90 students.

In addition to teaching physics, the faculty is devoted to the pursuit of original research in collaboration with their graduate students. Through laboratory practice and theoretical guidance, as well as regular research seminars, graduate students are exposed to forefront theories and techniques. Weekly department wide colloquia and teas permit association with distinguished visitors from other laboratories and institutions throughout the world. Opportunities exist for pursuing a wide range of topics for dissertation research. Specialty areas in theoretical physics include astrophysics, condensed matter, elementary particles and fields, fusion and plasma, general relativity, mathematical physics, nuclear physics and statistical mechanics. In the experimental area strong research efforts exist in the fields of astrophysics, atomic physics, condensed matter, cosmology, elementary particles, energy and resources, fusion and plasma, geochronology, low temperature, biophysics, optical and laser spectroscopy, and space physics.

The Department offers opportunities and resources to encourage students to express their creativity and inventiveness. Some of the student run extra-curricular activities, including: the Physics Graduate Student Association, the Society of Women in the Physical Sciences, The Compass Project, Career Development Initiative in the Physical Sciences and others. In addition, selected undergraduates and graduate students participate in various departmental committees working on PhD program requirements, course offerings, and departmental policy.

# PHYSICS FACULTY AND RESEARCH AREAS

## ASTROPHYSICS

A wide range of research opportunities in astrophysics is represented on the Berkeley campus. Current experimental programs include magnetospheric physics, space plasmas and fields, spectrum and anisotropy of the cosmic microwave background radiation, infrared spectroscopy and spatial inter-ferometry, gamma-ray astrophysics, experimental cosmology and the search for dark matter. Theorists study the interstellar medium, radio pulsars, star formation, neutron stars, asteroseismology, galaxy formation and cosmology. Astrophysical research is carried out at the Center of Particle Astrophysics, SSL, LBNL, and in close association with the Astronomy Department and the Theoretical Astrophysics Center.

### ASTROPHYSICS EXPT

Stuart Bale  
Steven Boggs  
Marc Davis  
Reinhard Genzel  
William Holzapfel  
Adrian Lee  
Daniel McKenzie  
Richard Muller  
Saul Perlmutter  
P. Buford Price (POG)  
Matthew Pyle  
Paul Richards (POG)  
Bernard Sadoulet  
George Smoot (E)

### ASTROPHYSICS THEORY

Jonathan Arons (E)  
Wick Haxton  
Daniel Kasen  
Christopher McKee (E)  
Eliot Quataert  
Uros Seljak  
Martin White

## ATOMIC, NUCLEAR, AND OPTICAL PHYSICS

Research opportunities in atomic and optical physics span a broad spectrum of topics, including: precision measurements; quantum and non-linear optics; laser cooling and atom trapping; short-pulse, high-power lasers; laser spectroscopy; beam-foil spectroscopy, spectroscopy related to astrophysics. Ongoing experiments include precision measurements of parity violating effects in atoms, a search for the electric dipole moment of the electron, atom trapping and cooling in optical lattices, the production and study of laser-induced plasmas, generation of ultra-short pulse x-rays, studies of causal superluminal wave propagation, creation of solitons in atomic vapors, and the spectroscopy of rare-earth atoms, molecules, and highly ionized charged plasmas.

Nuclear physics interests complement work in atomic particle physics, and include tests of time reversal non-invariance in nuclear and neutron beta decay, precision measurements of Standard Model parameters, particle searches, and tests of fundamental symmetries in nuclear and atomic systems. Much of the this work uses techniques drawn from atomic physics techniques such as trapping of radioactive atoms. Nuclear physics research is carried out on campus, at LBNL 88' cyclotron and at other facilities.

Dmitry Budker  
Roger Falcone  
Harmut Häfner  
Naomi Ginsberg  
Stephen Leone  
Holger Müller  
Dan Stamper-Kurn  
Norman Yao

## CONDENSED MATTER PHYSICS AND MATERIALS SCIENCES

Berkeley boasts a large community of researcher in condensed matter physics and materials sciences with diverse interests, both on campus at nearby LBNL. Experimental research with both basic and applied components includes conventional and high-temperature superconductivity, semiconductor physics, superfluidity and low temperature physics, magnetism, surface science, the quantized Hall effect, physics of nanostructures, optical properties of solids, liquid crystals, magnetic resonance, new spectroscopies, the development of new materials, and environmental physics. Theoretical efforts include the calculation of electronic and vibrational properties of solids, statistical mechanics of phase transitions, and many-body physics of interacting Fermi and Bose systems, including magnetism and superconductivity. Nanofabrication facilities on campus and at LBNL are additional resources for researchers in this area.

### CONDENSED MATTER EXPT

James Analytis  
Robert Birgeneau  
John Clarke (POG)  
Michael Crommie  
Frances Hellman

### CONDENSED MATTER THEORY

Ehud Altman  
Marvin Cohen (POG)  
Dung-Hai Lee  
Steven Louie  
Joel Moore

## CONDENSED MATTER EXPT    CONDENSED MATTER THEORY

Alessandra Lanzara  
Richard Packard (E)  
Zi Qiang Qiu  
Ramamoorthy Ramesh  
Yuen-Ron Shen (E)  
Irfan Siddiqi  
Feng Wang  
Alex Zettl

Jeffrey Neaton

## BIOPHYSICS

Structural biologists use x-ray crystallography, nuclear magnetic resonance, and a variety of computational techniques to study the static and dynamic properties of biomolecules with atomic resolution in research groups within the department of molecular and cell biology, chemistry and at LBNL. The campus also supports a strong program in neuroscience, investigating a wide range of problems at the molecular, cellular, and systems levels. Fundamental research in the physics of liquids and polymers is carried out in the chemistry and chemical engineering departments. Special facilities include the National Center for Electron Microscopy, the Calvin Laboratory for Chemical Dynamics, and the Advanced Light Source at LBNL.

Carlos Bustamante  
Michael DeWeese  
Oskar Hallatschek  
Daniel Rokhsar  
Ahmet Yildiz

## PARTICLE PHYSICS

Many research opportunities are available in elementary particle physics at Berkeley, with additional opportunities available via strong connections with LBNL. Theoretical work spans the full range of energy scales, from particle spectroscopy, perturbative QCD, and related phenomenology to studies of grand unification theories, supersymmetry, supergravity, and superstring theories, and general gauge theories of strong and electroweak interactions. Experimental activities at Fermilab and at the nearby Stanford Linear Accelerator Center (SLAC) examine important aspects of electroweak symmetry breaking. CP violation, and the physics of the heavy b and t quarks. Non-accelerator experiments study neutrinos and rare processes. Detector development is being done for these projects, and in preparation for experiments at the Large Hadron Collider (LHC).

### PARTICLE PHYSICS EXPT

Beate Heinemann  
Barbara Jacak  
Robert Jacobsen  
Yury Kolomensky  
Kam-Biu Luk  
Gabriel Orebi Gann  
Majorie Shapiro  
James Siegrist

### PARTICLE PHYSICS THEORY

Mina Aganagic  
Raphael Bousso  
Mary K. Gaillard (POG)  
Ori Ganor  
Lawrence Hall  
Wick Haxton  
Petr Hořava  
Hitoshi Murayama  
Yasunori Nomura  
Surjeet Rajendran

## PLASMA AND NONLINEAR DYNAMICS

The study of plasma physics and nonlinear dynamics focuses on the properties of classical, collective, many-body systems. Application include plasma processing, fusion, and fluid dynamics. At Berkeley, active areas of research include advance accelerators, astro and space plasmas, basic and theoretical plasma physics, heavy ion fusion, high power laser-plasma interactions, ion beam generation, plasma processing, plasma simulations, pure-electron plasmas, dissipative systems, ergodic processes, fluid dynamics, pattern formation, and semiclassical theory. Research is carried out in the Physics Department, LBNL, SSL, as well as in the Astronomy, Math, Chemical, Electrical, and Nuclear Engineering Departments.

Joel Fajans  
Edgar Knobloch  
Robert Littlejohn  
Jonathan Wurtele

(E=Emeritus, POG = Professor of Graduate School)

You may access our faculty and research information on the Web at

<http://www.physics.berkeley.edu/Research>

# THE DOCTORAL PROGRAM

## COURSE REQUIREMENTS

Requirements for the Ph.D. include the following courses: Physics 209 (Classical Electromagnetism), Physics 211 (Equilibrium Statistical Physics) and Physics 221A-221B (Quantum Mechanics) plus 19 units (five semester courses) of approved upper division or graduate elective courses (excluding any upper division courses required for the undergraduate major), of which, at least 11 units must be in the 200 series courses. Some of the 19 units could include courses in mathematics, biophysics, or astrophysics. Consult department postings for elective recommendations. Physics 290, 295, 299, 301 and 602 are excluded from the 19 elective units. Physics 209, 211 and 221A-221B must be completed for a letter grade (averaging at least B). No more than one-third of the 19 elective units may be fulfilled by courses graded Satisfactory, and then only with the approval of the Department.

Entering students are required to enroll in Physics 209 and 221A in the fall semester and Physics 211 and 221B in the spring semester. Exceptions to this requirement are as follows: 1) students who do not have sufficient background to enroll in these courses and have approval from their mentor to delay enrollment to take preparatory classes, 2) students who have taken the equivalent of these courses elsewhere (see below).

If a student has taken courses equivalent to Physics 209, 211 or 221A-221B, then subject credit may be granted for 209, 211 or 221A-221B. Students must meet with the instructor at the beginning of the semester for course approval. If the instructor agrees that the student has satisfied the course requirement elsewhere, he/she must secure the instructor's approval on the waiver form and turn the signed form into Student Services (372 LeConte) for the student's file. Please note that official course waiver approvals will not be granted until after the pre-lim results have been announced.

In exceptional cases, students transferring from other graduate programs may request a partial waiver of the 19 elective unit requirement. Such requests must be made at the time of application for admission to the Department.

A typical first year program for an entering graduate student:

### FIRST SEMESTER

Physics 209	Classical Electromagnetism
Physics 221A	Quantum Mechanics
Physics 251	Introduction to Graduate Research
Physics 301	Supervised Teaching
Physics 375	GSI Training Seminar

### SECOND SEMESTER

Physics 211	Equilibrium Statistical Physics
Physics 221B	Quantum Mechanics
Physics 301	Supervised Teaching

### UPPER DIVISION AND GRADUATE PHYSICS COURSES

Information about courses, prerequisites, units, and instructors may be obtained from the *Berkeley Bulletin* on-line at:

<http://bulletin.berkeley.edu/>

and the *Schedule of Classes* is on-line at:

<http://schedule.berkeley.edu/>

### UPPER DIVISION COURSES

Physics 105*	Analytical Mechanics
Physics 108	Laser Physics
Physics 110A-B*	Electromagnetism and Optics
Physics 111*	Modern Physics and Advance Electrical Laboratory
Physics 112*	Introduction to Statistical and Thermal Physics
Physics 124	Introductory Nuclear Physics
Physics 129	Particle Physics
Physics 137A-B*	Quantum Mechanics
Physics 138	Modern Atomic Physics
Physics 139	Special Relativity and General Relativity
Physics 141A-B	Solid State Physics
Physics 142	Introduction to Plasma Physics
Physics C161	Relativistic Astrophysics and Cosmology (also listed as <i>Astronomy C161</i> )
Physics 177	Principles of Molecular Biophysics
Physics H190*	Honors Seminar
Physics C191	Quantum Information Science and Technology (also listed as <i>Chemistry C191 &amp; Computer Science C191</i> )

\* May not be used as graduate elective course.

## GRADUATE COURSES

Physics C201	Introduction to Nano-Science and Engineering (also listed as <i>MSE C261 &amp; NSE C201</i> )
Physics 205A-B	Advanced Dynamics
Physics 209	Classical Electromagnetism
Physics 211	Equilibrium Statistical Physics
Physics 212	Nonequilibrium Statistical Physics
Physics 216	Special Topics in Many-Body Physics
Physics 221A-B	Quantum Mechanics
Physics 226	Particle Physics Phenomenology
Physics C228	Extragalactic Astronomy and Cosmology
Physics 231	General Relativity
Physics 232A-B	Quantum Field Theory I & II
Physics 233A-B	Standard Model and Beyond I & II
Physics 234A-B	String Theory I & II
Physics 240A-B	Quantum Theory of Solids
Physics 242A-B	Theoretical Plasma Physics
Physics 250	Special Topics in Physics
Physics 251	Introduction to Graduate Research
Physics C254	High Energy Astrophysics (also listed as <i>Astronomy 254</i> )
Physics C285	Theoretical Astrophysics Seminar (also listed as <i>Astronomy 285</i> )
Physics 290**	Research Seminars
Physics 295**	Special Study for Graduate Students
Physics 299**	Research
Physics 301**	Advanced Professional Preparation: Supervised Teaching of Physics
Physics 375	Professional Preparation: GSI Training Seminar
Physics 602**	Individual Study for Doctoral Students

\*\* May not be used towards any degree.

## THE PRELIMINARY EXAMINATION

The preliminary examination is a written examination and is designed to ensure that students command a broad spectrum of undergraduate physics prior to engaging in graduate research. The written exam is composed of four sections, and all four sections of the preliminary exam are offered at the beginning of both Fall and Spring semesters. A student who has passed all four sections of the exam will have passed the preliminary examination. The four sections cover (1) classical mechanics, (2) electromagnetism and optics, and special relativity, (3) thermodynamics and statistical physics, and (4) quantum mechanics. Note that these divisions do not preclude the possibility of questions on one section that draw from subject matter emphasized in a different section. (For example, a question that touches on thermodynamics in the quantum mechanics section.) A student who passes any section of the written exam need not take that section again. Each section lasts three hours and covers traditional, textbook style problems, as well as more comprehensive questions that specifically test physical and numerical insight (for instance, order-of-magnitude estimates including physical constants, analyzing physical situations by application of general principles instead of complex calculations, etc.).

The Department expects students to pass the examination within the first three semesters of graduate study. Students are encouraged, but not required, to attempt the examination during their first semester. Students are required to have attempted all of the written sections in their second semester. The status of students who have not yet passed all sections of the preliminary examination will be reviewed by a faculty committee each semester, beginning in the student's third semester, and recommendations of further action will be made. The intent of this third-semester review is to determine if deficiencies exist in a student's knowledge of undergraduate physics, and if so, what actions are required of the student to address these deficiencies. A faculty committee will then review the student's efforts towards returning to good academic progress at the beginning of each semester thereafter. Delay in passing the preliminary examination beyond the start of the 3rd year is highly discouraged and will only be considered under exceptional circumstances.

## RESEARCH

After selecting a general field of research, each doctoral student must find a faculty researcher in that field to supervise his or her dissertation research. This is usually arranged after the completion of the preliminary examination and generally no later than the end of the second year of graduate study. To that end, first year graduate students are encouraged to enroll in a seminar course, Physics 251 (Introduction to Graduate Research) where research supervisors present current research opportunities in their fields and attend the annual poster session in the fall.

## THE DOCTORAL PROGRAM (continued)

Research is a major part of the Ph.D. program and the Department offers opportunities in a wide variety of experimental and theoretical fields. Campus research includes atomic physics and spectroscopy, astrophysics, biophysics, cosmic rays, mass spectroscopy, nonlinear optics, condensed matter physics, and statistical mechanics. At LBNL extensive opportunities exist for research in elementary particle and nuclear physics, condensed matter physics and materials sciences, in plasma physics, and on energy and environmental problems. Space physics, interplanetary studies, solar plasma research, physics of the upper atmosphere, and cosmological problems are pursued both in the Department and at the Space Sciences Laboratory (SSL).

### THE MASTER OF ARTS

The Department will not consider applications from students who intend to work toward the M.A. degree only. However, students in the doctoral program may apply for the M.A. degree after completing:

- 1) Physics 209, 211 and 221A-221B or 19 replacement units of approved coursework, if subject waivers have been granted for prior coursework;
- 2) 16 additional elective units of approved upper division and graduate courses (including Physics 251 and 375); and
- 3) Passing a comprehensive examination on coursework (passing the preliminary exams constitutes passing the comprehensive exam)..

*Note: Total units required for M.A. degree is 35 units. Neither upper division courses included in the physics (undergraduate) major requirements nor Physics 100, 290, 295, 299, 301, or 602 may be used to satisfy the 35 unit requirement. No more than one-third of the 16 elective units may be fulfilled by courses graded Satisfactory, and then only if approved by the Department.*

Filing deadline is on the Friday of the fifth week of classes. Ph.D. candidates are not required to file for the Master's degree.

## FALL 2017 ADMISSION INFORMATION

### STANDARDS

The Department of Physics ordinarily admits only those applicants who have scholastic records well above a B+ average and who have completed the equivalent of the undergraduate major in physics. This program includes upper division courses in mechanics (4 semester units), electromagnetism and optics (8 semester units), statistical and thermal physics (4 semester units), quantum mechanics (8 semester units), and advanced undergraduate laboratory (5 semester units). Courses in atomic, nuclear and solid state physics, astronomy and applied mathematics are recommended as electives. Not all courses in the major are required for admission. Some courses required for the major program but not previously taken may have to be made up in the first year of graduate work. Applicants are required to submit a list of courses taken in physics and mathematics with course number, and applicable textbook, as well as a list of courses in progress.

In determining the admissibility of a prospective graduate student the Department attempts to carefully weigh all relevant factors, including transcripts of academic work, scores on the GRE, letters of recommendation, any research experience, and a statement of purpose. Usually the various pieces of information show a uniform pattern, but occasionally some non-uniformity is evident. It is therefore, to the advantage of the applicant that the supporting materials provided the Department be as complete as possible.

The graduate program in physics is designed for those intending to pursue work leading to the Ph.D. After completing the necessary course work requirements, an MA degree can be awarded. However, the Department does not consider applications from those intending to work toward the MA degree only.

### APPLICATION DEADLINE

The Physics Department has established December 15, 2016 as the final date for receipt of the 2017-2018 Graduate Application for Admission and Fellowships. The Department accepts applications for admission for the fall semester only.

### APPLICATION REQUIREMENTS

To be considered for admission and fellowship, the following must be submitted by the December 15 deadline.

- 1) You must apply online. The URL for the on-line application is:

<http://grad.berkeley.edu/admissions/index.shtml>

Please follow on-line instructions carefully. All supporting material should be uploaded to your application.

### QUALIFYING EXAMINATION

Within 2-3 semesters of beginning research, the Department expects students to take the University's Oral Qualifying Examination covering his or her research field and related areas. The examination is administered by a four-member committee (consisting of three Physics Department and one outside faculty member, including the research advisor) approved by the Graduate Division on behalf of the Graduate Council, and may be repeated once at the recommendation of the examining committee.

The oral examination lasts 2-3 hours. Graduate Division specifies that the purpose of the Qualifying Exam is "to ascertain the breadth of the student's comprehension of fundamental facts and principles that apply to at least three subjects areas related to the major field of study and whether the student has the ability to think incisively and critically about the theoretical and the practical aspects of these areas."

### THE DOCTORAL DISSERTATION

The dissertation is the most important requirement for the doctoral program. The degree is never granted for completion of course work only, no matter how extensive. It is awarded in recognition of a student's knowledge of a broad field of learning and for distinguished accomplishment in that field through an original contribution of significant knowledge and ideas. The student's research must reveal high critical ability and powers of imagination and synthesis. The dissertation, the product of independent investigation under faculty supervision, must be submitted to the committee in charge and must receive both its approval and the approval of the Graduate Council.

- 2) Please upload your transcript(s) to your application. Your application will be reviewed with your unofficial transcript(s). If you are recommended for admission to the Physics PhD program, you must submit official copies of your transcript(s) for final approval of your admission by Graduate Division's Graduate Admissions Office.

- 3) **Three recommendations** should be submitted. Please enter the contact information of your recommenders. They will be invited to submit their recommendations online. Recommenders should be people who can evaluate your physics training.

If your recommenders cannot submit their recommendation online, they should email:

sakima@berkeley.edu

- 4) You must submit a course and textbook list of all third and fourth year physics (including astrophysics) and mathematics courses. Please download our Course and Textbook List Form from:

[http://physics.berkeley.edu/sites/default/files/\\_PDF/crstxt.pdf](http://physics.berkeley.edu/sites/default/files/_PDF/crstxt.pdf)

You may complete our form and upload it to your online application, or you may use our form as a template.

- 5) The **Graduate Record Examination (GRE) in Advanced Physics and the Aptitude Test** (verbal, quantitative and analytical writing) - Both are required by the Physics Department. Information about these examinations is available at most college and university counseling centers or from:

GRADUATE RECORD EXAMS  
EDUCATIONAL TESTING SERVICES  
BOX 6000  
PRINCETON, NJ 08541-6000  
<http://www.ets.org/gre>

ETS codes for GRE exams:

Physics GRE: P77  
Institution Code: 4505 (U Ca Berkeley)  
Department Code - Physics: 0808

## FALL 2017 ADMISSION INFORMATION (continued)

These examinations are scheduled several times each year in most parts of the world, but an application must precede the examination by at least one month. Scores should be sent directly to UCB GRADUATE ADMISSIONS. **Students expecting to meet the December 15 application deadline must take October offerings of the GRE examinations.**

6) An English proficiency (TOEFL) test is required for students whose post-secondary training has not been in English. *Please see **International Students** for more detailed TOEFL information.*

7) **Processing Fee:** You must submit an application fee when you apply. The application fee is not refundable. If you are a U.S. citizen or current permanent resident, the application fee is \$105; for all others, the fee is \$125. Please pay the fee by credit card.

### INTERNATIONAL STUDENTS

International applicants must meet all of the previously stated requirements, as well as University requirements: 1) degree from an accredited institution comparable to the bachelor's degree offered at Berkeley; 2) sufficient undergraduate training to undertake graduate study in the chosen field; and 3) an outstanding scholastic average. International applicants must have an excellent command of English before beginning graduate study at Berkeley. No one can be admitted to graduate standing to learn English. Therefore, if you are applying from a country in which English is not the official language you must take the Test of English as a Foreign Language (TOEFL). The test is administered six times a year. You should register as soon as possible by writing either the TOEFL agent in your home country or to:

TOEFL/TSE PUBLICATIONS  
P. O. BOX 6154  
PRINCETON NJ 08541-6154  
USA

If you took the test more than two years ago, you must take it again. A *minimum score of 570* (Paper Based Test - PBT) or 68 (Internet Based Test or Next Generation TOEFL - iBT) *is required for admission to the University.*

ETS codes for TOEFL:

Institution Code iBT: 48  
Institution Code PBT: 570  
Department Code - Physics: 76

Berkeley International Office offers guidance on immigration services, advocacy, financial concerns, living at Berkeley, and other matters of importance to international students. Check their website at:

<http://InternationalOffice.berkeley.edu/>

### FELLOWSHIPS AND FINANCIAL AID

Except in rare instances graduate students in the Department of Physics normally obtain some financial assistance or support during their first academic year. The types of financial support available to qualified students include university or national fellowships, department graduate student instructor (GSI) and graduate student researcher (GSR) positions.

*All applications received by the December 15 deadline will automatically be considered for award of university and department fellowships and Graduate Student Instructor (GSI) positions. Reminder: US citizens and permanent residents should complete the Domestic Fellowship section and submit a FAFSA. International applicants should complete the International Fellowship section.*

### GRADUATE DIVISION AWARDS

University and Physics Department Fellowships are awarded to students of outstanding achievement and high promise who will begin graduate study toward the doctoral degree. The Berkeley Fellowship is a five-year award based on continued excellence. Students awarded these fellowships are usually offered the option of taking an additional part-time GSI position.

The university offers a variety of awards, including diversity awards. All awards are competitive, based on merit, and offered to Ph.D. students of outstanding achievement. Continued excellence in an advanced degree program is required. Recipients of diversity multi-year awards also demonstrate academic achievement despite challenges such as social, economic, or educational obstacles and contribute to the diversity of the campus. Please note, international applicants are not eligible for diversity awards. To be considered for these awards, domestic applicants (U.S. citizens and permanent residents) must complete the Domestic Fellowship section of the online application and submit a Free Application for Federal Student Aid (FAFSA). International applicant must complete the International Fellowship section.

Award amounts: Stipends range from \$20,000 to \$23,000 per academic year for one to two years, in addition to departmental support years which may range from one to five years of added support in the form of fellowships and/or research or teaching assistantships. All university awards include educational, registration, and campus fees. Nonresident tuition is paid for U.S. citizens and permanent residents only on the first year of the fellowship, if needed. For international students, nonresident tuition is included for all years of their fellowship tenure. Many awards include a summer stipend and fees as well. Some awards are not deferrable. Yearly renewal of all multi-year awards is based on continued academic excellence.

### GRADUATE STUDENT INSTRUCTORSHIPS

Students who meet the December 15 deadline will automatically be considered for GSI positions. *It is not necessary to complete additional application forms for GSI consideration.* A 2017-2018 graduate student instructorship yields \$19,896 for a 50% appointment for the 10 months of the academic year. A GSI is expected to devote approximately 16 to 20 hours per week to assigned teaching, grading and consultations. Appointments to these positions are made on the basis of the applicant's academic record and recommendations. The Graduate Division allows the award of a GSI appointment only to students who are officially registered, maintain an overall grade point average of 3.0 or better on a 4.0 scale, and have no more than two Incomplete grades on their record. Being a GSI is a valuable experience, and all students in physics are strongly urged to teach at some time.

Non-native speakers of English must pass a test of their proficiency in spoken English before they can hold GSI positions. This policy applies to all prospective GSIs, regardless of their citizenship or residency status. For this purpose, proficiency in spoken English must be demonstrated by passing with a minimum score: 1) the Test of Spoken English (TSE) or iBT- Speaking Test (fee charged) before coming to Berkeley or 2) the SPEAK test or the Oral Proficiency Test which are administered by the GSI Teaching and Resource Center (free of charge).

### RESEARCH ASSISTANTSHIPS

It is rare but possible for a first-year student to receive a research assistantship. Usually a student holds a graduate student instructorship or fellowship at the beginning of graduate study. After passing the preliminary examination, most students receive a research assistantship during research and dissertation preparation. Currently Physics GSR annual salary is \$31,139. Fees and NRT (if applicable) are covered by the appointment.

### NON-RESIDENT TUITION (NRT) SCHOLARSHIPS

All students classified as non-residents must pay the yearly tuition fee. The Department awards NRT scholarships to assist non-resident students with the yearly tuition fee. NRT scholarships are normally available for all first-year physics students. Domestic students who are non-residents their first year are required to become California residents by the beginning of their second year or become subject to the non-resident tuition (\$15,102 for 2016-2017). U.S. citizens and permanent residents may be classified as residents if they can demonstrate the establishment and maintenance of permanent California residence prior to the semester of attendance. Students wishing to prove California residency should investigate the current regulations at:

<http://registrar.Berkeley.edu/residency/legalinfo.html>

### NOTIFICATION OF ADMISSION

The Graduate Division and the Department of Physics will advise applicants regarding admissions, awards and appointments March 15; applicants who are admitted must respond by April 15.