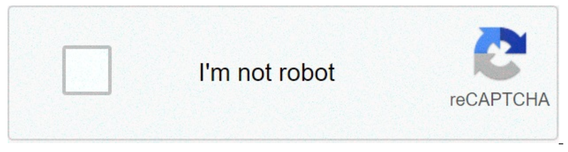

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Nuclear and particle physics an introduction pdf

UC Berkeley’s Fall 2021 Plans for Instruction Announced. The Physics major is designed to give the student a broad and thorough understanding of the fundamentals of physics. Therefore, the emphasis is on this general understanding rather than on specialized skills, although some specialized courses are among the options open to the student. Those considering a physics major are urged to consult a departmental adviser early, in order to discuss the content of the major and also the opportunities after graduation. Recent graduates have entered graduate work in a number of scientific fields, and others have gone on to jobs in academic, industrial, and government laboratories. Declaring the Major Students may declare a physics major when all of the prerequisites for the major have been completed or their equivalent with a 2.0 grade-point average (GPA) in the prerequisites and a 2.0 GPA in all University courses. For further information regarding the prerequisites, please see the Major Requirements tab on this page. The department will consider applications to declare a physics major throughout the academic year. Students (continuing and transfer) declaring must furnish a copy of their grade record or past transcripts which include the prerequisite courses or their equivalents. Students must have their records reviewed and have a departmental file prepared by the undergraduate adviser in 368 Physics North prior to seeing a faculty major adviser for departmental approval of the petition to declare a physics major. Students should be prepared to discuss a tentative schedule of their upper division courses. Honors Program Students with an overall grade point average (GPA) of 3.3 or higher in all courses in the major, upper division courses in the major, and all University courses may be admitted to the honors program. A major advisor should be consulted before the student's last year of residence. This program requires completion of the major, at least one semester of PHYSICS H190, and a senior thesis, PHYSICS H195A and PHYSICS H195B. Minor Program The department also offers a minor program in Physics. Students may petition for a minor in Physics from the time that the requirements are complete until the student graduates from the College of Letters & Science. Students who have completed the requirements for the minor will be required to furnish transcripts (official or unofficial) to the undergraduate advisor (in 368 Physics North) to show their work and GPA in physics and math. After completing a confirmation of minor program petition (available in 368 LeConte Hall), the students will be directed to a faculty major adviser who will approve the completion of the minor program.Visit Department Website In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program. General Guidelines All courses taken to fulfill the major requirements below must be taken for graded credit, other than courses listed which are offered on a Pass/No Pass basis only. Other exceptions to this requirement are noted as applicable. No more than two upper division courses may be used to simultaneously fulfill requirements for a student's double major and no more one course may be used to fulfill minor program requirements with the exception of minors offered outside of the College of Letters & Science. A minimum grade point average (GPA) of 2.0 must be maintained in both upper and lower division courses used to fulfill the major requirements. For information regarding residence requirements and unit requirements, please see the College Requirements tab. Lower Division Requirements In addition to the requirements below, students who: 1) Have not taken a substantial chemistry course in high school are urged to take a one-year sequence or 2) Unfamiliar with a computer programming language are encouraged to include an introductory course in computer science. Upper Division Recommended Courses Students who are interested in graduate school should consult Physics Undergraduate Advisors for more information on additional recommended courses. Students who have a strong interest in an area of study outside their major often decide to complete a minor program. These programs have set requirements and are noted officially on the transcript in the memoranda section, but they are not noted on diplomas. General Guidelines All minors must be declared no later than one semester before a student's Expected Graduation Term (EGT). If the semester before EGT is fall or spring, the deadline is the last day of RRR week. If the semester before EGT is summer, the deadline is the final Friday of Summer Sessions. To declare a minor, contact the department advisor for information on requirements, and the declaration process. All courses taken to fulfill the minor requirements below must be taken for graded credit. A minimum of three of the upper division courses taken to fulfill the minor requirements must be completed at UC Berkeley. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements. Courses used to fulfill the minor requirements may be applied toward the Seven-Course Breadth requirement for Letters & Science students. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs. All minor requirements must be completed prior to the last day of finals during the semester in which the student plans to graduate. Students who cannot finish all courses required for the minor by that time should see a College of Letters & Science adviser. All minor requirements must be completed within the unit ceiling. (For further information regarding the unit ceiling, please see the College Requirements tab.) Requirements Undergraduate students must fulfill the following requirements in addition to those required by their major program. For detailed lists of courses that fulfill college requirements, please review the College of Letters & Sciences page in this Guide. For College advising appointments, please visit the L&S Advising Pages. University of California Requirements Entry Level Writing All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing requirement. Fulfillment of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley. American History and American Institutions The American History and Institutions requirements are based on the principle that a US resident graduated from an American university, should have an understanding of the history and governmental institutions of the United States. Berkeley Campus Requirement American Cultures All undergraduate students at Cal need to take and pass this course in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity and culture of the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture. College of Letters & Science Essential Skills Requirements Quantitative Reasoning The Quantitative Reasoning requirement is designed to ensure that students graduate with basic understanding and competency in math, statistics, or computer science. The requirement may be satisfied by exam or by taking an approved course. Foreign Language The Foreign Language requirement may be satisfied by demonstrating proficiency in reading comprehension, writing, and conversation in a foreign language equivalent to the second semester college level, either by passing an exam or by completing approved course work. Reading and Composition In order to provide a solid foundation in reading, writing, and critical thinking the College requires two semesters of lower division work in composition in sequence. Students must complete parts A & B reading and composition courses by the end of their second semester and a second-level course by the end of their fourth semester. College of Letters & Science 7 Course Breadth Requirements Breadth Requirements The undergraduate breadth requirements provide Berkeley students with a rich and varied educational experience outside of their major program. As the foundation of a liberal arts education, breadth courses give students a view into the intellectual life of the University while introducing them to a multitude of perspectives and approaches to research and scholarship. Engaging students in new disciplines and with peers from other majors, the breadth experience strengthens interdisciplinary connections and context that prepares Berkeley graduates to understand and solve the complex issues of their day. Unit Requirements 120 total units Of the 120 units, 36 must be upper division units Of the 36 upper division units, 6 must be taken in courses offered outside your major department Residence Requirements For units to be considered in "residence," you must be registered in courses on the Berkeley campus as a student in the College of Letters & Science. Most students automatically fulfill the residence requirement by attending classes here for four years. In general, there is no need to be concerned about this requirement, unless you go abroad for a semester or year or want to take courses at another institution or through UC Extension during your senior year. In these cases, you should make an appointment to meet an adviser to determine how you can meet the Senior Residence Requirement. Note: Courses taken through UC Extension do not count toward residence. Senior Residence Requirement After you become a senior (with 90 semester units earned toward your BA degree), you must complete at least 24 of the remaining 30 units in residence in at least two semesters. To count as residence, a semester must consist of at least 6 passed units. Intercampus Visitor, EAP, and UC Berkeley-Washington Program (UCDC) units are excluded. You may use a Berkeley Summer Session to satisfy one semester of the Senior Residence requirement, provided that you successfully complete 6 units of course work in the Summer Session and that you have been enrolled previously in the college. Modified Senior Residence Requirement Participants in the UC Education Abroad Program (EAP), Berkeley Summer Abroad, or the UC Berkeley Washington Program (UCDC) may meet a Modified Senior Residence requirement by completing 24 (excluding EAP) of their final 60 semester units in residence. At least 12 of these 24 units must be completed after you have completed 90 units. Upper Division Residence Requirement You must complete in residence a minimum of 18 units of upper division courses (excluding UCEAP units), 12 of which must satisfy the requirements for your major. The goal of the Physics major is to provide students with a broad understanding of the physical principles of the universe, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments, and to provide training for students planning careers in physics and in the physical sciences broadly defined including those whose interests lie in research, K-12 or college teaching, industrial jobs, or other sectors of society. Physics majors complete a program which includes foundational lower division course work in math and physics and in-depth upper division course work. These topics are traditionally broadly divided into classical and modern physics. Some core topics, such as special relativity, classical optics, and classical thermodynamics, are covered only in lower division courses. Other topics, such as quantum mechanics, classical mechanics, statistical mechanics, thermodynamics, electricity and magnetism, and optics, are covered first at an introductory level in lower division and then at a more advanced level in the upper division courses. Advanced elective courses provide students the opportunity to further their knowledge in specific areas (such as atomic physics, condensed matter physics, optical properties, quantum computing, biophysics, astrophysics, particle physics). A two-semester upper division laboratory course provides additional training in electronic instrumentation, circuits, computer interfacing to experiments, independent project design, and advanced laboratory techniques experiments. This laboratory course also provides the capstone experience to the core courses, bringing the knowledge gained in different courses together and making the connection between theoretical knowledge taught in textbooks/homework problems and the experimental foundations of this knowledge. Activities outside the classroom, such as independent research or study, allow students to further develop their knowledge and understanding. A student graduating from Berkeley with a major in physics will understand classical and modern physics (as outlined in the course requirements below) and will also acquire the skills to apply principles to new and unfamiliar problems. Their understanding should include the ability to analyze physical problems (often posed as word problems), be able to derive and prove equations that describe the physics of the universe, understand the meaning and limitations of these equations, and have both physical and numerical insight into physical problems (e.g., be able to make order-of-magnitude estimates, analyze physical situations by application of general principles as well as by textbook type calculations). They will also have developed basic laboratory, library, and computational skills, be familiar with important historical experiments and what physics they revealed, and be able to make both written and oral presentations on physics problems posed to them. At graduation, physics majors will have a set of fundamental competencies that are knowledge-based, performance/skills-based, and affective. Learning Goals for the Major Graduates will have the following: Mastered a broad set of knowledge concerning the fundamentals in the basic areas of physics (quantum mechanics, classical mechanics, statistical mechanics, thermodynamics, electricity and magnetism, optics, and special relativity). This does not refer to knowledge about specific facts, but rather to a working knowledge of fundamental concepts that can then be applied in many different ways to understand or predict what nature does. An understanding of the physical principles required to analyze a physical question or topic, including those not previously seen, and both quantitative and qualitative physical insight into these principles in order to understand or predict what happens. This includes understanding what equations and numerical physical constants are needed to describe and analyze fundamental physics problems. A set of basic physical constants that enable their ability to make simple numerical estimates of physical properties of the universe and its constituents. An understanding of how modern electronic instrumentation works, and how both classical and modern experiments are used to reveal the underlying physical principals of the universe and its constituents. An understanding of how to use computers in data acquisition and processing and how to use available software as a tool in data analysis. An understanding of modern library search tools used to locate and retrieve scientific information. Skills Graduates will have the following abilities: Solve problems competently by identifying the essential parts of a problem and formulating a strategy for solving the problem. Estimate the numerical solution to a problem. Apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret the results. Explain the physics problem and its solution in both words and appropriately specific equations to both experts and non-experts. Understand the objective of a physics laboratory experiment, properly carry out the experiments, and appropriately record and analyze the results. Use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments. Know how to design, construct, and complete a science-based independent project (specifically in the area of electronics). Know and follow the proper procedures and regulations for safely working in a lab. Communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills. Affective Graduates will be able to do the following: Successfully pursue career objectives in graduate school or professional schools, in a scientific career in government or industry, in a teaching career, or in a related career. Think creatively about scientific problems and their solutions, to design experiments, and to constructively question results they are presented with, whether these results are in a newspaper, in a classroom, or elsewhere. Major Maps help undergraduate students discover academic, co-curricular, and discovery opportunities at UC Berkeley based on intended major or field of interest. Developed by the Division of Undergraduate Education in collaboration with academic departments, these experience maps will help you: Explore your major and gain a better understanding of your field of study Connect with people and programs that inspire and sustain your creativity, drive, curiosity and success Discover opportunities for independent inquiry, enterprise, and creative expression Engage locally and globally to broaden your perspectives and change the world Reflect on your academic career and prepare for life after Berkeley Use the major map below as a guide to planning your undergraduate journey and designing your own unique Berkeley experience. View the Physics Major Map PDF. All students interested in the Physics major should come in for major advising as soon as possible starting their first semester on campus for individualized assistance. Professional advisers can assist with a wide range of matters including academic course planning, research, career, and graduate school goals. Undergraduate Advisor Kathleen Cooney kathleen.cooney@berkeley.edu 374 Physics North 510-664-7557 Berkeley Connect in Physics is a mentoring program that pairs physics graduate mentors with undergraduate physics students. The goals of the program are to help students develop understanding, community, and career preparedness that go beyond what traditional courses provide. Interactions with graduate students and faculty will play a large role throughout the semester. The course is a small seminar class led by the physics graduate student mentor. Some of the meetings will include the following: Visits to research labs on campus and at the national labs to talk to faculty, scientists, and graduate students. Preparing students for a broad range of career trajectories including ones outside of academia. Discussions of science in the news and science and society. Resources for finding research opportunities on campus, REUs, internships. Developing skills that will make you an attractive candidate for undergraduate research. Exploration of the idea of scientific models. Building a community of physics student scientists. Berkeley Connect is a 1 unit seminar course that meets once a week for one hour. It is designed to be very low workload but have large benefits for physics undergraduates. For more information please visit the Berkeley Connect website. + Indicates this faculty member is the recipient of the Distinguished Teaching Award.FacultyMina Aganagic, Professor. Particle physics.Research ProfileEhud Altman, Professor. Atomic, molecular, and optical physics, ultracold atomic physics, atomic quantum gases, .Research ProfileJames Analytis, Associate Professor. Experimental Condensed Matter Physics.Research ProfileStuart Bale, Professor. Experimental space physics, plasma astrophysics, low frequency radio astronomy.Research ProfileEric Betzig, Professor. Biophysics.Robert Birgeneau, Professor. Physics, phase transition behavior of novel states of matter.Research ProfileRaphael Bousso, Professor. Physics, quantum mechanics, gravity, unified description of nature, string theory, quantum properties of black holes, the geometry of spacetime, covariant entropy bound, cosmological constant.Research ProfileCarlos J. Bustamante, Professor. Nanoscience, structural characterization of nucleo-protein assemblies, single molecule fluorescence microscopy, DNA-binding molecular motors, the scanning force microscope, prokaryotes.Research ProfileMichael F. Crommie, Professor. Physics, electronic properties of atomic-scale structures at surfaces, atomic-scale structures, morphology and dynamics of mesoscopic systems, atomic manipulation, visualizing low dimensional electronic behavior.Research ProfileMichael Deweese, Associate Professor. Machine learning, computation, systems neuroscience, auditory cortex, neural coding.Research ProfileJoel Fajans, Professor. Astrophysics, plasma processing, physics, basic plasma physics, non-neutral plasmas, basic plasma physics experiments, pure electron plasma traps, cyrogenic plasmas, plasma bifurcations, basic non-linear dynamics, autoresonance.Research ProfileOri J. Ganor, Associate Professor. Physics, string theory, -theory, F-theory, matrix-models, noncommutative geometry, six-dimensional theories and their large N limit, supersymmetric field theories, coupled quantum systems, nonperturbative and strong-coupling, nonlocal behavior, space.Research ProfileHernan G. Garcia, Assistant Professor. Biophysics.Research ProfileNaomi Ginsberg, Associate Professor. Atomic, Molecular and Optical Physics, Biophysics, Condensed Matter Physics and Materials Science.Research ProfileHeather Gray, Assistant Professor. Physics.Research ProfileHartmut Haeffner, Associate Professor. Quantum information and computation, precision measurements, ion traps, quantum state engineering, decoherence, quantum simulations, quantum energy transport, quantum chaos, cryogenic electronics.Research ProfileLawrence J. Hall, Professor. Physics, standard model of particle physics, symmetries of nature, the symmetry of the electroweak interaction, spacetime symmetries: weak scale supersymmetry, constrained theories for the quark and charged lepton masses, supersymmetric theory.Research ProfileOskar Hallatschek, Associate Professor. Biophysics, random mutational events, genetic diversity, genome architecture, statistical physics, stochoastic reaction-diffusion systems, .Research ProfileWick Haxton, Professor. Astrophysics, neutrino physics, nuclear astrophysics, tests of symmetries and conservation laws in nuclear and particle and atomic physics, many-body theory, effective theories.Research ProfileFrances Hellman, Dean of the Division of Mathematical and Physical Sciences, Professor. Condensed matter physics and materials science.Research ProfileWilliam L. Holzapfel, Professor. Cosmology, physics, measurement and interpretation of anisotropies of the cosmic microwave background, the universe, density of energy, baryonic matter in the universe, the degree angular scale interferometer, the arcminute cosmology bolometer array.Research ProfilePetr Horava, Professor. Cosmology, physics, quantum geometry, particle physics, string (and M-) theory, quantum gravity.Research ProfileBarbara Jacak, Professor. Nuclear physics, particle physics, quark gluon plasma.Research Profile+ Bob Jacobsen, Professor. 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Nanostructures, physics, solid-state physics, complex novel materials, correlated electron systems, temperature superconductors, colossal magneto-resistance manganites, organic material, fullerenes, nanotubes, nanosphere, nanorods.Research ProfileAdrian T. Lee, Professor. Physics.Research ProfileDung-Hai Lee, Professor. Physics, theoretical condensed matter, organization principles enabling microscopic degrees of freedom to behave cooperatively, matter and their formation mechanisms, low dimensional quantum magnets, strongly correlated Fermi and Bose fluids.Research ProfileStephen R. Leone, Professor. Physical chemistry, molecular dynamics, atomic, molecular, nanostructured materials, energy applications, attosecond physics and chemistry, radical reactions, combustion dynamics, microscopy, Optical physics, chemical physics, soft x-ray, high harmonic generation, ultrafast laser, aerosol chemistry and dynamics, neutrals imaging.Research Profile+ Robert G. Littlejohn, Professor Emeritus. Plasma physics, nonlinear dynamics, physics, atomic, molecular, optical, and nuclear physics, dissipation in many-particle systems, semiclassical treatment of spin-orbit forces in nuclei, normal form theory for mode conversion or Landau-Zener transition.Research ProfileSteven G. Louie, Professor. Nanoscience, nuclear magnetic resonance, semiconductors, metals, physics, fullerenes, nanotubes, condensed matter theory, surfaces, defects, nanostructure materials, clusters, many-electron effects in solids.Research ProfileKam-Biu Luk, Professor. Physics, particle physics, neutrinos coming from the nuclear processes in the sun, neutrino oscillation, anti-neutrinos, neutrino mixing parameters, nuclear instrumentation, data mining.Research ProfileChung-Pei Ma, Professor. Astrophysics, dark matter, cosmology, formation and evolution of galaxies, cosmic microwave background radiation.Research ProfileDaniel Mckinsey, Professor. Dark matter, noble gases, cryogenics, high voltages, particle physics, astrophysics, low temperature physics, detector physics, neutrinos.Research ProfileJoel E. Moore, Professor. Physics, nanotubes, condensed matter theory, the properties of, electron-electron interactions, zero-temperature phase transitions, interaction effects in nanoscale devices, quantum phase transitions.Research ProfileHolger Mueller, Associate Professor. Atomic, molecular, and optical physics.Research ProfileHitoshi Murayama, Professor. Physics, particle physics, the universe, fundamental constituents of matter, Higgs boson, anti-matter, neutrino oscillations, finite value of the cosmological constant, triple coincidence of energy densities.Research ProfileJeffrey B. Neaton, Professor. Condensed matter theory, Materials Physics, nanoscience, physical chemistry, Electronic Structure Theory, Transport, Hard-Soft Interfaces, Complex Oxides, renewable energy, energy conversion.Research ProfileYasunori Nomura, Professor. Electroweak symmetry, developing new ideas and building realistic models in particle physics, particle physics theory and cosmology, hidden extra spatial dimensions and supersymmetry, physics of the multiverse, multiverse and quantum gravity.Research ProfileGabriel Orebi Gann, Assistant Professor. Particle physics.Research ProfileJoseph W. Orenstein, Professor. Physics, optics, electromagnetic radiation, probe condensed matter systems, light waves, transmission and reflection coefficients, high-Tc superconductors organic molecular crystals, quasiparticles, origin of superconductivity, terahertz spectroscopy.Research ProfileSaul Perlmutter, Professor. Cosmology, dark energy, physics, astrophysics experiments, observational astrophysics, supernovae, accelerating universe.Research ProfileMatt Pyle, Assistant Professor. Astrophysics, nuclear physics, dark matter, detector technology, massive low temperature calorimeters, SuperCDMS.Research ProfileZi Q. Qiu, Professor. Physics, novel behavior of the quantum magnetism in magnetic nanostructures, oscillatory interlayer coupling, the giant magnetoresistance, condensed matter experiment, technology applications, molecular beam epitaxy, artificial structures.Research ProfileEliot Quataert, Professor. Compact objects, theoretical astrophysics, theoretical physics, black holes, accretion theory, plasma physics, high energy astrophysics, galaxies, stars.Research ProfileSurjeet Rajendran, Assistant Professor. Theoretical Particle Physics, precision metrology.Research ProfileR. Ramesh, Professor. 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Physics, particle experiments, experimental particle physics, high energy fission, experiments with antiprotons, pion-nuleon and nucleon -nucleon scattering with polarized targets, pi-N phase shift analyses, the spin and intrinsic parity of hyperons.Research ProfileM. Lynn Stevenson, Professor Emeritus. Mark Strovink, Professor Emeritus. Physics, discrete symmetries, particle experiments, absolute predictions fundamental tenets of the standard model, charge parity, nonconservation in K meson decay, establishment of upper limits on the quark charge radius, effects of gluon radiation.Research ProfileMahiko Suzuki, Professor Emeritus. Physics, chiral symmetry, particle theory, electroweak symmetry, supersymmetry, standard model of particle interaction, heavy quark symmetry, B meson physics, disoriented chiral condensate, semileptonic D and B decays.Research ProfileGeorge H. Trilling, Professor Emeritus. Physics.Research ProfileRobert D. Tripp, Professor Emeritus. 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