The Undergraduate Experience

A guide for potential students & transfer students
Dear Prospective Students,

I would like to share some of the exciting opportunities and possibilities available for students who choose to major in Physics. Why Physics? Physics is the most fundamental of the sciences. It deals with the world around us; from the most elementary particles to the whole universe and from the beginning of time to the near future. A Physics degree is broad and versatile. When it comes to jobs and employment, you might be surprised to know that a Physics degree prepares students for these careers and more:

- Medicine
- Engineering
- Law
- Finance
- Government research
- Secondary & Higher Education
- Academic research
- Industrial research & development
- Oceanography
- Biomedical Physics
- Astronomy & Astrophysics
- Physics Education
- Academic research
- Space Exploration
- Biophysics
- Meteorology
- Geoscience
- Medicine
- Engineering
- Law
- Finance
- Government research
- Secondary & Higher Education
- Academic research
- Industrial research & development
- Oceanography
- Biomedical Physics
- Astronomy & Astrophysics
- Physics Education
- Academic research
- Space Exploration
- Biophysics
- Meteorology
- Geoscience

The University of Utah is the flagship research university in the State of Utah. It has the lowest tuition of all the schools in the PAC-12. Many scholarships are available through the University, College of Science and within our department. The University of Utah consistently ranks in the top 50 of many listings of great schools and consistently ranks above many private universities.

The Department of Physics and Astronomy has nearly forty faculty members who conduct research in a wide range of subjects including nano-electronics, photovoltaic solar cells, cosmic rays, dark matter, elementary particle physics, cosmology, and galaxy evolution. Most of our undergraduate students engage in research in one of these labs or groups in the department. These undergraduate research experiences set the Department of Physics and Astronomy apart from other institutions and offers unique opportunities that are seldom found at other colleges and universities.

Our graduates have been accepted into the best graduate schools, medical schools, dental schools, and law schools. To help prepare students for graduate school and careers, we offer a range of Bachelor’s of Science options:

- Physics
- Applied Physics
- Biomedical Physics
- Astronomy & Astrophysics
- Physics Education

If you are a student who enjoys math and science, then studying physics could be the right choice for your academic major and a pathway to achieve your career goals. I hope you will find this information useful and that we will soon be welcoming you as Physics major.

Sincerely,

Carleton DeTar
Professor and Chair
Department of Physics and Astronomy
Wh Y Physics?

How some of our alumni answered this question:

“I love math and science. Physics combines both of these subjects into one. Physics challenges me and keeps me on my toes.”

“I was interested in gaining a deeper understanding of the fundamental principles underlying modern technology before moving on to a career in engineering.”

“Students who love math and want to use it to solve real problems find a home in physics. Students who are interested in science, and discover that they want to know the fundamental principles behind it all, find their way to physics. Students interested in engineering, who want both greater understanding and a more challenging field, change their major to physics. Students seeking a technical degree with broadest possible background discover physics is the place for them.”

“I [wanted to learn to] think like what I considered to be the greatest minds throughout human history - all of which seemed to be physicists.”

“Physics students find that they are able to get into a wide variety of graduate programs and enter many technical and health related fields with a degree in physics. Because it is the fundamental science, students with a degree in physics have a strong foundation for whatever they wish to do next.

“Physics students are passionate about learning how the world works, discovering the fundamental principles that govern it, learning how to express these principles mathematically and communicate through math, and who seek out the most challenging and rigorous curriculum.”
Areas of Research

Research is a major component of life at the U, benefiting students as well as the region. The faculty in the Department of Physics & Astronomy conduct research in these specialized fields.

Astronomy & Astrophysics

Black holes, the Big Bang, supernovae, gamma ray bursts, pulsars, quasars, active galactic nuclei: the Universe is a beautiful and fascinating place. While astronomy is the most ancient of sciences, it also is largely unknown, and poorly understood. Recent technological advances place us at the cusp of a scientific revolution in our understanding of the Universe. The University of Utah has long been a leader in theoretical astrophysics, gamma-ray astronomy, and cosmic-ray astronomy. In the last couple decades we have grown this program to include a broad range of interests, including high-energy astrophysics, cosmology, large scale structure, galactic origin and structure, and black holes.

Cosmic Rays

Surrounding the Earth is a constant shower of subatomic particles called cosmic rays. Many originate from our own Sun, but some come from far more distant and mysterious origins. The Telescope Array Project is designed to study the rarest, most mysterious, and highest energy cosmic rays. Over time scientists hope to unravel the nature of these mysterious visitors, their origins, and to uncover new knowledge about the universe. The University of Utah has a long and distinguished history of leading research into these extremely rare and mysterious visitors from space. International collaborations like the Telescope Array Project are helping to ensure the University of Utah remains a world leader in the new and growing field of astroparticle physics.

Biophysics

At the University of Utah, scientists engage in cutting edge research in biophysics and related areas. In the department of Physics and Astronomy, biophysics research is pushing the limits of nanometer-scale optical microscopy techniques, with the goal of studying molecular-scale biological systems; studying the process by which a new enveloped virus is created on the membrane of its host cell; and studying the properties of molecular motors, focusing on how these motors work together, how they are regulated, and how their functioning is disrupted or altered in various diseases.
Experimental Condensed Matter Physics

Moore's Law is the observation that computing speed doubles every 18 months; we expect our computers to become smaller, faster and cheaper. In the last few years, Moore's Law appears to be reaching its physical limit. Electronics cannot get any smaller. Physicists at the University of Utah are conducting fundamental research on materials that could hail the next advance in electronics: organic semiconductors, non-linear optical solids, high-Tc superconductors, spin electronics, quasicrystals, etc. The University of Utah is recognized as a leader in developing techniques for understanding the properties of these materials, including atomic force microscopy and tunable infrared lasers. Our condensed matter experimentalists also study other exotic materials, such as hyperpolarized nobel gases, atomically thin materials, and low temperature quantum solids.

Medical Physics

Medical Physics is the branch of physics focusing on the broad and diverse application of physics to health care. The Medical Physics Program offers training and research through a variety of courses and research positions in the laboratories of the program faculty. As health care advances toward new and improved therapies, medical imaging and targeted therapies are playing ever increasing roles in personalized medicine. This is a long term growth area with exciting applications of physics principles to solve real world health care problems.

Particle Physics

The recent announcement of the discovery of the Higgs Boson rocked the world. The Higgs Boson, or “God Particle” is the particle within the Standard Model of Particle Physics that gives mass to all other particles. While the discovery of the Higgs Boson does solve one problem of particle physics, there are many problems yet unsolved. Particle physics research at the University of Utah is investigating physics beyond the standard model. Researchers are using connections between theoretical particle physics, cosmology and astrophysics, solving strong interactions of quarks and gluons through numerical simulation, and working on various problems in the frontier of theoretical physics including particle theory, condensed matter theory and mathematical physics.

Theoretical Condensed Matter Physics

What are the unusual phases of spin frustrated anti-ferromagnets? What are the magnetic responses of a surface topological insulator? What is the magnetoresistance in organic spin valves? What causes the anomalous behavior of plasmons in nanotubes? What is the photoconductivity in an ordered nanocrystal array? These are a few of the research topics of current interest studied by the condensed matter theory group at the University of Utah. Condensed matter theorists at the University of Utah are recognized world-wide as leaders in the field.
The University of Utah Department of Physics and Astronomy has approximately 40 professors, most of whom are working on research, and most of whom have a research grant. The departmental grant budget for 2014-2015 was over $4 million. Approximately 50% of majors work on faculty mentored research projects. Many faculty have grants that include undergraduate research as part of the grant.

Those faculty who do not have specific money ear-marked for research will work with undergraduates to help them write their grant applications to obtain funding from the University Office of Undergraduate Research. A student who is interested in engaging in research, should be able to find a faculty mentor, and should be able to be paid for his/her work. Students are responsible for negotiating research with professors. Professors also will send exceptional undergraduates to events such as the 4-corners APS meeting.

The opportunity for our undergraduate students to participate in scientific research provides a unique experience. This is what makes the study of Physics & Astronomy different at the U than other academic institutions.
Undergraduate Ethan Lake presents his paper at the International Astronomical Union meeting (XXIX IAU General Assembly, Honolulu Hawai‘i.) Professor Zheng Zheng worked with Ethan to mentor this research. Ethan is just one of many undergraduate students who actively work on research and publish results in the Department of Physics and Astronomy. Ethan was the first author on his paper which was published in The Astrophysics Journal.

There are grants available to students traveling to present at research conferences. In addition, there are opportunities locally to present research: the Department of Physics and Astronomy holds an Undergraduate Research Symposium in the late summer, and the Office of Undergraduate Research has a campus-wide event in the spring. Both offer opportunities to present research. The UROP publishes the abstracts of student research on campus, which is a citable source for publications. An undergraduate student who has made a valid and significant contribution to the research that his/her faculty mentor is working on, may find his/her name on the resulting publication. Our professors are published in such journals as Nature, Science, the PhysRevLettts, and other less general publications. The amount of research and the level of publication and presentation is mostly limited by the undergraduate student's motivation.
I wish I would have done an internship. Although, the undergraduate research helped more than I thought it would.

The educational experience at the department of physics and astronomy fully prepared me for the next stages of my professional development. A degree in physics prepares you intellectually to take on challenges in myriad situations, so don't be afraid to branch out.

**Advice from our alumni**

*Having a physics background is usually attractive to employers and admissions committees, no matter the field.*

I was offered a job because of my research experience. It had a significant computational component.

**Trust in your department advisor, share your goals with them. Get to know your teachers.**

A bachelor's degree in physics is an excellent stepping stone to a graduate degree of your choosing. Of my four friends who graduated with our Bachelor's in physics, two are medical residents, one is getting a Ph.D. in medical physics, and I am finishing my medical degree with the plan to enter a surgery residency.

Keeping studying hard and worry more about completing and understanding the projects then the grades. If you can find practical hands on experiences such as internships they will help you in the long run the most.

Learn well the basic concepts of physics, as well as some computer programming language(s). These skills will be very helpful when you apply for a job.
Where are they now?

Many of our alumni are now at these institutions and companies:

- Amazon
- American Univ. in Cairo
- Apantac, LLC.
- Apple
- Areva
- ARINC Co.
- ARUP
- ATK Aerospace Systems
- Atlantic Health System
- Autodesk
- B.E. Meyers
- Boeing Co.
- Boeing-Spectro Lab
- Bruker Corp.
- Bungie
- BYUIdaho
- Cal Tech
- Carthage College
- Century Software
- Ceramatec
- Cleveland Clinic
- CMCC Euro-Mediterranean
- Columbia Univ.
- CoreLinQ Innovation
- Cummins
- Dartmouth Medical School
- Department of Defense
- Deutsche Bank Securities
- Eastern Michigan Univ.
- Energizer
- European Southern Observatory
- Fairchild Semiconductor
- Fulldome.Pro
- GE Healthcare Surgery
- George Washington Univ.
- Georgia Inst. of Technology
- Goengineer
- Goldman Sachs
- Google
- High Energy Astrophysics Inst.
- HighRes Biosolutions
- Hitachi Europe
- Huntington Learning Center
- INL
- Intelligence Software Solutions
- Intermolecular
- Intermountain Healthcare
- International Rectifier
- IPG Photonics
- Japan Atomic Energy Agency
- Jet Propulsion Lab
- Johns Hopkins
- kindig-it design
- King’s College
- KLA-TENCOR
- Latham, Watkins
- Lawrence Berkeley National Lab
- Lawrence Livermore National Lab
- Legacy Technical Grp.
- Loma Linda Univ. Medical Center
- Los Alamos National Lab
- Lumenis, Inc.
- Lumeras LLC
- Marketstar
- Maschoff Brennan
- Maschoff Gilmore & Israelsen
- Mayo Clinic
- Medical College of Wisconsin
- Merck & Co., Inc.
- Michigan State
- Michigan Technological Univ.
- Micron Technology
- Microsoft
- Motorola Solutions
- Mrs. Fields Famous Brands, Inc.
- Nano Innovations, LLC
- National Renewable Energy Lab
- Natl. Securities Technology
- Nelson Labs
- Netquake, LLC
- Northrop Grumman
- Oak Ridge National Lab
- Ochsner Health System
- Ohio State Univ.
- Openmarket
- Pacific Light Technologies
- Park City Municipal Corporation
- Patent Law Works
- Pfizer
- Princeton Univ.
- RENEW (www.renewstrategies.com)
- Rockwell Collins
- Rocky Mountain Nanotechnology
- saltstack
- Sandia National Lab
- SanDisk
- Santa Clara Univ. / Patent Law
- Science Applications International
- SE Solutions
- Siemens
- SLAC National Accelerator Lab
- Source Med.
- Space Dynamics Lab
- Spectralink Corp.
- Spreadtrum Inc.
- Sprint Corp.
- SRA Int'l.
- SSA Marine
- St. Jude's Children's Research Hospital
- Stellar Science
- Stoe Rives LLP
- Texas Instruments
- TGS-NOPEC Geophysical Co.
- Thermo Fisher Scientific
- TraskBritt, PC
- Tulane Univ.
- U.S. Air Force
- U.S. Army
- U.S. Navy
- UC Berkeley, Davis & San Diego
- UNC-Chapel Hill
- Univ. of Pittsburgh Med. Sch.
- Univ. College London
- Univ. of Arizona
- Univ. of Chicago
- Univ. of Maryland Medical Center
- Univ. of South Florida
- Univ. of Southern California
- Univ. of Stuttgart, Germany
- Univ. of Texas at Austin
- Univ. of Utah
- Univ. of Utah Hospital
- Univ. of Virginia
- Univ. of Washington
- Univ. of Wisconsin
- Utah State Univ.
- Utah Valley Univ.
- VanCott, Bagley, Cornwall & McCarthy
- Varian Med. Systs.
- Virginia Tech
- Voss Scientific
- Wayne State Univ.
- Western Digital
- Woodbury Corp.
- Yale Univ.
- Zenimax Online Studios
- Zions Mortgage Co.
Major Courses - a selection of courses required for the physics major

PHY 4410/4420 – Classical Physics I and Classical Physics II
This sequence is one of the hallmark courses of the professional physics program. These courses explore advanced mechanics and electrodynamics from the 18th and 19th centuries, a period of unparalleled mathematical and physical discoveries. The end of this era hailed the birth of modern physics. However, the mathematical and physical discoveries of this time make this one of the most beautiful eras in the history of physics.

PHY 5450/5460 – Introduction to Quantum Mechanics and Quantum Mechanics and Statistical Mechanics
This sequence is also one of the hallmark courses of the professional physics program. Quantum mechanics and statistical mechanics arose from the few problems that remained unsolved at the end of the classical era. The formalism for quantum mechanics descended from the mathematics developed in the classical era. Therefore, PHY 4410/4420/5450/5460 should be treated like a single four semester sequence of classes. Students completing this sequence should be well prepared for the rigors of graduate school.

PHY 3730 – Introduction to Computing in Physics
This course assumes little to no computing skills, but students will complete the semester being able to write functional code in C++ as well as other computing languages. Students will solve physics problems, such as the Ising model of spin frustration, using numerical methods techniques. This course is accepted as a technical elective in Mathematics and Engineering

PHY 5110 – Introduction to Nuclear and Particle Physics
Because of the University of Utah’s leadership in the areas of nuclear and particle physics, this class is required for most of the physics tracks. This class is a good capstone course, as it draws from all areas of physics: classical mechanics, classical electrodynamics, quantum mechanics, relativity, as well as probes less explored areas, such as astrophysics, and cosmology. Students interested in the standard model and beyond will enjoy learning about the key discoveries and outstanding questions in this field.

Elective Courses - additional course offerings

PHY 3150 – Energy and Sustainability: A Global Perspective
This course addresses the relationship between energy use and the environment through the fundamental laws of physics, and provides a scientific foundation for understanding the energy and environmental issues facing our country and world. Many students in technical fields will take this course to fulfill their International Bachelor’s Degree requirement.

ASTR 4060 – Observational Astronomy for Scientists
Students in this class use the facilities at the University of Utah, including the new telescope at Frisco Peak, to explore the cosmos and study the Sun, planets, asteroids, stars and galaxies. Students are able to make measurements and use this data to determine such things as the mass of Jupiter and the ages of stars.

PHY 4210 – Optics in Biology
The use of optics in biology has evolved from the simple light microscope used by Darwin to the complex cryo-electron and live cell high resolution microscopes used today. This course is designed to give students a good understanding of physics involved in advanced optics while focusing their attention on the biological problems amenable to these techniques.
Things you can work on now:

Which courses should I take in high school?
To prepare for a degree in physics, take as much math as is offered at your high school. Math is the language of Physics. A degree in Physics at the University of Utah takes four years beginning with your first semester of calculus. In fact, **there are no physics classes that apply to a physics degree that do not require at least one semester of calculus.**

Entry into Mathematics courses at the University of Utah is by placement exam. You may use your ACT, SAT or AP Math AB or AP Math BC scores to secure placement into the appropriate math class. The higher your initial math placement, the less time (and money) you will need to spend in preparatory coursework. Once you are accepted to the U, you can also take the Accuplacer exam, to attempt to place into a higher math class. There are resources available to help you prepare for the Accuplacer exam.

AP courses can be helpful. AP exams in the math and sciences will not replace coursework in these areas. However, a good score on an AP Math AB or AP Math BC exam will place a student into the second or third semester of calculus. A good score on the AP Chemistry exam may place a student into the second semester of chemistry. Any of the AP Physics exams may help prepare a student for the introductory physics sequence. Good AP exam scores in other areas will count towards general education and general elective credit.

I’m currently enrolled at a college/university. What can I be working on?
Mathematics is still important. If you are already enrolled in a college or university, continue taking math classes so that you will be prepared for the calculus sequence. The classes you have already taken can be used for initial math placement at the University of Utah. You may still choose to take the Accuplacer exam.

Arrange to meet with the undergraduate advisor for your program as well as the academic advising offices in the SSB. These meetings will help you determine if a course on your transcript will satisfy a departmental or university requirement. You might also learn about interesting courses that can satisfy more than one requirement.

Is there anything else I can do to prepare to major in Physics?
Develop good study skills and learn to work in groups. Physics is a challenging degree program with very rigorous courses. Students who have learned how to study, and who form study groups with their peers, are more successful in the program.