

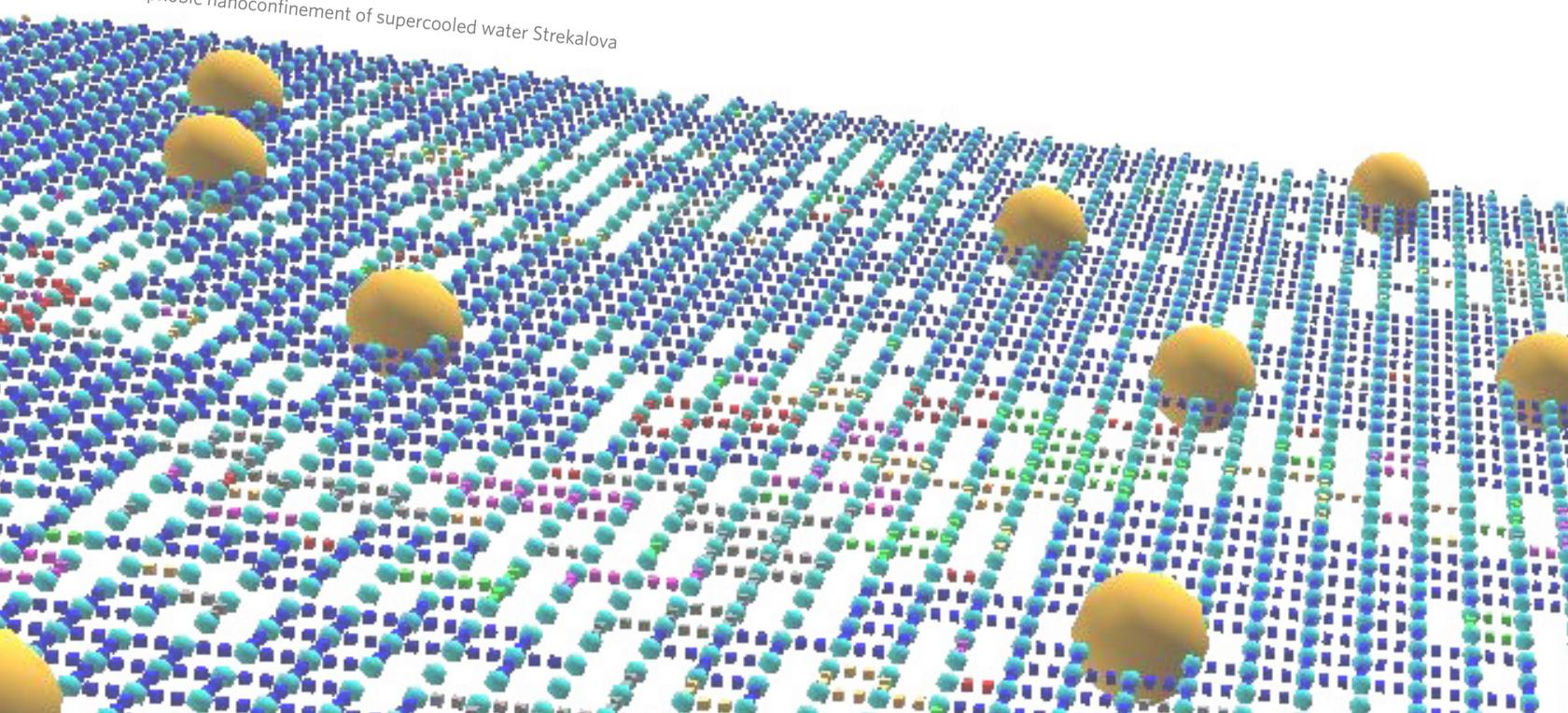
Physics at Boston University Undergraduate Program



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Hydrophobic nanoconfinement of supercooled water Strekalova



BU Physics

Undergraduate Program

Why study physics?

Physics is one of the most fundamental sciences, focused on the nature of elementary constituents of matter, the character of the universe and its evolution, and the emergent behavior that arises from the interactions of large numbers of elemental units. Throughout the course of your studies, you will acquire essential analytical, quantitative, and problem-solving skills that will be valuable in a wide range of careers.

The underlying principles of physics are an integral part of many other sciences, including: chemistry, astronomy, biology, earth sciences, meteorology, and engineering. Physics is also valuable in certain areas of medicine, business, computer science, and law. As such, physics majors and minors receive ideal basic training to pursue successful careers in other fields. At the same time, many students enjoy the process of search and discovery in physics research, and have made lifetime careers as educators, or as physicists in national or industrial research laboratories. Our department offers a variety of educational programs to fit the needs of students with career aspirations in all of these diverse areas.

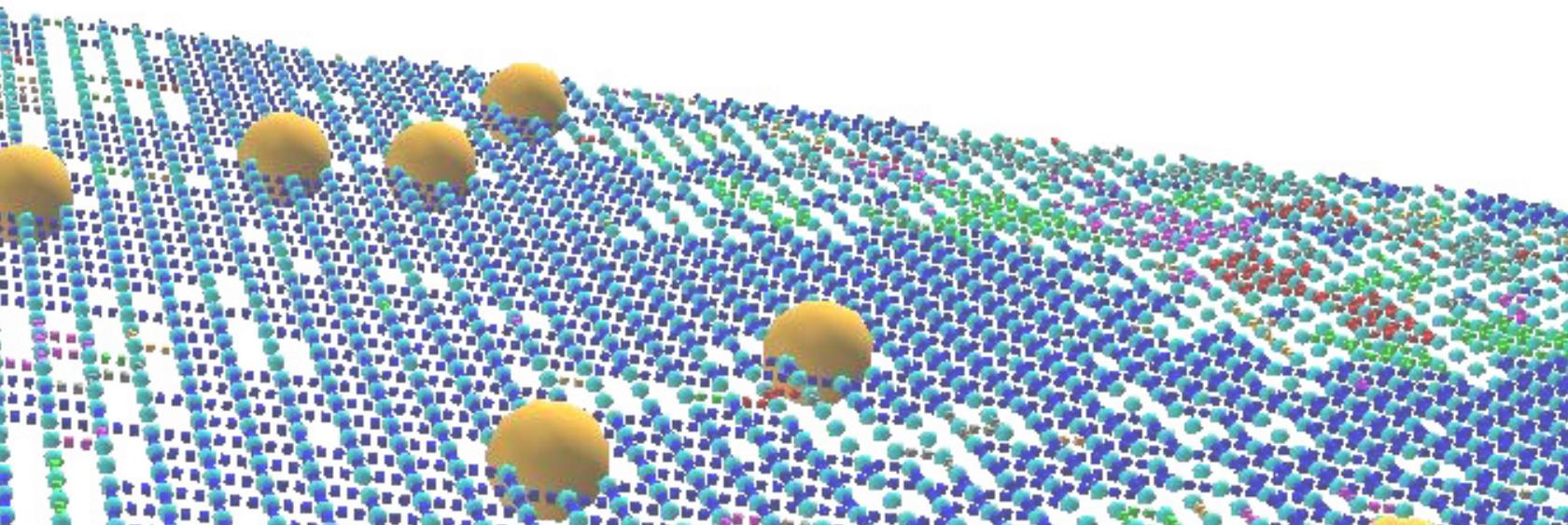
Why Boston University?

There are many advantages to studying physics at Boston University. While located in a dynamic, urban environment at a large university, a strong sense of community is maintained through small class sizes and close contact with faculty.

Our department prides itself on the quality of its teaching, while also maintaining a vigorous research program. The diverse faculty assures an opportunity for close interaction with teachers and mentors. Students are encouraged to participate in ongoing research projects, and many get involved as early as their sophomore year. Students may also take advantage of our study abroad program at CERN in Geneva, Switzerland. With classes at the University of Geneva and directed research at CERN, our program brings students directly to the cutting edge of modern physics.

Many of our students are actively involved in Photon, our undergraduate student organization, which serves as both a social organization and a place where students can meet to get advice from upperclassmen and form study groups.

We hope you find the information in these sections useful in evaluating the opportunities and advantages of pursuing a physics major at Boston University!



Degree Programs

BA Physics (Graduate)

This option provides students with a comprehensive and rigorous education in classical and modern physics. It is well-suited for students intending to pursue graduate study in physics or a closely related field, or planning to enter a technical physics-related career upon graduation.

Prerequisites

- Calculus I and II (MA 123, 124)
 - or Enriched Calculus (MA 127)
 - or Honors Calculus (MA 129)
- Principles of Physics (PY 251, 252) and Modern Physics I (PY 351)
 - or General Physics (PY 211, 212) and Elementary Modern Physics (PY 313)
- Methods of Theoretical Physics (PY 355)

Principal Courses

- Electromagnetic Fields and Waves I and II (PY 405, 406)
- Intermediate Mechanics (PY 408)
- Statistical Thermodynamics (PY 410)
- Quantum Physics I and II (PY 451, 452)
- Advanced Laboratory (PY 581)
- An additional physics course at the 300 level or higher (excluding PY 401, 402, 482, 491, and 492)

Required Related Courses

- Multivariate Calculus (MA 225)
- An additional mathematics course at the 200 level or higher

Recommended Courses

- Modern Physics II (PY 352)
- Electronics for Scientists (PY 371)
- Senior Independent Work (PY 401, 402)
- Undergraduate Physics Seminar (PY 482)
- Introduction to Solid State Physics (PY 543)
- Introduction to Particle Physics (PY 551)
- Linear Algebra (MA 242)
- Advanced Calculus (MA 411)
- Complex Variables (MA 412)
- Methods of Applied Mathematics (MA 561)

BA Physics (Interdisciplinary)

This option provides students with a strong physics preparation, but also allows them the flexibility to pursue an interdisciplinary academic program combining physics with training in a related science (Astronomy, Biology, Chemistry, Computer Science, Mathematics, Geography, Energy and Environmental Studies or Earth Sciences). It is well-suited for students planning to pursue graduate studies in another discipline or entering a career in a related field upon graduation. Students pursuing this option consult closely with each of their advisors and file a formal plan of study with the department.

Prerequisites

- Calculus I and II (MA 123, 124)
 - or Enriched Calculus (MA 127)
- Principles of Physics (PY 251, 252) and Modern Physics I (PY 351)
 - or General Physics (PY 211, 212) and Elementary Modern Physics (PY 313)
- Methods of Theoretical Physics (PY 355)

Principal Courses

- Electromagnetic Fields and Waves I (PY 405)
- Intermediate Mechanics (PY 408)
- Quantum Physics I (PY 451)
- Two additional physics courses at the 300 level or above (excluding PY 401, 402, 482, 491, 492, 581)
- Three coordinated courses from a participating science or engineering department

Required Related Courses

- Multivariate Calculus (MA 225)
- An additional mathematics course at the 200 level or higher

Recommended Courses

- Modern Physics II (PY 352)
- Electronics for Scientists (PY 371)
- Electromagnetic Fields and Waves II (PY 406)
- Introduction to Computational Physics (PY 421)
- Statistical Thermodynamics (PY 410)
- Quantum Physics II (PY 452)
- Undergraduate Physics Seminar (PY 482)

BA Astronomy & Physics

Physics when paired with Astronomy helps students understand how physical concepts are applied in our universe. Whether students are interested in solar flares or the Big Bang, this joint-degree program arms them with the knowledge and skills to observe physics in our solar system and beyond. Students who choose this concentration will be prepared to enter graduate school to study astronomy or astrophysics.

Prerequisites

- Principles of Astronomy I and II (AS 202, 203)
- Principles of Physics (PY 251, 252)
or General Physics (PY 211, 212)

Principal Physics Courses

- Modern Physics I and II (PY 351, 352)
or Elementary Modern Physics (PY 313)
- Methods of Theoretical Physics (PY 355)
- Electromagnetic Fields and Waves I and II (PY 405, 406)
- Intermediate Mechanics (PY 408)
- Statistical Thermodynamics (PY 410)
- Quantum Physics I (PY 451)

Principal Astronomy Courses

- Planetary Physics (AS 311)
- Stellar and Galactic Astrophysics (AS 312)
- Observational Astronomy (AS 441)
or Advanced Laboratory (PY 581)

Two courses from the following list::

- Extragalactic Astrophysics and Cosmology (AS 413)
- Solar and Space Physics (AS 414)
- Quantum Physics (PY 452)

Required Related Courses

- Calculus I and II (MA 123, 124)
or Enriched Calculus (MA 127)
- Multivariate Calculus (MA 225)

Recommended Courses

- Any courses from the above list if not taken as a principal course
- Electronics for Scientists (PY 371)
- Remote Sensing of Environment (GE 302)
- Climate and the Environment (GE 310)
- Introduction to Computer Science (CS 111, 112)

BA Philosophy & Physics

With this degree option, the Physics and Philosophy departments enable students to study the fundamental, philosophical questions underlying modern physics, the study of matter and energy, and how they interact. This joint-degree program provides a framework within which students can better understand some of the more theoretical aspects of the field of Physics.

Prerequisites

- One course in philosophy at the 100 level
- Principles of Physics (PY 251, 252)
or General Physics (PY 211, 212)
- Calculus I and II (CAS MA 123, 124)

Principal Physics Courses

- Modern Physics i and II (PY 351, 352)
- Methods of Theoretical Physics (PY 355)
- Electromagnetic Fields and Waves I and II (PY 405, 406)
- Intermediate Mechanics (PY 408)
- Quantum Physics I and II (PY 451, 452)

Principal Philosophy Courses

- Philosophy of Science (PH 270)
- History of Ancient Philosophy (PH 300)
- History of Modern Philosophy (PH 310)
- Symbolic Logic (PH 360)
or Philosophical Problems of Logic and Mathematics (PH 468)
- Philosophy of Physics (PH 470)
or a directed study in philosophy.

Required Related Courses

- Multivariate Calculus (MA 225)

Degree Programs

BA MA Physics

This five-year program is intended for students who want to continue their education in Physics at a graduate level, as well as for students who want to extend their knowledge of Physics beyond the undergraduate level before entering the job market. Students should enroll in this program no later than the end of their sophomore year.

Prerequisites

- Calculus I and II (MA 123, 124)
or Enriched Calculus (MA 127)
- Principles of Physics (PY 251, 252)
- Modern Physics I and II (PY 351, 352)
- Methods of Theoretical Physics (PY 355)

Principal Courses

- Electromagnetic Fields and Waves I and II (PY 405, 406)
- Intermediate Mechanics (PY 408)
- Statistical Thermodynamics (PY 410)
- Quantum Physics I and II (PY 451, 452)
- Mathematical Physics (PY 501)
- Quantum Mechanics I and II (PY 511, 512)
- Electromagnetic Theory I (PY 521)
- Statistical Mechanics I (PY 541)
- Advanced Laboratory (PY 581)
- Introduction to Solid State Physics (PY 543) or Introduction to Particle Physics (PY 551).

Required Related Courses

- Multivariate Calculus (MA 225)
- An additional mathematics course at the 200 level or higher

Recommended Courses

- Computational Physics (PY 502)
- Introduction to Solid State Physics (PY 543)
- Introduction to Particle Physics (PY 551)
- Introduction to Nuclear Physics (PY 561)
- Linear Algebra (MA 242)
- Advanced Calculus (MA 411)
- Complex Variables (MA 412)
- Mathematical Logic (MA 531)
- Methods of Applied Mathematics II (MA 561)

BA MA Astrophysics & Space Physics

The BA/MA program in Astrophysics and Space Physics is designed for those well-prepared students who wish to obtain a master's degree by adding a fifth year of intensive study in Astrophysics and Space Physics. Application to the Department of Astronomy's Director of Graduate Studies must be completed by March of the junior year.

The requirements of the BA/MA program consist of those for the BA in Astronomy and Physics plus those of the MA in Astronomy. There are two tracks in the program, one comprising 38 courses plus a master's thesis, and one comprising 40 courses without a thesis. Further details may be obtained at the Department of Astronomy office or from the Director of Graduate Studies.

Minor in Physics

A minor in Physics is a great way to supplement any science major or simply support a student who would like a well-rounded background. Many math and engineering students decide to enhance their majors with a minor in Physics.

Principal Courses

- Principles of Physics (PY 251, 252) and Modern Physics I (PY 351)
or General Physics (PY 211, 212) and Elementary Modern Physics (PY 313)
- Modern Physics I (PY 351)

Two Of The Following Courses

- Methods of Theoretical Physics (PY 355)
- Electromagnetic Fields and Waves I (PY 405)
- Electromagnetic Fields and Waves II (PY 406)
- Intermediate Mechanics (PY 408)
- Statistical Thermodynamics (PY 410)
- Quantum Physics I (PY 451)
- Quantum Physics II (PY 452)

Teach Physics!

Perhaps you were inspired to become a physics major by one of your teachers in high school. You can go on to inspire new generations of students to study science or engineering by becoming an inspiring teacher yourself. There has always been a need for qualified physics teachers in this country. Recently, that need has increased significantly because many school districts (including the Boston Public Schools) have adopted a Physics First curriculum, with many students taking a conceptual physics course in the 9th grade.

To be able to teach effectively, a teacher needs a solid background in their subject area. As a physics major, you will learn many different things about how the world works. Deciding to share your knowledge with others by becoming a physics teacher could be the best decision you ever make.

Possible routes include a BA in physics, followed by a one-year Master of Arts in Teaching (MAT) program through the School of Education; an interdisciplinary BA in Physics and Education, which combines a degree in Physics with several education courses; and a double major in Physics and Education through the Boston University Collaborative Degree Program (BUCOP).

If you're interested in becoming a physics teacher and would like more information, contact Andrew Duffy in the Physics Department (aduffy@bu.edu).

Student Spotlight

Andrea J. Welsh, CAS '11

How would you describe being a physics major at BU?

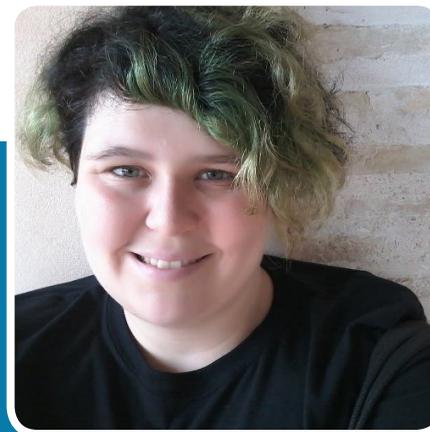
Being a physics major at BU made me feel like a physicist, and not merely just a student. There were a lot of faculty who were happy to talk to us about their work and life in general. I remember being encouraged to go to colloquia, which was intimidating especially when I didn't understand a lot of the work at the time, but it helped me know what was vaguely going on in different research areas and also made me feel like I belonged in the department. Also, I really looked up to older students that I met through Photon and it brought me out of my shell.

Describe what you are doing right now

I am just about to defend my Ph.D. in the School of Physics at Georgia Institute of Technology. I do research on coupled oscillators and active matter in biophysics. I have a postdoc offer in the fall for the Max Planck Institute for Dynamics and Self Organization. I would like to be faculty, to do research and work with students eventually.

How did your experience at BU prepare you for graduate school?

I got a lot of different research opportunities. I started volunteering in Prof Zimmerman's group the end of my freshman year and learned a bit about data manipulation in that short time. Prof Goldberg in our freshman seminar stressed the importance of starting research right away



which was why I had reached out and also looked into applying to REU's as early as possible. I actually worked with him for a year on graphene annealing and fabrication. I then had the opportunity to go to Geneva in the inaugural CERN study abroad program which gave me a lot of insight into work in an international group and gave me my first experience of traveling abroad (and being on a plane).

What was your favorite aspect of the physics community/what do you miss?

My favorite part is just the community in general. I am still in contact with much of my graduating class and some of the students who graduated before and after me. Some of them I see at annual meetings like the APS March Meeting, but others I see while traveling and just keep in contact with those both in and out of academia (and of course, one I am married to). I also loved being a part of events like the Pumpkin Drop where the whole department would come together. I haven't really experienced something like that in other departments yet. It was also great to have dinner with other students and faculty, which I got to do on a few different occasions.

Study at CERN

Boston University's Geneva Physics Study Abroad Program, in cooperation with the University of Geneva, brings students directly to the cutting edge of modern physics. Students take classes at the University of Geneva and conduct research at CERN, under the direction of some of the world's leading physicists. Research opportunities are also available in laboratories at the University of Geneva.

The semester starts with a six-week orientation. In addition to an intensive French class, students take a course at CERN on computational methods in elementary particle physics. Both courses are accompanied by weekly discussion sections.

After completing orientation, students begin their coursework at the University of Geneva. The lectures for both Electrodynamics and Quantum Mechanics are delivered in French, with a separate discussion section in English held weekly. Students on the program enjoy all the privileges of full-time University of Geneva students. Boston University's residence hall is located in the center of Geneva.

For more information visit physics.bu.edu/sites/geneva-program/

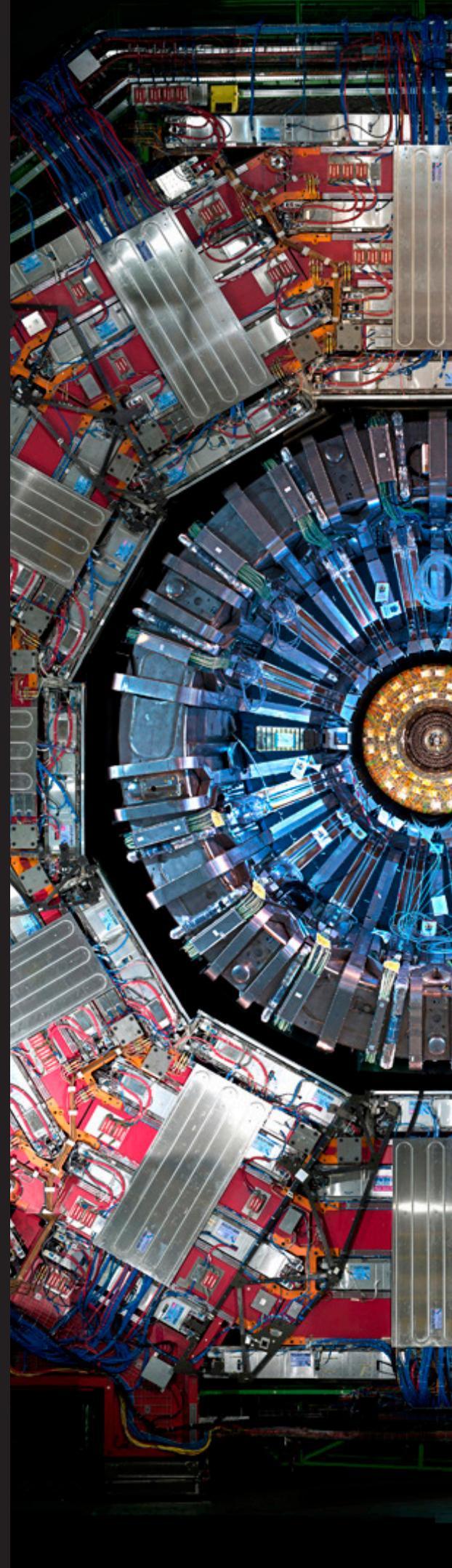




Image: CERN



Physics and the Boston University Hub

The BU Hub is Boston University's university-wide general education program that emphasizes working across disciplines to prepare for a complex and diverse world. Students can explore a variety of courses and innovative learning experiences while developing six essential capacities and fulfilling Hub requirements. The Hub has been integrated into much of the Physics curriculum. Currently twelve of the twenty six required Hub units will be filled by required courses on the graduate track. This leaves just fourteen Hub units to be completed outside of the curriculum. These Hub units can be completed through Hub Electives.



The easiest and most effective way to fulfill the Hub areas is to take the Core Curriculum.

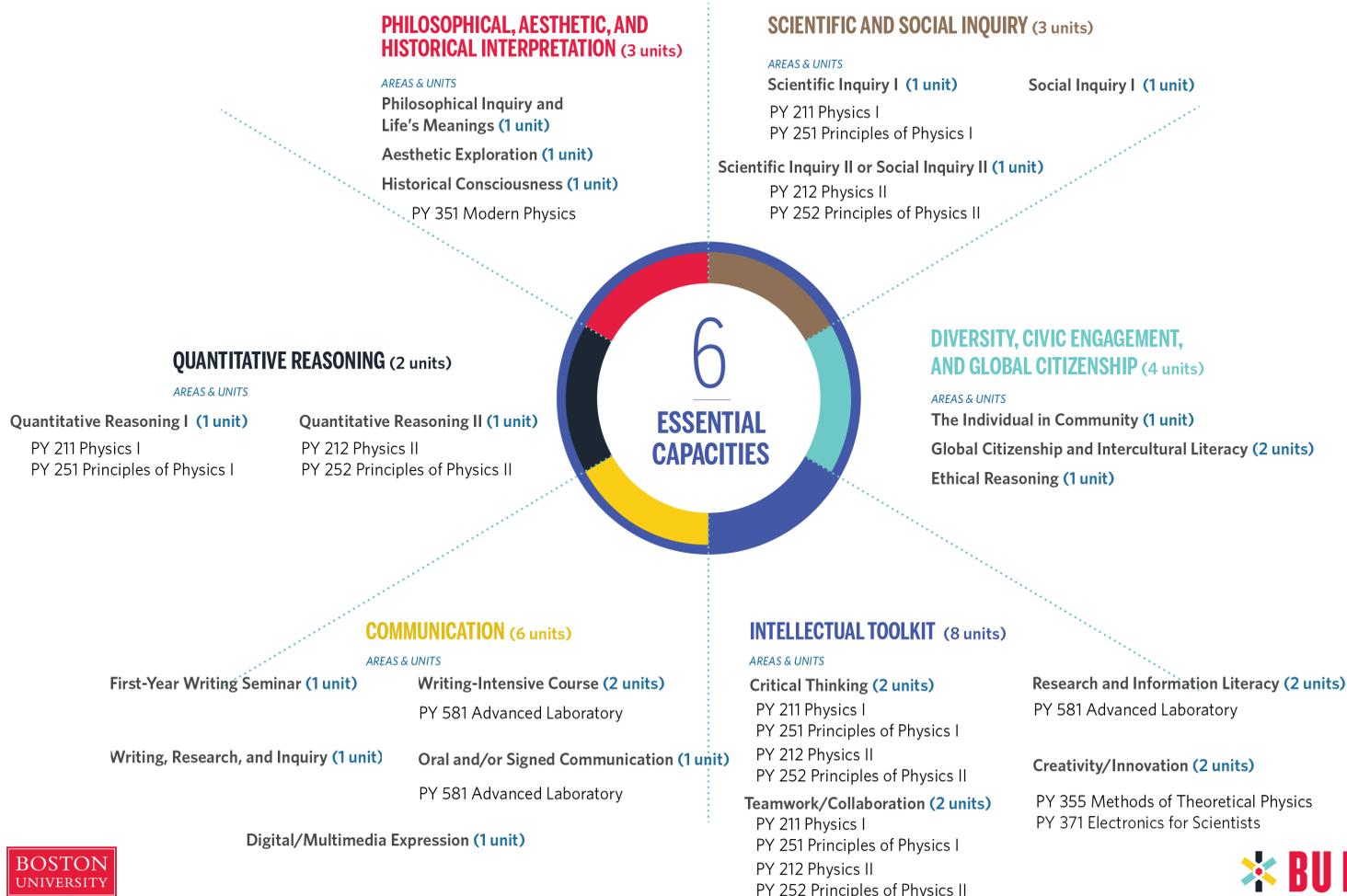
Students can use the Course Description search tool to find courses that fit their remaining Hub units.

BU HUB REQUIREMENTS FOR STUDENTS

26 units in approximately 10-12 courses | Hub courses can also count toward majors and minors

In the Hub, you will explore a broad array of disciplines and ways of thinking as you prepare to navigate an increasingly complex and interconnected world.

BU.EDU/HUB



Sample Schedule of Graduate Track Physics Student taking the Core

	Year 1	Year 2	Year 3	Year 4
Fall	PY 251	PY 351	PY 405	PY 452
	MA 124	MA 226	PY 408	PY 581
	CC 101	CC 201	elective	elective
	language	language		elective
Spring	PY 252	PY 355	PY 406	PY 410
	MA 225	MA 242	PY 451	PY 371
	CC 102	CC 202	CC 112	elective
	language	language		elective

Sample Schedule of Interdisciplinary Track Physics Student taking the Core

	Year 1	Year 2	Year 3	Year 4
Fall	PY 251	PY 351	PY 405	PY 581
	MA 124	MA 226	PY 408	I4
	CC 101	CC 201	I2	elective
	language	language	elective	elective
Spring	PY 252	PY 355	PY 451	PY 406
	MA 225	MA 242	I3	PY 452
	CC 102	I1	CC 112	I5
	language	language	CC 202	elective

I1-I5: 3 interdisciplinary courses + 2 prerequisites for them

Research Opportunities

BU Physics Department tries to ensure that all undergraduate students have an opportunity to conduct research.

Research provides students the hands-on experience that supplements the lessons learned in the classroom. Research prepare students for both graduate school and careers in industry



and education. We encourage our undergraduates to become involved in research by the end of their sophomore year, and to continue through graduation. Students are often included as authors on peer-reviewed scientific articles. Some students write a senior honors thesis on their research.

Some research is coordinated through the Undergraduate Research Opportunity Program (UROP), which is managed by BU. To choose a UROP opportunity, first choose an area of interest and then speak with professors and advisers about research possibilities. Once you have clarified your interests, check the UROP website and bulletin boards in the Undergraduate Resource Room for opportunities. If you find none that suit you, check professor profiles on the BU Physics website and contact professors who do research in your area of interest. Discussing research with professors is paramount, as most UROP application submissions require two letters of recommendation in addition to the application. Those conversations will acquaint you with the professors' research, as well as help them learn about you. More information is available at www.bu.edu/urop.

Student Spotlight

Jessica Allan, CAS '17

How would you describe being a physics major at BU?

Being a physics major is a thoroughly enjoyable experience. You must work hard, but you learn a lot and are rewarded immensely for your endeavours. Coming to BU as an international student, I was concerned about fitting in and finding my community but I found it in the department. The student groups and the professors are welcoming, and I felt supported in my classes, as well as in the major more generally. There are so many opportunities; for research, to study abroad, to attend undergraduate conferences. I found the experience extremely rewarding.

Describe what you are doing right now.

I work as a Data Analyst at a tech startup incubator in Cambridge, MA. This involves a certain amount of coding knowledge, as well as using the problem-solving skills I developed as a physics major. My company aims to provide a

stable environment for tech startups to thrive, and a supportive environment for early-stage entrepreneurs. In particular, my team is developing a product to aid future homeowners in deciding where to live, and how to budget for mortgage and home repairs.

How did your experience at BU prepare you for industry?

Aside from technical knowledge and facts I learned from physics classes, the ability to problem solve is vital in my role, and the majority of jobs you may go to after a physics degree. There are so many skills you can learn from a physics degree that are applicable in areas outside the strict academic world. I was exposed to coding through my research, which I also use in my job, and worked with different personalities and nationalities on the Geneva Study Abroad program – a skill that is useful in any office or lab.



What was your favorite aspect of the physics community/what do you miss?

In physics, you tend to be surrounded by people who are just as passionate about the subject matter as you are, and you never have to travel far to find someone going through the same thing as you. I really miss having my peers close by and bonding over problem sets and our shared love of physics. The student groups, Photon and PRISM, were so beneficial to me in building that group of like-minded friends.



Photon

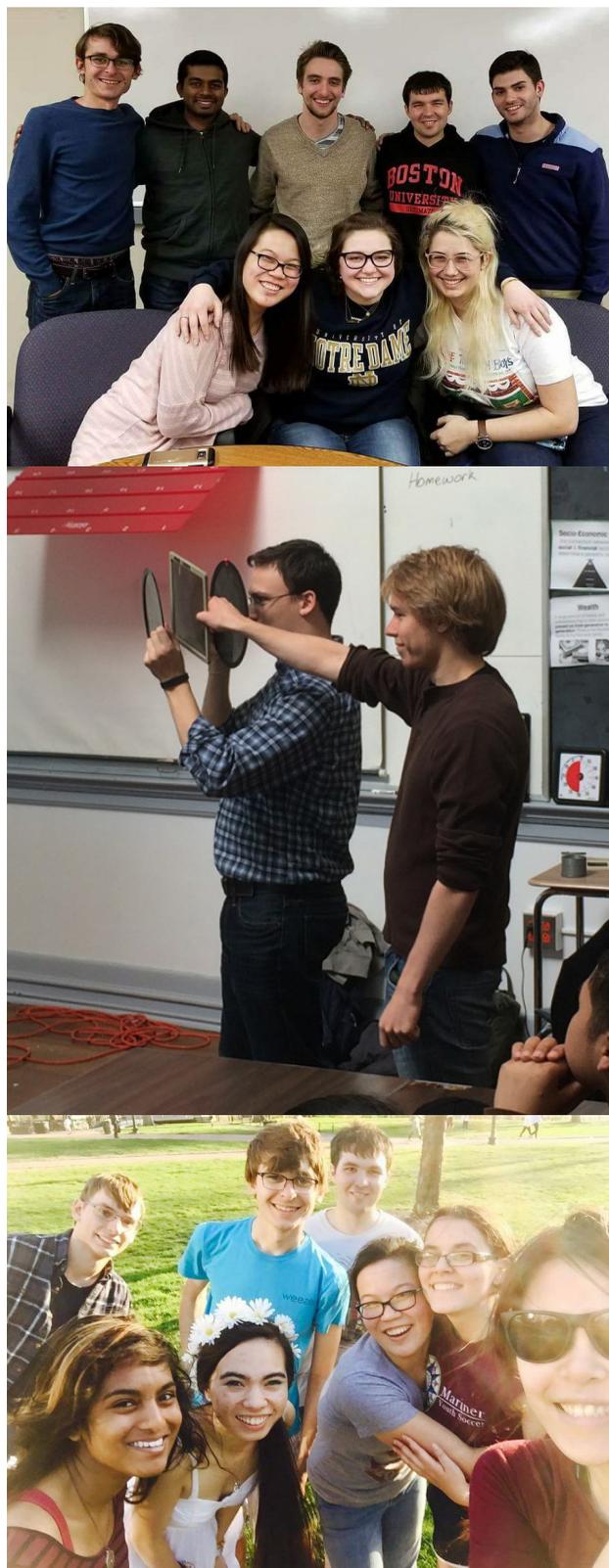
Undergraduate Student Organization

Photon is Boston University's chapter of the Society of Physics Students (SPS). The organization hosts social interactions among physics majors and helps share their enthusiasm for the physical sciences with a broader community. Some activities include hands-on demonstrations, talks by faculty and students on subjects of interest, and participation in outreach programs in the Boston area. Photon maintains ties with other local SPS chapters, such as Harvard, MIT, and Northeastern.

Weekly meetings allow members to deepen their understanding of physics in an informal atmosphere. Many meetings feature guest speakers. Topics have included the physics of stomach bacteria, femtosecond lasers, and neutrino detection with the Super-K detector. In addition, Photon hosts the Meet the Physics Department Panel, which allowed for undergraduates to connect with members of the physics department faculty. With the help of the Physics Demo Room, members are able to experiment with liquid nitrogen, non-Newtonian fluids, Van de Graaf generators, lasers and Tesla coils. Photon also hosts group trips to local science venues, such as the annual Museum of Science College Night.

Photon is involved in bringing science to students within Boston University and the surrounding community. Each year, Photon members participate in a program for female high school students called SET (Science, Engineering, and Technology) in the City. Members prepare a variety of physics demonstrations and talk to students about pursuing a physics degree. Photon provides volunteers for the physics department's annual Pumpkin Drop. In addition, Photon holds Python workshops for students who wish to expand their programming skills, which have become an important component of the physics curriculum.

Photon provides a relaxed environment for undergraduates interested in physics. Students will often gather for an hour or more after the meeting to socialize. Members are placed in a "Photon Family". Families are small groups of members led by an officer. Throughout the semester, families spend time with each other in outings, study sessions, and informal competitions. More generally, Photon members get the chance to interact with other students from their classes, without the stress of class or work. Photon can help students form effective study groups. Younger students can learn more about the degree programs from more senior members. Overall, Photon is a great way for students to continue learning the physics they love in a relaxed and convivial setting.



Peer Resources

Undergraduate physics students support each other through a variety of peer resources.

Peer Mentors

Initiated and run entirely by students, the PRISM (PeeRs for Incoming Students Mentorship) program is an undergraduate support network for entering physics majors. Participating freshmen are assigned a junior or senior mentor with whom they meet five times during the semester. Meetings are designed to address mentee questions and concerns, while also inspiring involvement in department life. Mentors also provide help navigating the numerous research and academic opportunities available in the department and at BU.



“ It really helps bonding with a physics student, someone who has already gone through all the challenges that I am facing now. ”

— PRISM mentee

Learning Assistants

The Learning Assistant Program recruits high-achieving undergraduates to help teach physics courses they have successfully completed. Learning Assistants (LAs) work closely with faculty and receive training in science pedagogy through the School of Education. These students are well-equipped to bring their unique perspective as peer educators into the classroom, facilitating active and collaborative learning in a student-centered, small-group environment.



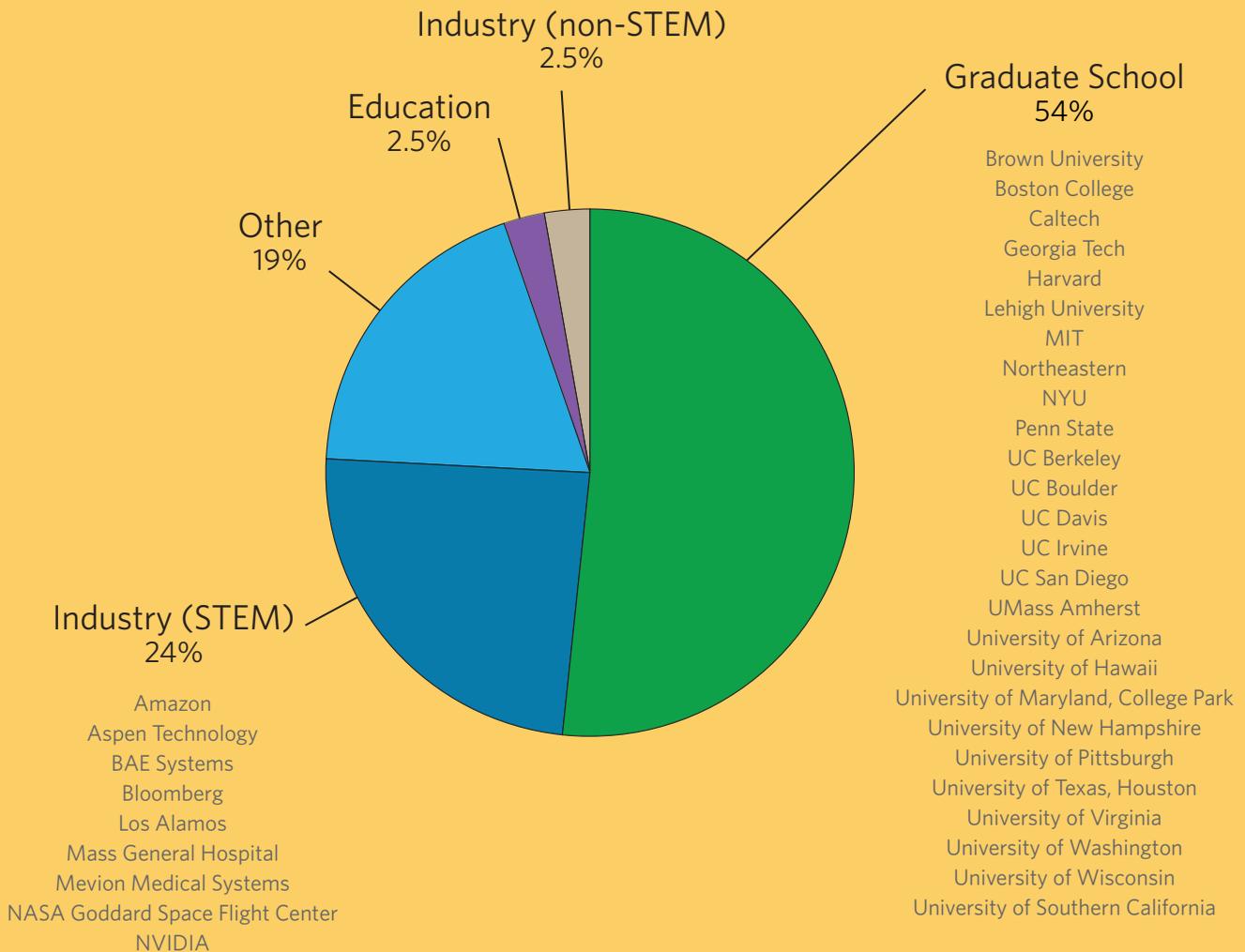
Graduate Opportunities

Bachelor's recipients from the Physics Department have been successful in being accepted to the most prestigious graduate programs in the US. Graduates have also been successful in entering into a diverse range of disciplines, reflecting the broad value of an undergraduate degree in Physics.



Average breakdown of initial placements for BU Physics graduates

Includes some recent companies and institutions



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Photo by Cydney Scott
(reprinted from BU Today)



Pumpkin Drop

Many students get involved in the department's annual Pumpkin Drop in October, which involves dropping pumpkins filled with substances from whipped cream to neon paint from the top of the Metcalf Science Center. Now in its fifteenth year, the event has become a beloved BU tradition, and has garnered media attention from local and national news outlets.



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