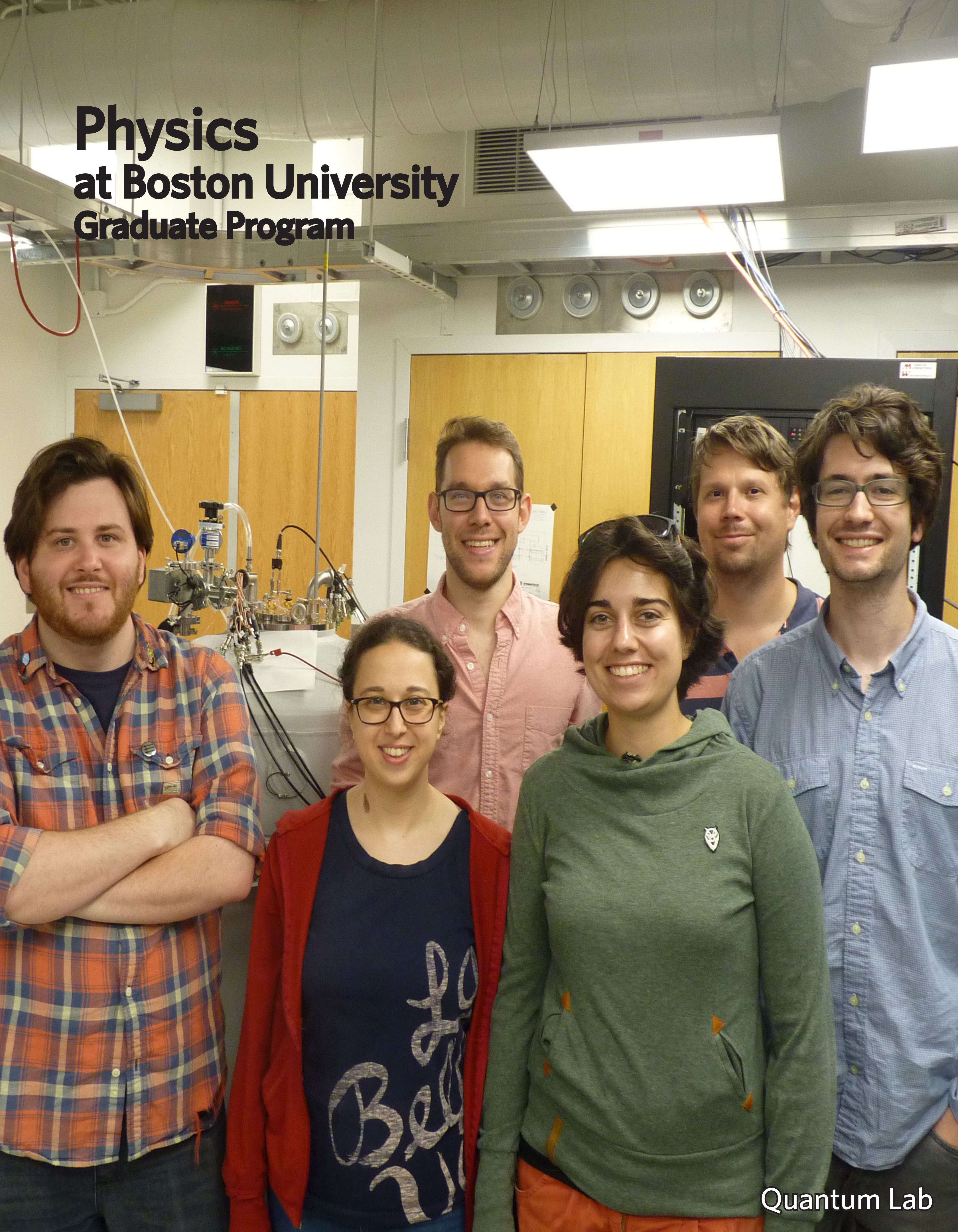
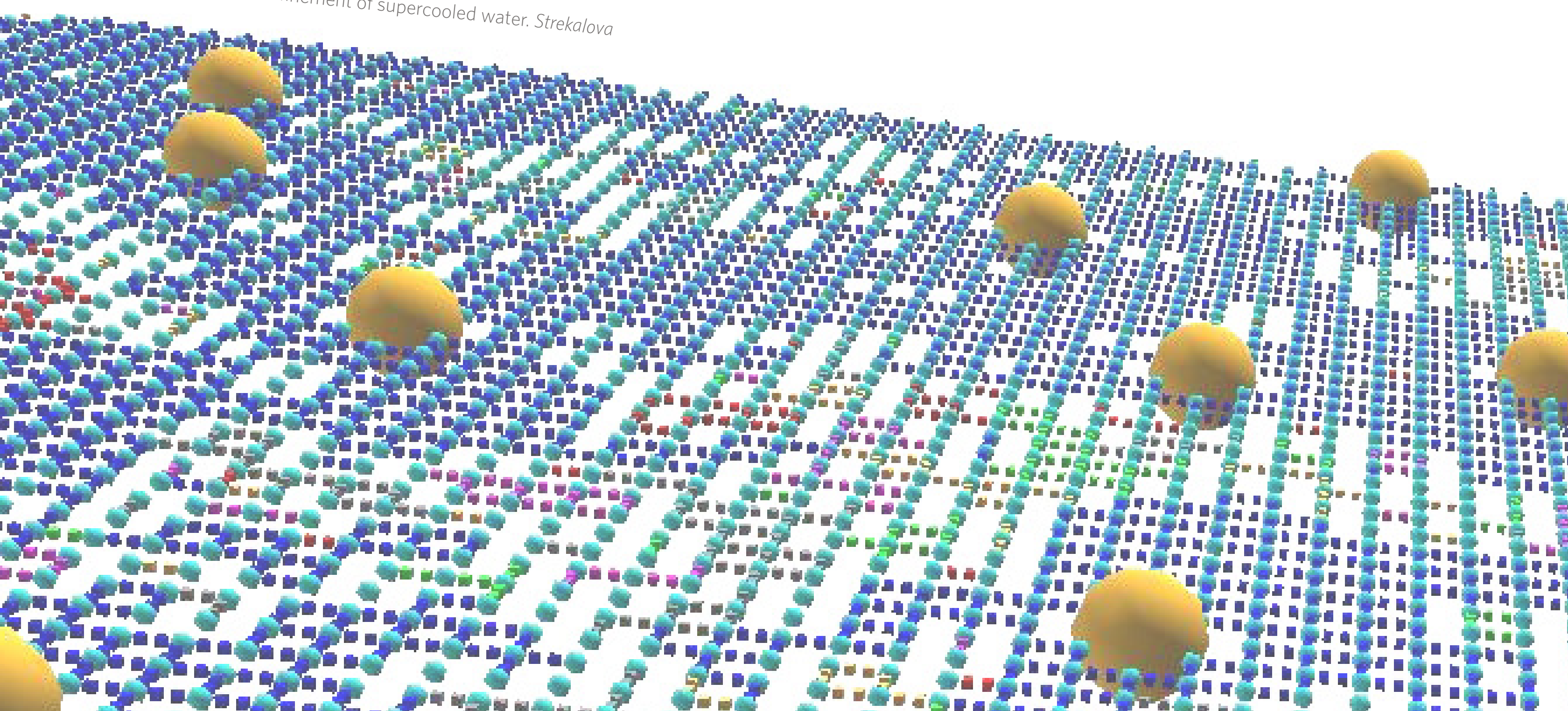
Physics
at Boston University
Graduate Program

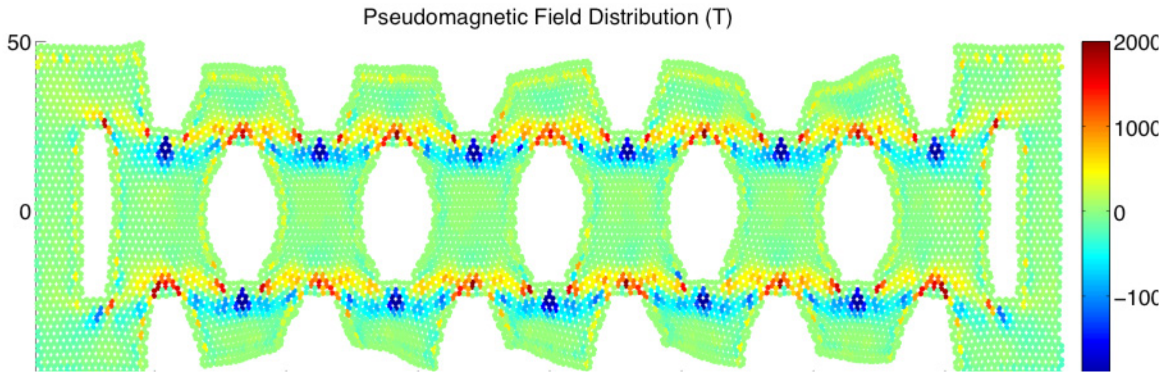


Quantum Lab

CONTENTS

Hydrophobic nanoconfinement of supercooled water. *Strekalova*





Distribution of the pseudomagnetic field in a graphine kirigami ribbon.Note the field strength in Tesla.

Greetings from the Boston University Physics Department! We welcome you to learn more about our Graduate Program, the Faculty and their research, as well as applying.

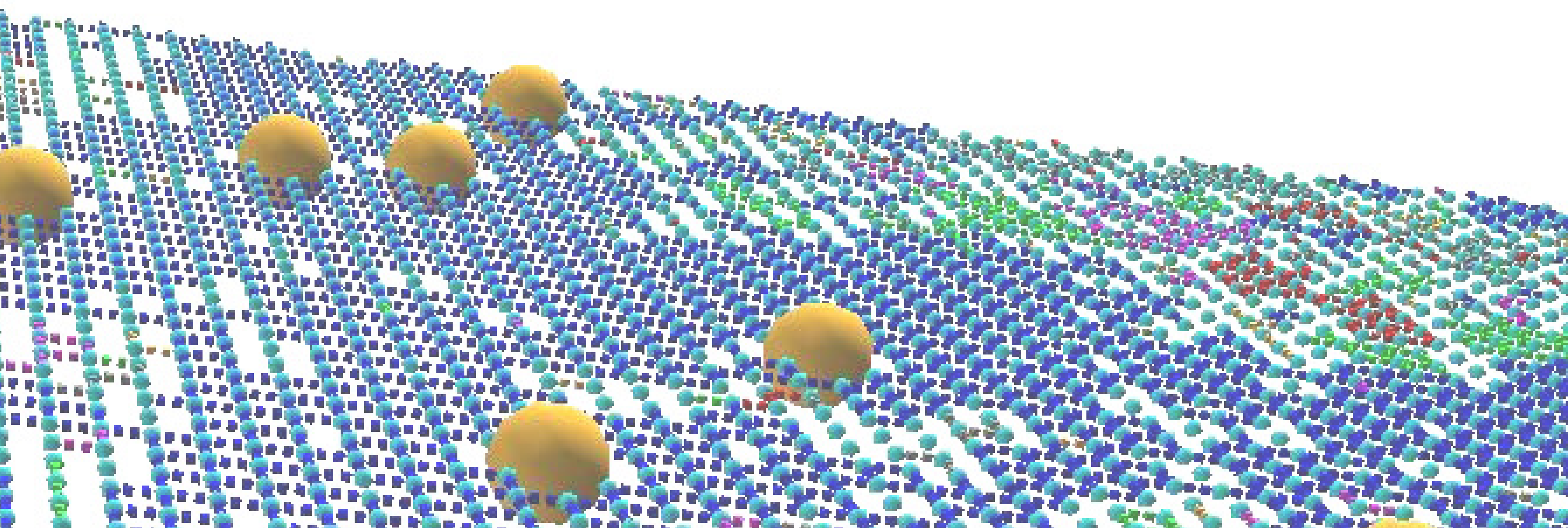
Our typical incoming class is between ten and twenty students. Through a combination of teaching fellowships, research assistantships, and University fellowships, our department provides full tuition, stipends, and basic medical insurance for all our graduate students.

We have numerous full-time faculty members, along with affiliated faculty members whose primary appointments are in other departments, including Engineering, Chemistry, Biology, and Mathematics. Our faculty are printed and featured in numerous publications, hold high-level positions at major experiments around the world, and over half are Fellows of the American Physical Society.

Our research specialties include experimental particle physics, particle astrophysics, theoretical particle physics and cosmology, molecular biophysics, experimental biophysics, experimental condensed matter physics, theoretical quantum condensed matter physics, statistical physics, polymer physics, network theory, econophysics, and computational physics. There are numerous interdisciplinary opportunities, particularly with the School of Engineering, Center for Photonics Research, the Medical Campus, the Department of Mathematics, and the Department of Biology.

Major resources include the Scientific Instrument Facility, the Electronics Design Facility, and state-of-the-art supercomputer clusters in the Center for Computational Science.

In addition to the resources available at Boston University, the Boston area offers a wealth of cultural, scholarly, scientific, and technological activities. We hope that you will consider a graduate career in physics at BU, and we look forward to welcoming you to our program!



PROGRAM OVERVIEW

The Physics Department at Boston University offers a PhD in Physics with an optional MA degree en route to the PhD.

The PhD degree requires the completion of 64 credit hours (equivalent to sixteen semester courses), a preliminary oral exam, a departmental seminar, completion of a dissertation, and a dissertation oral defense. The dissertation must exhibit an original contribution to the field. Each student must also satisfy a residency requirement of a minimum of two consecutive regular semesters of full-time graduate study at Boston University. Additional details are provided on page 3.

The MA degree requires the completion of 32 credit hours (equivalent to eight semester courses). The requirements for a master's degree may be satisfied as part of the PhD degree program

APPLYING

The application deadline for fall admission is early January. Spring admission is not offered.

For admission to the graduate program, a bachelor's degree in physics, or a Bachelor's Degree in another field with comparable preparation in junior and senior level physics courses including quantum mechanics, intermediate mechanics, electricity and magnetism, and statistical/thermal physics is required. Official GRE results (general and physics subject tests) are required; scores are weighed within the context of the applicant's overall record. Official TOEFL or the IELTS results are required of all applicants whose native language is not English; please visit *https://www.bu.edu/physics/admissions/graduate-program-admissions/* for minimum score requirements.

FINANCIAL AID

Through a combination of teaching fellowships, research assistantships, and University fellowships, physics graduate students receive full-tuition scholarships and basic health insurance coverage for the duration of their studies, as well as a stipend. The annual stipend rate for the 2021 – 2022 academic year, including summer, is $36,782.

Metcalf Center for Science and Technology

COURSES

Sixteen (16) courses are required. At least ten must be lecture courses from the 500-850 levels, including five initial-sequence theoretical courses, Scholarly Methods in Physics (PY 961), Advanced Laboratory (PY581), and two distribution courses from outside the student's field of specialization. Additional coursework may include directed research, directed study (two maximum), and seminar courses (two maximum). Students who have taken equivalent courses may petition for specific course waivers.

ORAL QUALIFYING EXAMINATION

The Oral Qualifying Examination should be taken no later than January of the third year. Completion of Advanced Laboratory (PY581) is required before a student is eligible for the Oral Examination. Four committee members are selected at least three weeks before the examination, and a one-page abstract is due to the committee at least two weeks before the examination.

DEPARTMENTAL SEMINAR

The Departmental Seminar must occur within two years of the Oral Qualifying Examination and at least six months before the dissertation defense. A thesis proposal is due to the committee at least two weeks before the seminar.

PHD DISSERTATION AND DEFENSE

An approved thesis abstract must be received by the Graduate School at least three weeks prior to the defense. A draft of the thesis must be received by the thesis committee at least two weeks prior to the defense. Approximate deadlines: mid-April for May (Spring) graduation, mid-August for September (Summer) graduation, and mid-December for January (Fall) graduation.

Find out where a PhD in Physics from BU can take you (page 14)

Physicists Uncover Swimming Secrets of *H. pylori* Bacteria

By Barbara Moran
Reprinted from BU Research Magazine

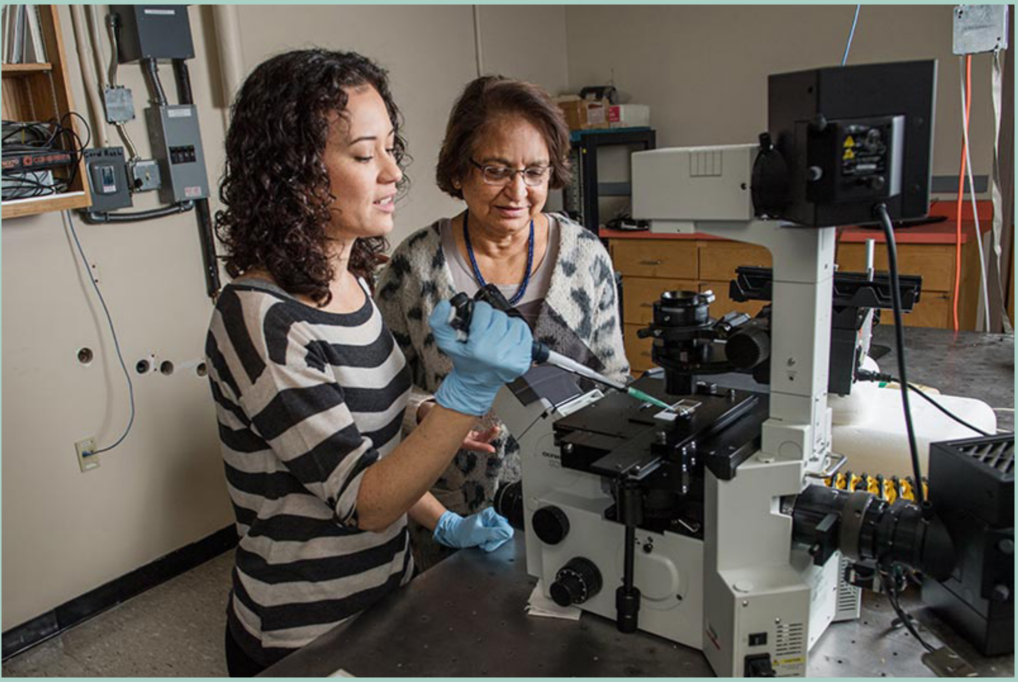
While not as inspiring as the heart or as mysterious as the brain, the stomach is just as impressive: the muscular sack churns with acid so powerful it will dissolve metal—but it doesn't digest the organ itself.

The stomach protects itself from its own acid with a coating of mucus, a tactic that doesn't always work against the ulcer- and cancer-causing Helicobacter pylori, the only bacterium known to colonize that harsh environment. H. pylori somehow survives the acid, swims through the mucus layer, and infects stomach cells. An estimated 50 percent of humans harbor H. pylori in their gut, but only some of them develop ulcers or stomach cancer. So understanding how H. pylori survives here is key to understanding those diseases.

Rama Bansil, a Boston University professor of physics who has studied stomach mucus for over two decades, has uncovered two factors that give the bacterium a leg up: the chemicals it secretes and its skill at swimming. Both are critical to its success.

Bansil, whose work is funded by the National Science Foundation, became curious about stomach mucus in the late 1980s. "The question back then was: The stomach produces nearly half a gallon of gastric juice a day, which is acidic and can digest nails—so why doesn't it digest the stomach?" she says. Researchers suspected that the thin layer of mucus protected the stomach from this acid, but nobody knew exactly how it worked. Bansil, whose area of research is gels and gelation, began to study the purified protein mucin, which gives stomach mucus its ability to gel. In this early work, she and her colleagues found that it gelled only under extremely acidic conditions, below a pH of 4.

Later, she turned her attention to H. pylori. "I decided that we would actually try and see how this bacterium gets across, since this layer is probably gel-like—or at least certainly very viscous, like a soft toothpaste or petroleum jelly," she says. "How does something swim through such a medium?"



Rama Bansil and Maira Constantino study how H. pylori's shape contributes to its swimming ability. Their work could impact the fields of drug delivery and cancer treatment. Photo by Jackie Ricciardi

Some researchers had hypothesized that the spiral-shaped bacterium drilled its way through the thick mucus like a corkscrew. But in laboratory experiments, Bansil and her colleagues found, surprisingly, that H. pylori, which propels itself with rotating flagella, couldn't swim through a gel at all. "Even though it's alive and its flagella are rotating, it doesn't move ahead. It just stays in place," she says.

Not so in stomach mucus. There, H. pylori secretes an enzyme called urease, which breaks down urea in the stomach into carbon dioxide and ammonia, giving the smell of ammonia to the breath of infected people. Ammonia, a base, reacts with the stomach mucus, raising its pH and liquefying it. "It de-gelled the gel, and this reversible gelation was the key to letting this bacterium get across," says Bansil, who published this research in Proceedings of the National Academies of Sciences in 2009.

If H. pylori's corkscrew shape didn't help it drill through mucus, wondered Bansil and her colleagues, why did it have that shape? Another spiral-shaped bacterium called Campylobacter jejuni is able to colonize the upper part of the small intestine, so the shape must be important for something. "We wanted to find out why H. pylori has a helical body," says Maira Constantino (GRS'17), a PhD candidate who joined Bansil's lab in 2014. "What is the advantage there?"

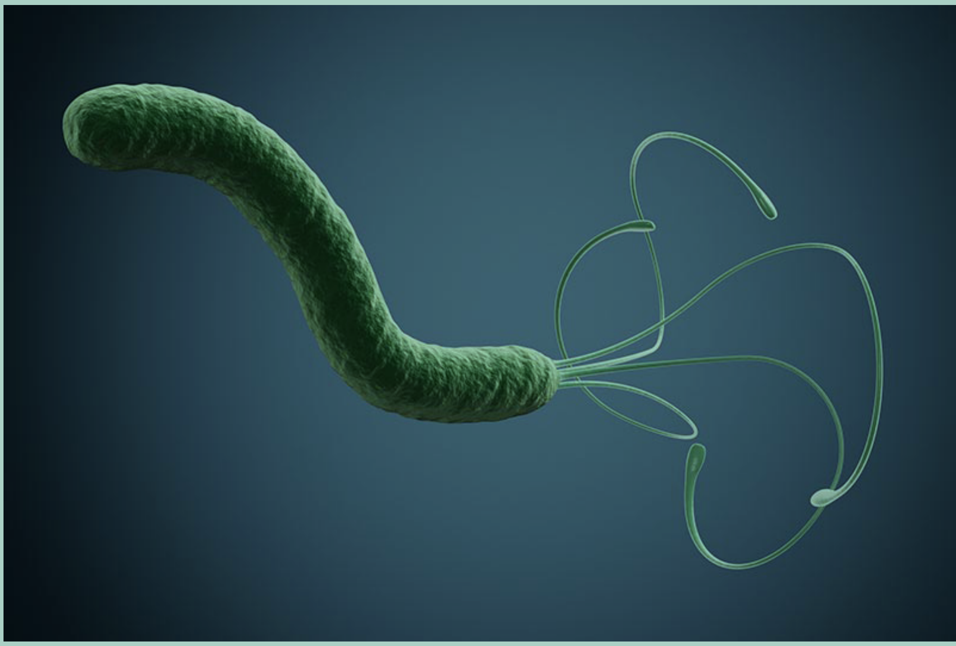
Many assumed that the corkscrew-shaped body increased H. pylori's swimming speed in general, because corkscrew shapes produce thrust when they spin. Previous experiments by other groups supported this, finding that spiral-shaped Helicobacter swam two to three times faster than rod-shaped E. coli. "But that's not a good comparison, because you're really comparing two different organisms," says Bansil. She collaborated with Nina Salama, a microbiologist at the Fred Hutchinson Cancer Research Center in Seattle who had bred mutant H. pylori, the same as the original but rod-shaped.

Then they filmed them, hundreds at a time, swimming in mucin and culture broth, to see which ones swam faster. Comparing the videos, they found that, on average, helical bacteria were about 10 to 15 percent faster than their rod-shaped relatives. They published their results in Molecular Microbiology in 2015.

But those results were only averages. Constantino wanted to take the analysis further, by filming the motion and shape of single bacteria, a painstaking process. By taking video at high speed, 200 frames per second, she was able to record the speed, rotation, and body shape of individual bacteria. She and her colleagues discovered that both types of bacteria spun as they swam, about 10 to 15 body lengths per second—"a pretty good stride," but the helix swam a little faster, says Bansil. To understand exactly why, Bansil and Constantino sent the data to colleague Henry Fu, an associate professor in the mechanical engineering department at the University of Utah, and his student Mehdi Jabbarzadeh, who used it to build a theoretical model of H. pylori swimming. The Utah scientists found that having more flagella contributed more to speed than body shape; the helical shape contributed, at most, 15 percent to the bacteria's propulsive thrust, confirming what the scientists had found before. "The 15 percent difference doesn't look very large, but it may be enough of an advantage that the helical one will win over the rod long-term," says Bansil.

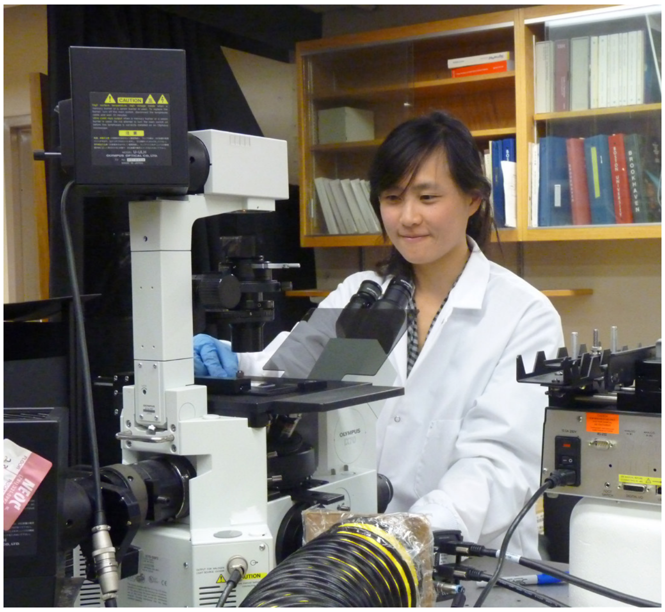
The results, and video evidence, were published in November 2016 in Science Advances. Bansil and her colleagues are now studying H. pylori from a cancer patient, as well as the patient's stomach mucus, looking for clues in the specific interaction of the bacterium with mucin.

Bansil's work may prove useful in another arena of science: drug delivery. "Many drugs cannot get across the mucus. Only very small drugs can get through, or those which can break down the mucus," she says. It is not difficult to render H. pylori harmless by genetic manipulations, and if it can be loaded like a capsule, with, say, a chemotherapy drug, the bacterium could then use its innate ability to get across mucus and carry the treatment across, and deliver it where it's needed. "This might be a very clever way to deliver a targeted drug orally," says Bansil.



Spiral-shaped H. pylori is the only bacteria known to colonize the human stomach. An estimated 50 percent of humans harbor H. pylori in their gut, but only some develop ulcers or stomach cancer. Photo by lucadp/iStock

RESEARCH



The Physics Department is part of Boston University's Science and Engineering Complex, centrally located on the main Charles River Campus.

On-campus facilities include electronic and mechanical nanostructure fabrication and measurement, metastable-helium-atom probes of surface spin order and dynamics, photoemission and soft X-ray fluorescence probes of electronic structure in novel materials, X-ray diffractometers, and the optics and transport of electrons at high fields and low temperatures.

Biological physics and polymer physics labs include optical microscopy light scattering, Raman and Brillouin scattering, and ultrafast infrared and Terahertz spectroscopy, as well as modern facilities for genetically manipulating biomolecules.

The high energy physics labs include facilities for the design, production, and testing of key components of various particle detectors. Collaborations include the Mu2e experiment at Fermilab; the ATLAS and CMS experiments at the CERN Large Hadron Collider; the MuLan and MuSun experiments at PSI, Switzerland; the Super-Kamiokande experiment in Kamioka, Japan, including the KEK/K2K and T2K/JPARC neutrino accelerator projects; the CLEAN/DEAP dark matter experiments; CALICE calorimeter R&D for the ILC; and the neutron EDM experiment at ORNL.

The Boston University Photonics Center is a collaborative research and education center that supports physicists, engineers, chemists, and biomedical researchers to advance academic research, educational programs, commercial incubation, and photonics technology development. For additional information, visit *www.bu.edu/photonics*.

Boston University's Center for Nanoscience and Nanobiotechnology is an interdisciplinary research and academic center that includes basic materials science, surface science, physics, chemistry, and engineering, and extends into molecular and cellular biology, biophysics, and the technologies of microfluidics, MEMS, and onto manufacturing. The Center's strengths are in developing and using nanotechnology advances in materials and platforms with our capabilities in biomedical engineering to focus on applications in understanding subcellular processes, biomolecular function, and human physiology. For additional information, visit *nanoscience.bu.edu*.

An extensive network of computational facilities supports the research activities of the Department. For computationally intensive applications, students have access to supercomputing resources supported through the Center for Computational Science and the Office of Information Technology. The Departmental Computer Facility supports a wide range of software applications for physics data collection, analysis, simulation, and visualization.

CORE COURSES

PY 501 MATHEMATICAL PHYSICS

Introduction to complex variables and residue calculus, asymptotic methods, and conformal mapping; integral transforms; ordinary and partial differential equations; non-linear equations; integral equations.

PY 502 COMPUTATIONAL PHYSICS

Fundamental methods of computational physics and applications; numerical algorithms; linear algebra, differential equations; computer simulation; vectorization, parallelism, and optimization. Examples and projects on scientific applications.

PY 511 QUANTUM MECHANICS I

General theory of quantum mechanics, including the Schrodinger, Heisenberg, and interaction pictures. The path integral formulation. Angular momentum: orbital and spin angular momentum, addition of angular momenta, Wigner-Eckart theorem. Scattering theory: time-independent, partial waves and phase shift, identical particles, time dependent, and propagators.

PY 512 QUANTUM MECHANICS II

Continuation of CAS PY 511. Degenerate and nondegenerate perturbation theory. Second quantization of nonrelativistic systems with applications to scattering, lifetime of excited states, many-body problems. Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation.

PY 521 ELECTROMAGNETIC THEORY I

Vector and tensor analysis. Electrostatics, uniqueness, electrostatic energy, capacitance. Boundary value problems, conformal mapping, variable separation, Green's functions. Multipole expansion, electric polarization, atomic models, anisotropic media. Contour integration and application to frequency-dependent dielectric constant. Dielectrics, electrostatic energy, boundary value problems.

PY 522 ELECTROMAGNETIC THEORY II

Continuation of CAS PY 521. Magnetostatics, dipole moment, magnetic materials, boundary value problems. Electromagnetic induction, magnetic energy, Maxwell's equations. Electromagnetic waves in materials, reflection, refraction. Waveguides. Scattering and diffraction. Special relativity. Lorentz transformations, covariant electrodynamics. Interaction of charges with matter. Radiation, Lienard-Wiechert potential, synchotron radiation, antennas.

PY 536 QUANTUM COMPUTING

Quantum physics as a powerful computational paradigm. Quantum bits (qubits), qubit operations and quantum gates, computation, and algorithms. Computational complexity classes, and efficiency of classical vs. quantum computers. Quantum Fourier transform and Shor's factorization algorithm. Physical implementation of quantum computation.

PY 538 ECONOPHYSICS

Expands upon the foundations of finance theory with interdisciplinary approaches from statistical physics and machine learning. Equips the students with the Python tools to tackle a broad range of problems in quantitative financial analysis and combines the study of relevant financial concepts with computational implementations. Students learn to use packages like Numpy, Pandas, Statsmodels and Scikit, which are commonly used in research and in the industry.

PY 541 STATISTICAL MECHANICS I

Probability theory. Ensembles. Steepest descent methods. Paramagnetism, ideal gas, Einstein model, adsorption isotherms. Thermodynamics, Maxwell relations, heat capacity. Bose and Fermi gases. Electrons in metals, white dwarf stars, black-body radiation, phonons, Bose-Einstein condensation. Interacting systems, virial expansion, Van der Waals gas. Phase transitions: mean-field theories, spin systems.

PY 542 STATISTICAL MECHANICS II

Continuation of CAS PY 541; emphasis on applications. Phase transitions: thermodynamic theory of phase transitions, mean field theories (Landau theory). Fluctuations: equilibrium fluctuations, instabilities, fluctuation dissipation theories. Elementary kinetic theory: mean free path approach, Boltzmann equation. Stochastic mathematics: probability theory, Markoff processes, Gaussian processes. Brownian motion: Langevin equations, Fokker-Planck equation.

PY 543 INTRODUCTION TO SOLID STATE PHYSICS

An introduction to crystal structure; lattice vibrations; electronic energy bands and Fermi surfaces; semiconductors, conductors, and insulators; superconductivity and magnetism.

PY 551 INTRODUCTION TO PARTICLE PHYSICS

Fundamental particles and their symmetries. Isospin and flavor. Discrete symmetries. Phenomenology of weak and strong interactions. Introduction to detector techniques.

PY 555 COSMOLOGICAL PHYSICS

Early universe cosmology: inflation, thermodynamics in an expanding universe with radiation, matter, vacuum energy. Growth of density perturbations, cosmic microwave background, large scale structure. The cosmological standard model and open questions, dark matter, dark energy, neutrinos.

PY 571 Introduction to Biological Physics

Introduction to biomolecular forces, energy flow, information and thermodynamics in biological systems. Nucleic acid, protein, and biomembrane structure. Mechanisms of transport and signaling in biological membranes. Biophysical techniques including spectroscopy. Emphasis on the physical principles underlying biological structure and function.

PY 581 ADVANCED LABORATORY

Classical experiments in atomic and nuclear physics, development of new experiments, basic research projects. Experiments include magnetic resonance, nuclear-decay studies, Zeeman effect, holography, black-body radiation, X-ray diffraction, Mossbauer studies, and flux quantization, positron annihilation.

ADVANCED COURSES

PY 621 ADVANCED SCIENTIFIC COMPUTING IN PHYSICS

Introduction to computer programming and methods used to formulate and solve physics problems on the computer. Also touches on more advanced topics such as parallel computing and graphical visualization.

PY 677 AN INTRODUCTION TO EVIDENCE-BASED UNDERGRADUATE STEM TEACHING

Online course with in-person faculty-led sessions. Participants learn about effective teaching strategies and the research that supports them and apply approaches to lesson design and assignments for future teaching opportunities.

PY 681 ELECTRONICS FOR SCIENTISTS

A survey of practical electronics for all College of Arts and Sciences science students wishing to gain a working knowledge of electronic instrumentation, and in particular, its construction. Two four-hour laboratory-lecture sessions per week.

PY 713 QUANTUM FIELD THEORY I

Provides an introduction to the techniques of quantum field theory with applications to high-energy and condensed-matter physics. Topics include field equations and quantization of many-body systems; Green function and linear response theory; S-matrix and scattering theory; path integration; perturbation expansions and the Feynman rules; renormalization and effective field theories; epsilon expansion and critical exponents.

PY 714 QUANTUM FIELD THEORY II

A continuation of GRS PY 713 for particle physicists. Topics include relativistic fields; LSZ formalism; the Lorentz group; quantum electrodynamics; non-Abelian gauge symmetry; spontaneous symmetry breaking; Goldstone's theorem; the Higgs mechanism; the Glashow-Weinberg-Salam model.

PY 731 THEORY OF RELATIVITY

An introduction to general relativity: the principle of equivalence; Riemannian geometry; Einstein's field equation; the Schwarzschild solution; the Newtonian limit; experimental tests; black holes; cosmology.

PY 741 SOLID-STATE PHYSICS I

One electron band structure: Formalism: Hartree-Fock, density functional frameworks. Methods: Green function, pseudopotentials, and tight binding. Linear response. Optical properties. Elastic properties. Phonons: lattice dynamics and phenomenological methods. Electronic instabilities and transitions. Topological aspects of band structure and topological phases.

PY 742 SOLID-STATE PHYSICS II

Many-body formalism: second quantization, Green function, perturbation theory, Feynman diagrams. BEC and superfluidity. Fermi liquids; Luttinger liquids, bosonization. Electron-phonon interactions and superconductivity. Quantum magnetism: exchange mechanisms; magnetic insulators, spin-wave theory; itinerant magnetism, spin-density waves. Magnetic impurities, Anderson model, Kondo effect.

PY 743 LOW-TEMPERATURE PHYSICS

Superconductivity, superfluidity, and properties of ^{3}He and ^{4}He at low temperatures. Techniques and measurement of physical quantities near absolute zero.

PY 744 POLYMER PHYSICS

Introduction to polymer physics, focusing on the structure, phase behavior, and dynamics of isolated chains, polymer solutions, and gels. Development of underlying theoretical formalism and comparison with experimental results. Discussion of applications to novel polymeric materials.

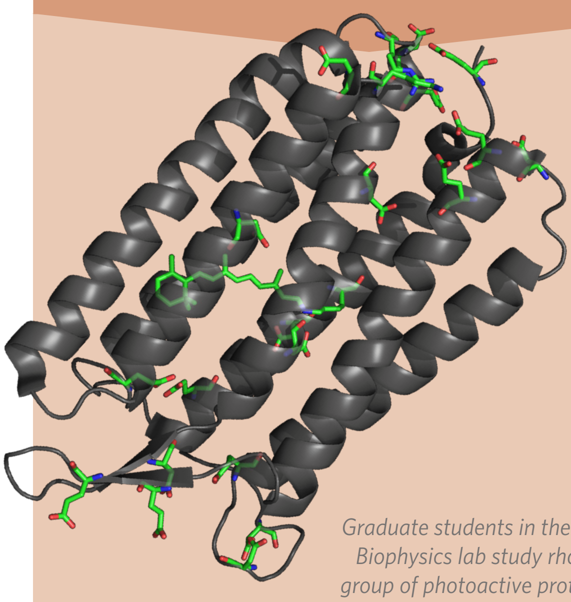
PY 745 EXPERIMENTAL SURFACE PHYSICS AND CHEMISTRY

Introduction to the principles and experimental techniques of surface and interface physics and chemistry. Electronic, structural, vibrational, and magnetic properties of solid surfaces and interfaces. Emphasis on how these properties are measured. Also vacuum technology and x-ray generation.

PY 747 ADVANCED STATISTICAL MECHANICS
Introduction to classical and quantum chaos: Random Matrix Theory. Eigenstate thermalization hypothesis. Doubly stochastic evolution. Fluctuation theorems and other thermodynamic relations. Integrable systems, Many-body localization. Dynamics of Hamiltonian systems close to the adiabatic limit. Counter-adiabatic driving. Non-adiabatic response and quantum geometry.

PY 751, 752 HIGH-ENERGY PHYSICS
Yearlong course (with GRS PY 752) on phenomenological aspects of modern high-energy physics. Principal topics are the Standard Model of strong and electroweak interactions with its symmetries, symmetry breaking and the Higgs mechanism, and aspects of physics beyond the standard model. Emphasis on calculation and discussion of observables. Intended for both theoretical and experimental students.

PY 771 BIOPHYSICS
Focus is modern work on modeling biochemical networks. Core material includes signaling, genetic switches, biological oscillators and development. Begins with chemical kinetics in the context of molecular biology. Simple yet informative models based on physics approaches are emphasized.



Graduate students in the Molecular Biophysics lab study rhodopsins, a group of photoactive proteins found in the rods and cones of our eyes, to understand the molecular mechanisms of membrane protein function.

PY 782 ADVANCED MATERIALS CHARACTERIZATION
Introduction to the principles and applications of advanced materials characterization including study of atomic structure, electronic structure, defects, mechanical properties, transport properties, and carrier dynamics.

PY 789 COMPUTATIONAL QUANTUM MANY-BODY PHYSICS
This course introduces computational techniques for lattice models of interacting fermions, bosons, and quantum spins. Methods include Lanczos diagonalization, matrix-product states, and quantum Monte Carlo methods. Applications are taken from condensed matter and quantum-device physics (e.g., quantum annealing).

PY 811 ADVANCED QUANTUM FIELD THEORY
Covers Scale Invariant Theories and Conformal Invariant Theories in various dimensions with applications to quantum criticality, statistical physics, and high-energy physics.

PY 841 SYMMETRY IN CONDENSED MATTER PHYSICS
Theories of finite groups and their irreducible representations (Irreps), symmetry projection operators. Product groups and product representations. Crystalline symmetry, symmorphic and non-symmorphic space groups and induction of their Irreps. Spin-1/2 double groups, magnetic color groups. Time-reversal symmetry and co-representations.

PY 895, 896 SPECIAL TOPICS IN THEORETICAL PHYSICS
Theoretical research topics include general relativity, quantum field theory, high energy and particle physics, phase transitions, renormalization group, laser physics, kinetic equations, biophysics, computational physics, and selected topics in mathematical physics..

PY 897 SPECIAL TOPICS IN EXPERIMENTAL PHYSICS
Surface physics; intermediate energy nuclear physics experiments; low temperature techniques, liquid and solid helium, and magnetism at low temperatures. Raman effect, gels, and biophysics. High-energy physics experimental techniques.

PY 961 SCHOLARY METHODS IN PHYSICS
Introduction to scholarly methods in physics teaching and research: Effective STEM instructional techniques; successful oral and written presentations; reading and reporting scientific literature; ethical obligations in physics teaching and research; career paths in physics. Required of first-semester doctoral students.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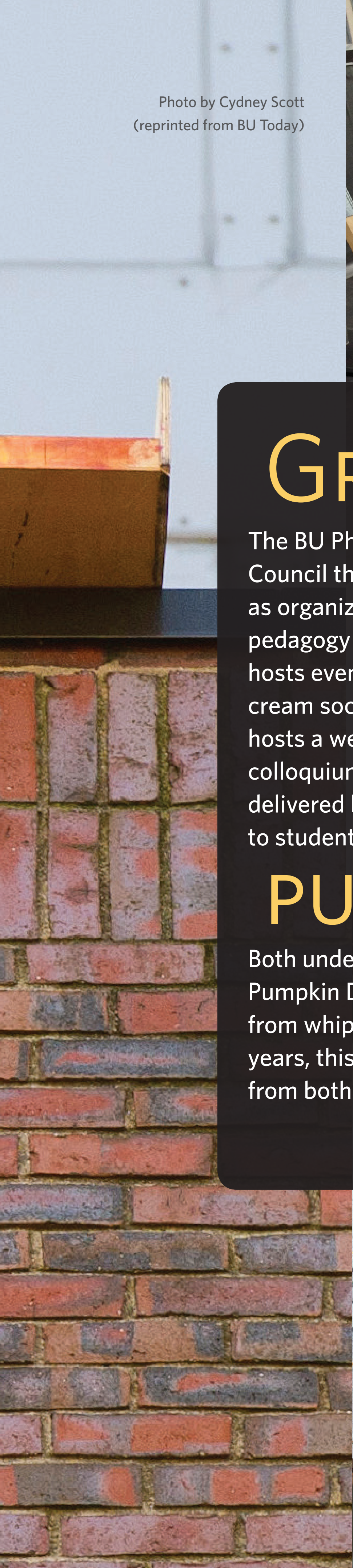


Photo by Cydney Scott
(reprinted from BU Today)

Graduate Community

The BU Physics graduate students have several organizations, including a Grad Student Council that meets regularly with the Chair and Director of Graduate Studies as well as organizes various events; a Teaching Group that meets to discuss physics teaching, pedagogy and novel active learning; and a Women in Physics Group that organizes and hosts events for female physicists. The Grad Student Council organizes a monthly ice cream social where faculty, staff, and students are invited to attend. The Department hosts a weekly colloquium, and students have a private lunch with the speaker. A special colloquium, the Dean S. Edmonds Sr. Memorial Lecture, is given annually. This lecture is delivered by a distinguished physicist. Awards for teaching and research are presented to students just before this colloquium.

Pumpkin Drop

Both undergraduate and graduate 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, off the top of the Metcalf Science Center. Over the years, this event has become a beloved BU tradition, and has garnered media attention from both local and national news outlets.

CAREER PATHS

Graduates of our program have been successful in obtaining excellent postdoctoral positions, faculty appointments, and research positions at major industrial laboratories. Some recent examples are listed below.

POSTDOCTORAL FELLOWSHIPS

Argonne National Laboratory • Boston University • Clark University • Fermilab • Harvard University
Los Alamos National Lab • Lucent Technology • Massachusetts General Hospital • MIT
National Cancer Institute • National Institutes of Health • National Institute of Standards and Technology
New York University • Northwestern University • Rensselaer Polytechnic Institute • Rockefeller University
SLAC National Accelerator Laboratory • State University of New York • Tufts University • UC Irvine • UC San Diego
University of Illinois • University of Maryland • University of Michigan, Ann Arbor • University of Nevada
UNC Chapel Hill • University of Oregon • University of Wisconsin, Madison
INTERNATIONAL: Center for Particle Physics of Marseilles • Leiden University
Ludwig Maximilian University • Max Planck Institute for Complex Systems • National Research Council (Italy)
Scuola Normale Superiore • Technical University of Berlin • University of Geneva • University of Oxford
University of Tokyo • University of Toronto • University of Vienna • University of Waterloo

FACULTY APPOINTMENTS

Bloomsburg University • Boston College • Boston University • Brigham and Women's Hospital/Harvard Medical School
Brooklyn College • George Mason University • Indiana University • Kenyon College • Northeastern University
Northwestern University • Randolph Macon College • Suffolk University • Texas A&M University • UC Davis
University of New Mexico • University of Washington • University of Wisconsin • Virginia Tech
INTERNATIONAL: Boğaziçi University • Chinese Academy of Sciences • Institute for Advanced Study
Ludwig Maximilian University • Macquarie University • Nankai University • National Taiwan University
Seoul National University • University of Berlin • University of Cambridge • University of Naples • University of Oxford
University of Rome

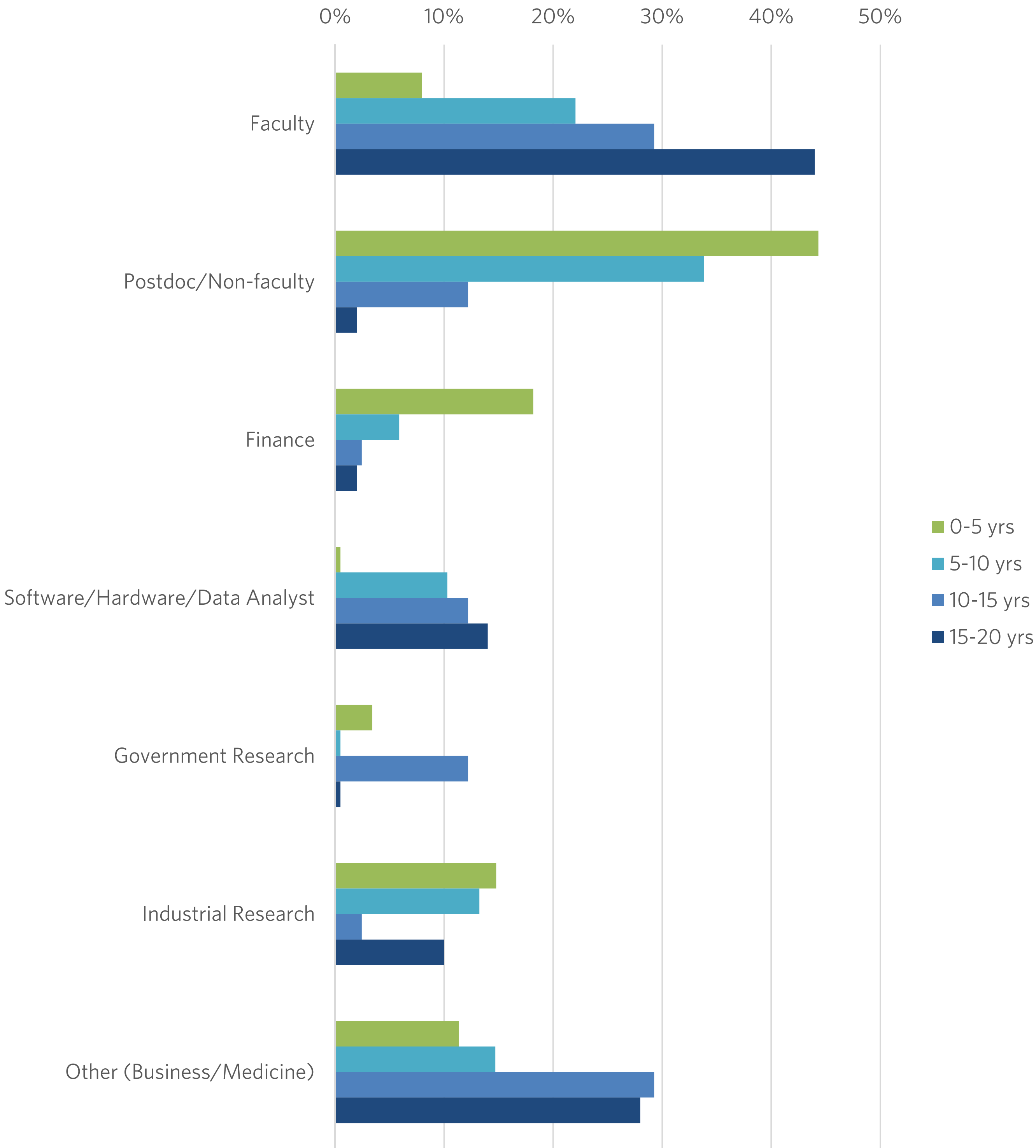
INDUSTRIAL LABORATORIES AND CORPORATE POSITIONS

Ab Initio Software Corporation • Advanced Rendering Technology • Arcadia Healthcare Solutions • Avant • Bloomberg
Brion Technologies • D.E. Shaw • Draper Labs • Facebook • Federal Aviation Administration • Frontier Technology
GE Global Research • Google • IBM • Investment Technology Group • LinkedIn • LongView Group • Mariner Investment Group
• Mobilygen Corporation • MTPV Corporation • Nortel Networks • Omni Guide • Raytheon • Sand 9
Science Research Laboratory • Spectral Sciences • Stanford Functional Genomics Facility • Stui Group • Wentworth Institute
INTERNATIONAL: Barclays Bank • Element Six • Scotia Bank

WHERE ARE THEY NOW?

GRADUATE CAREER PATHS, 1995-2015

The following chart shows current fields for BU Physics graduates from the past 20 years. Graduates are grouped into 5-year cohorts. Percentages indicate the portion of a cohort in a given field.



BOSTON UNIVERSITY

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