VIRGINIA TECH

DEPARTMENT OF PHYSICS

Blacksburg, Virginia 24061
http://www.phys.vt.edu

General University Information

President: Timothy Sands
Dean of Graduate School: Karen DePauw
University website: http://www.vt.edu/
School Type: Public
Setting: Rural
Total Faculty: 4,964
Total number of Students: 36,383
Total number of Graduate Students: 6,414

Department Information

Department Chair: Prof. Mark L. Pitt, Chair
Department Contact: Mark L. Pitt, Department Chair
Total full-time faculty: 36
Full-Time Graduate Students: 77
Female Full-Time Graduate Students: 17
First-Year Graduate Students: 19
Female First-Year Students: 5
Total Post Doctorates: 20

Department Address

Robeson Hall (MC 0435)
850 West Campus Drive
Blacksburg, VA 24061
Phone: (540) 231-6544
Fax: (540) 231-7511
E-mail: info@phys.vt.edu
Website: http://www.phys.vt.edu

ADMISSIONS

Admission Contact Information

Address admission inquiries to: Graduate Program Coordinator, Physics Department
Phone: (540) 231-8728
E-mail: gradphys@vt.edu
Admissions website: http://www.phys.vt.edu

Application deadlines

Fall admission:
U.S. students: January 5 *Int'l. students*: January 5

Application fee

U.S. students: $75 *Int'l. students*: $75

Admissions information

For Fall of 2020:
Number of applicants: 113
Number admitted: 58
Number enrolled: 18

Admission requirements

Bachelor's degree requirements: Bachelor's degree in Physics with a minimum undergraduate GPA of 3.0 in physics/math during the last two years of undergraduate study or, if the Bachelor's degree is in a subject other than physics, 18 semester hours in intermediate mechanics, electromagnetism, and quantum mechanics, excluding general physics, are required.
Minimum undergraduate GPA: 3.0

GRE requirements

The GRE is not required.
For the Fall 2021 cycle, the GRE test score will be optional.

GRE Physics requirements

The GRE Physics is not required.
For the Fall 2021 cycle, the GRE Physics subject score will be optional.

TOEFL requirements

The TOEFL exam is required for students from non-English-speaking countries.
Minimum accepted TOEFL scores:
PBT score: 550
iBT score: 90
TOEFL scores of 20 or greater in Listening, Writing, Speaking, and Reading subsections are required.

Other admissions information

Undergraduate preparation assumed: *Undergraduate preparation assumed:* Thornton, Marion, *Classical Mechanics*; Reitz, Milford, and Christy, *Foundations of Electromagnetic Theory*; Griffiths, *Electrodynamics*; Hecht, *Optics*; Kittel, Kroemer, *Thermal Physics*; Griffiths, *Quantum Mechanics*; Liboff, *Quantum Mechanics*.

TUITION AND ASSISTANTSHIPS

Teaching Assistants, Research Assistants, and Fellowships

Number of first-year
Teaching Assistants: 19
Average stipend per academic year
Teaching Assistant: $17,352
Research Assistant: $17,352
All assistantships come with tuition waivers.

Tuition year 2020–21:

Tuition for in-state residents
Full-time students: $6,938 per semester
Tuition for out-of-state residents
Full-time students: $13,807 per semester
Part-time students: $4,646 per semester
Tuition for part-time is for three credit hours. Assistantships come with proportional tuition waivers.
Credit hours per semester to be considered full-time: 9
Deferred tuition plan: No
Health insurance: 88% subsidy of University negotiated plan.
Other academic fees: In-state residents, $1,077 ($538.50, part-time/three credits) per semester. Out-of-state residents: $1,379 ($689.50, part-time/three credits) per semester.
Academic term: Semester
Number of first-year students who received full tuition waivers: 19

FINANCIAL AID

Application deadlines

Fall admission:
U.S. students: January 5 *Int'l. students*: January 5

Loans

Loans are not available for U.S. students.
Loans are not available for international students.
GAPSFAS application required: No
FAFSA application required: No

For further information

Address financial aid inquiries to: Graduate Program Coordinator, Physics Department.
E-mail: gradphys@vt.edu
Financial aid website: http://www.finaid.vt.edu/

HOUSING

Availability of on-campus housing

Single students: Yes
Married students: No
Childcare Assistance: No

For further information

Address housing inquiries to: Housing Residence and Life, 144 New Hall West, Blacksburg, VA 24061-0428.
Phone: (540) 231-6205
Housing aid website: http://www.housing.vt.edu

Table A—Faculty, Enrollments, and Degrees Granted

Research Specialty	2020–21 Faculty	Enrollment Fall 2020 Master's	Enrollment Fall 2020 Doctorate	Number of Degrees Granted 2019–20 (2008–20) Master's	Number of Degrees Granted 2019–20 (2008–20) Terminal Master's	Number of Degrees Granted 2019–20 (2008–20) Doctorate
Astrophysics	3	–	5	–(1)	–(3)	1(6)
Biophysics	2	–	1	–(2)	–	–(2)
Condensed Matter Physics	16	–	34	2(30)	–(8)	10(75)
Nuclear Physics	7	–	12	1(8)	–(3)	2(19)
Particles and Fields	9	–	6	–(7)	–(2)	3(13)
Non-specialized	–	1	18	–	4(16)	–
Total	35	1	76	3(48)	4(32)	16(115)
Full-time Grad. Stud.	–	1	76	–	–	–
First-year Grad. Stud.	–	1	18	–	–	–

GRADUATE DEGREE REQUIREMENTS

Master's: Both thesis and non-thesis options are available. A written thesis must be submitted and defended at an oral final examination. For the non-thesis option, 32 hours of coursework are required. An oral final examination must be passed. For both options, a minimum 3.0 grade point average must be maintained. There is no foreign language requirement.

Doctorate: A Ph.D. candidate must pass an oral qualifying and preliminary examination covering classical mechanics, electromagnetism, and non-relativistic quantum mechanics. The preliminary examination covers the proposed thesis research. Ninety-two hours total (minimum) must be completed, including coursework (32 hours minimum) and research while maintaining a minimum 3.0 grade point average. A written dissertation is required and must be defended at an oral final examination.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

The faculty in Virginia Tech's Physics Department conducts research in astronomical, mathematical, medical, nuclear, elementary particle, and condensed-matter physics. Medical and neuroscience research is conducted at sites in Arlington and Roanoke, Virginia. Much of the research activity in astronomy and experimental nuclear and particle physics utilizes off-campus facilities, while most of the instrumentation and data analysis are performed on-campus. These facilities include Brookhaven National Laboratory, CERN, Daya Bay, Fermilab, KEK, LANL, ORNL, TJNAF, NRAO, Gran Sasso, Jefferson National Lab, and the nearby Kimballton Underground Research Facility (KURF). Telescopes used by the astronomy group include the Hubble Space Telescope, the Very Large Telescope, the Chandra X-ray satellite, the Spitzer IR satellite, and the XMM-Newton X-ray satellite.

Experimental facilities in condensed-matter physics include low-temperature facilities and variable-temperature high-magnetic-field magneto-transport systems, low-temperature optical systems, pulsed near- and mid-infrared lasers, visible-ultraviolet lasers, spectrometers, confocal microscopy and related optical characterization facilities, nanofabrication systems, thin-film materials deposition systems, materials synthesis, room-temperature and low-temperature scanning tunneling microscopy, and various other microscopy systems. More analytical and nanofabrication systems (e.g., X-ray, Auger, TEM, AFM, SIMS, SQUID, and FIB) are housed in on-campus facilities. Research is also performed off-campus, for example, at the National High Magnetic Field Laboratory.

Housed in Robeson Hall is the University's Center for Neutrino Physics (CNP). Many theorists are members of the University Center for Statistical Mechanics, Mathematical Physics, and Theoretical Chemistry, composed of faculty from the Departments of Chemistry, Physics, and Mathematics.

The Department of Physics is also home to the Center for Soft Matter and Biophysics at Virginia Tech. This interdisciplinary research Center was established in February 2016, and is administered by the Department of Physics in the College of Science. Its mission is to advance the rapidly growing research areas of soft matter and biological physics. Special attention will be extended to how these developments can address many of the most significant problems currently facing society, for example effective drug design and delivery, next generation materials, programmable biology, and models for human disease.

Virginia Tech University computing offers multiple high-performance computing systems. The Physics Department has two dedicated clusters. Access to supercomputers is available through national and international networks.

The Physics Department operates a professional machine shop, a computer shop, and a student shop.

Table B—Separately Budgeted Research Expenditures by Source of Support

Source of Support	Departmental Research	Physics-related Research Outside Department
Federal government	$4,382,298	
State/local government	$109,342	
Non-profit organizations	$93,178	
Business and industry	$30,733	
Other		
Total	$4,615,551	

Table C—Separately Budgeted Research Expenditures by Research Specialty

Research Specialty	No. of Grants	Expenditures ($)
Astrophysics	–	$277,367
Condensed Matter Physics	–	$3,071,887
Nuclear Physics	–	$285,704
Particles and Fields	–	$980,593
Total	–	$4,615,551

FACULTY

Professor

Arav, Nahum, Ph.D., University of Colorado, Boulder, 1994 Astrophysics.
Chang, Lay Nam, Ph.D., University of California, Berkeley, 1967. Theoretical particle physics.
Economou, Sophia, Ph.D., University of California at San Diego, 2006. William E. Hassinger, Jr. Senior Faculty Fellow in Physics. Theoretical condensed matter physics.
Heflin, James R., Ph.D., University of Pennsylvania, 1990. Associate Dean for Research, College of Science. Experimental condensed matter physics; biophysics.
Heremans, Jean J., Ph.D., Princeton University, 1994. Experimental condensed matter physics.
Huber, Patrick, Ph.D., Technische Universität München, 2003. Roger Moore and Mojdeh Khatam-Moore Faculty Fellow. Theoretical particle physics.
Khodaparast, Giti A., Ph.D., University of Oklahoma, 2001. L.C. Hassinger Faculty Fellow. Experimental condensed matter physics; biophysics.
Link, Jonathan M., Ph.D., University of California, Davis, 2001. Experimental nuclear and particle physics.
Minic, Djordje, Ph.D., University of Texas, Austin, 1993. Theoretical particles physics.
Montague, Read P., Ph.D., University of Alabama, 1988. Neuroscience; medical physics; biophysics.
Mun, Seong K., Ph.D., SUNY, Albany, 1979. Neuroscience; medical physics.
Park, Kyungwha, Ph.D., Princeton University, 2000. Theoretical condensed matter physics.
Piilonen, Leo E., Ph.D., Princeton University, 1985. Experimental nuclear and particle physics.
Pitt, Mark, Ph.D., Princeton University, 1992. Chair of the Department of Physics. Experimental nuclear and particle physics.
Pleimling, Michel J.F., Ph.D., Universität des Saarlandes, 1996. Director of the Academy of Integrated Sciences for the College of Science. Theoretical condensed matter physics.
Sharpe, Eric R., Ph.D., Princeton University, 1998. Theoretical particle physics.
Simonetti, John H., Ph.D., Cornell University, 1985. Astrophysics.
Täuber, Uwe C., Ph.D., Technische Universität München, 1992. Theoretical condensed matter physics.
Vogelaar, R. Bruce, Ph.D., California Institute of Technology, 1989. Experimental nuclear and particle physics.

Associate Professor

Anderson, Lara B., Ph.D., Oxford University, 2008. Theoretical particle physics.
Barnes, Edwin, Ph.D., University of California at San Diego, 2006. Theoretical condensed matter physics.
Cheng, Shengfeng, Ph.D., Johns Hopkins University, 2010. Theoretical condensed matter physics.
Gray, James, Ph.D., University of Sussex, 2001. Theoretical particle physics.
Horiuchi, Shunsaku, Ph.D., University of Tokyo, 2009. Astroparticle physics.
Mariani, Camillo, Ph.D., University of Rome, 2008. Experimental nuclear and particle physics.
Nguyen, Vinh, Ph.D., University of Amsterdam, Zeeman Intstitute, 2004. Experimental condensed matter physics.
Robinson, Hans D., Ph.D., Boston University, 2000. Experimental condensed matter physics.
Scarola, Vito W., Ph.D., Pennsylvania State University, 2002. Theoretical condensed matter physics.
Soghomonian, Victoria, Ph.D., Syracuse University, 1995. Experimental condensed matter physics.
Takeuchi, Tatsu, Ph.D., Yale University, 1989. Theoretical particle physics.

Assistant Professor

Ashkar, Rana, Ph.D., Indiana University, 2012. *Biophysics, Condensed Matter Physics*. Experimental condensed matter physics.
Boer, Marie, Ph.D., Paris-Sud University, 2014. *Nuclear Physics*. Experimental nuclear and particle physics.
Emori, Satoru, Ph.D., Massachusetts Institute of Technology, 2013. *Condensed Matter Physics, Nano Science and Technology*. Experimental condensed matter physics.
Kaplan, Cihan N., Ph.D., Brandeis University, 2012. Theoretical condensed matter physics.
O'Donnell, Thomas M., Ph.D., University of California- Berkeley, 2011. *High Energy Physics, Nuclear Physics*. Experimental Particle Physics.
Petrescu, Alexandru, Ph.D., Yale University and Ecole Polytechnique, 2015. *Condensed Matter Physics*. Theoretical condensed matter physics.
Shoemaker, Ian, Ph.D., University of California- Los Angeles, 2010. *Particles and Fields, Theoretical Physics*.

Research Faculty

Özcan, Alpay, Ph.D., Washington University, St. Louis, 2000. Neuroscience; medical physics.
Wong, Kenneth, Ph.D., University of California, Berkeley/San Francisco, 2002. Neuroscience; medical physics.

DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF

Theoretical

Condensed Matter/Statistical Physics. Current research includes: Spin-based quantum computation; Biological and synthetic polymers, nanoparticles, nanocomposites, and membranes; Quantum optics and quantum information with a range of physical systems; Theoretical and computational studies of electronic, magnetic, and transport properties of spin-orbit-coupled nanostructures; Out-of-equilibrium dynamical behavior of complex systems; Graphene, the fractional quantum Hall effect, composite fermions, quantum dots, quantum computing, and ultracold atoms in optical lattices; Statistical mechanics of flux lines in superconductors. Barnes, Cheng, Economou, Kaplan, Park, Pleimling, Scarola, Täuber.

Particles and Fields. Analysis of high-energy particle physics phenomenology and precision tests within and beyond the standard model framework. One special focus is neutrino phenomenology in close collaboration with the Center for Neutrino Physics and includes internationally well-known efforts like the development of the GLoBES software package. Neutrinos are also investigated in astrophysical settings. Also in connection to astrophysics is the study of the nature of dark matter using neutrino, gamma-ray, and other cosmic messengers. Another special focus is on string theory and M theory, especially string compactifications, supersymmetric field theories, and mathematical aspects of string theory. Research is also carried out on QCD and other gauge theories, supersymmetric, and otherwise, in three and four dimensions. Anderson, Chang, Gray, Horiuchi, Huber, Minic, Sharpe, Shoemaker, Takeuchi.

Experimental

Astrophysics. The group at Virginia Tech is active in extragalactic astronomy and studies of radio transients. Current extragalactic research is concerned with measuring stellar and super-

massive black hole mass assembly history in galaxies from multiwavelength surveys and the observation and interpretation of mass outflow from active galactic nuclei (AGNs). This work has impact on studies of the formation of galaxies and galaxy clusters and the way these structures trace the underlying dark matter distribution. Searches for radio transients are under way in collaboration with searches for gravity wave signals (e.g., by LIGO, the Laser Interferometer Gravitational Wave Observatory). This work has impact on the study of high-energy or explosive astrophysical events (e.g., supernovae, mergers of compact objects, and the explosion of primordial black holes) and implications for work at the frontier of fundamental physics (e.g., the existence of gravitational radiation and extra-spatial dimensions). Research facilities currently used include the Hubble Space Telescope, the Herschel Space Observatory, the Spitzer Space Telescope, the Chandra X-Ray Observatory, the Very Large Telescope, the Long Wavelength Array (LWA), and the Eight-meter-wavelength Transient Array (ETA). Arav, Horiuchi, Simonetti.

Biophysics. Current research includes: Nanoscale structure and dynamics in biomimetic membranes; Topographically nanostructured lipid membranes; Hierarchal structure and dynamics in polymer nanocomposites; Applications of statistical physics to biological problems; the interplay between the material composition, dynamics, form, and emergent function in living systems using theory and simulations and thereby guide the synthesis of analogous biomimetic materials. Experimental approaches include near-infrared laser techniques, self-assembly techniques, optical characterization, voltametric methods, temporally resolved fluorescence microscopy, x-ray and neutron scattering, ps-ns spectroscopy, imaging, MD simulations, and molecular biology techniques. Ashkar, Heflin, Khodaparast, Montague.

Condensed Matter Physics. Current research includes: the investigation of novel materials through light-matter interactions, using advanced optical techniques; quantum coherence and spin coherence, spintronics, nanoscale electronic and optical devices, low-dimensional materials, and quantum and correlated-electron materials;synthesizing novel materials systems, characterizing their structure and electrical properties, and making proof-of concept systems and devices, e.g. battery cells and ultracapacitors, to study the electrical energy storage capabilities; the dynamics of electrons confined in very tiny semiconductor structures and dynamics of biological molecules through Terahertz spectroscopy; Optical and quantum mechanical properties of metal and semiconductor nanostructures; synthesis of nanoscale thin-film magnetic materials; pure spin current transport and magnetization dynamics. Ashkar, Emori, Heflin, Heremans, Khodaparast, Nguyen, Robinson, Soghomonian.

Neuroscience and Medical Physics. Topics include computational models of cognitive functions to gain insight into healthy and injured brain cognition and the characterization of cognitive phenotypes, both supported by magnetic resonance imaging; the use of medical physics to study sleep; the transitions between wake and sleep states in the brainstem; the interplay between sleep and stress on brain networks; multisource-multimodal data analysis methods, including but not limited to medical imaging and bioinformatics, with initial focus on prostate cancer and multiple sclerosis; development of new diffusion magnetic resonance imaging methods for assessment of brain white matter integrity; development of mobile health systems for military medics development of open source electronic health record architectures. Experimental efforts use functional magnetic resonance imaging, positron emission tomography, and electroencephalography. A study of interacting subjects uses new models of social exchange and uses the new technique of hyperscanning. Özcan, Montague, Mun, Wong.

Nuclear and Particle Physics. Much of our research in this area explores the properties of neutrinos, the primary focus of the Department's Center for Neutrino Physics. Current experimental activities include measurement of neutrino mixing angles with the Daya Bay reactor neutrino experiment in China and with liquid-argon-based accelerator neutrino detectors, including the Short Baseline Neutrino Program at Fermilab and CERN's ProtoDUNE SP. Faculty are involved in solar neutrino studies with Borexino and in searches for neutrinoless double beta decay with CUORE, both at Gran Sasso Underground lab in Italy. The department manages the Kimballton Underground Research Facility (KURF), a nearby low-background laboratory (1,700-foot depth), which supports VT and external experiments. Future experiments are in development to constrain sterile neutrinos and fundamental neutrino parameters (CHANDLER, NULAT, DUNE). Heavy-flavor physics (b and c quarks and tau leptons) is studied to probe CP violation and other phenomena at the Belle and Belle II experiments at KEK in Japan. Electron scattering experiments (e-Ar, QWEAK and MOLLER) are carried out at Jefferson Laboratory (Newport News, VA) to understand neutrino interactions in matter and to test the standard model using parity-violating scattering experiments. The department has laboratory space and machine/electronic shop support for significant equipment contributions to our experiments. Boer, Link, Mariani, O'Donnell, Piilonen, Pitt, Vogelaar.