

CARNEGIE MELLON UNIVERSITY

DEPARTMENT OF PHYSICS

Pittsburgh, Pennsylvania 15213

<http://www.cmu.edu/physics>

General University Information

President: Dr. Subra Suresh
Dean of Graduate School: Fred Gilman
University website: <http://www.cmu.edu>
Control: Private
Setting: Urban
Total Faculty: 1,436
Total Graduate Faculty: 1,436
Total number of Students: 12,569
Total number of Graduate Students: 6,290

Department Information

Department Chairman: Gregg Franklin, Chair
Department Contact: Heather Corcoran, Student Programs Coordinator
Total full-time faculty: 33
Total number of full-time equivalent positions: 37
Full-Time Graduate Students: 75
First-Year Graduate Students: 21
Female First-Year Students: 4
Total Post Doctorates: 40

Department Address

5000 Forbes Avenue
Pittsburgh, PA 15213
Phone: (412) 268-2849
Fax: (412) 681-0648
E-mail: physgrad@andrew.cmu.edu
Website: <http://www.cmu.edu/physics>

ADMISSIONS

Admission Contact Information

Address admission inquiries to: Graduate Studies, Department of Physics, Carnegie Mellon University, Pittsburgh, PA 15213
Phone: (412) 268-2849
E-mail: physgrad@andrew.cmu.edu
Admissions website: <http://www.cmu.edu/physics/graduate-program/admission>

Application deadlines

Fall admission:
U.S. students: January 1 *Int'l. students:* January 1

Application fee

There is no application fee required.

Admissions information

For Fall of 2012:
Number of applicants: 338
Number admitted: 97
Number enrolled: 21

Admission requirements

Bachelor's degree requirements: A bachelor's degree in physics or related field is required.

GRE requirements

The GRE is required.

Advanced GRE requirements

The Advanced GRE is required.

TOEFL requirements

The TOEFL exam is required for students from non-English-speaking countries.

Other admissions information

Additional requirements: No minimum scores are specified.
Undergraduate preparation assumed: A typical student will have completed intermediate courses in mechanics (Marion), electricity and magnetism (Griffiths or Wangsness), modern physics (Eisberg and Resnick), wave mechanics (Townsend), thermodynamics and statistical mechanics (Reif or Swendsen), and modern physics laboratory (Melissinos).

TUITION

Tuition year 2013-14:

Full-time students: \$40,000 annual

Part-time students: \$556 per credit

Deferred tuition plan: No

Health insurance: Available at the cost of \$1090 per year.

Other academic fees: \$688/year

Academic term: Semester

Number of first-year students who received full tuition waivers: 21

Teaching Assistants, Research Assistants, and Fellowships

Number of first-year

Teaching Assistants: 19

Fellowship students: 2

Average stipend per academic year

Teaching Assistant: \$20,025

Research Assistant: \$20,025

Fellowship student: \$20,025

FINANCIAL AID

Loans

Loans are not available for U.S. students.

Loans are not available for international students.

GAPSFAS application required: No

FAFSA application required: No

HOUSING

Availability of on-campus housing

Single students: No

Married students: No

Table A—Faculty, Enrollments, and Degrees Granted

Research Specialty	2013-14 Faculty	Enrollment Fall 2012		Number of Degrees Granted 2012-13 (2008-13)		
		Mas-ter's	Doc-torate	Mas-ter's	Terminal Master's	Doc-torate
Applied Physics	10	–	2	–	–	1(7)
Astrophysics	10	–	7	–	–	1(7)
Biophysics	9	–	11	–	–	2(7)
Computational Physics	13	–	–	–	–	–
Condensed Matter Physics	13	–	14	–	–	2(8)
Nuclear Physics	6	–	7	–	–	–(9)
Particles and Fields	10	–	12	–	–	3(7)
Quantum Foundations	1	–	1	–	–	–(3)
Statistical & Thermal Physics	4	–	1	–	–	1(2)
Non-specialized	–	–	20	12(73)	–	–
Total	–	–	75	12(73)	–	10(50)
Full-time Grad. Stud.	–	–	75	–	–	–
First-year Grad. Stud.	–	–	21	–	–	–

GRADUATE DEGREE REQUIREMENTS

Master's: Thirty-two semester hours (96 units) of course work with grade average of B or above are required. Four semester hours (12 units) of experimental work are required. There are no thesis or foreign language requirements. Written qualifying examination is required. One year of residence is required.

Doctorate: Satisfactory performance in an approved program. Additional course requirements will depend on level of preparation. Comprehensive oral and written qualifying examinations, annual research reviews, thesis, and final thesis defense are required. One year of residence as a full-time student required. There is a teaching requirement for the Ph.D. degree.

Thesis: Thesis may be written in absentia.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

Astrophysics research is integrated within the Bruce and Astrid McWilliams Center for Cosmology, which brings together astrophysicists, particle physicists, computer scientists, and statisticians to advance our understanding of dark matter and dark energy which dominate the universe. Observational astrophysics is performed using a variety of space-based and ground-based telescopes. Computation for astrophysics research uses in-house clusters, including two clusters that together have over 1500 cores.

The department maintains facilities for condensed matter and biological physics research, including apparatus for x-ray diffraction and reflection, laser spectroscopies, calorimetry, magnetic and electrical transport measurements, optical characterization of interfaces, scanning tunneling and atomic force microscopies, low energy electron microscopy, and sample preparation. Scattering experiments are performed at an in-house x-ray facility, including fix tube and rotating anode sources as well as at national synchrotron and neutron facilities. Computation facilities for these groups include five multicore, multinode, high-performance clusters. Collaborations with other departments provide access to additional facilities, including clean-room facilities, electron microscopies, optical microscopies, magnetic measurements, and fluids and interface characterization.

High energy research is performed by faculty using facilities at the Fermi National Accelerator Laboratory (Chicago, Illinois),

CERN (Geneva, Switzerland), and IHEP (Beijing, China). A data analysis laboratory is maintained on campus, as are laboratories for the development of detection systems.

The medium energy physics group builds and performs experiments at the Thomas Jefferson National Accelerator Facility (JLab) in Virginia. Present work uses the ongoing JLab energy upgrade and includes the GlueX exotic meson search and the Hall A spin-physics program. The group uses a 1000-core computer cluster for computational studies.

Departmental facilities include machine shops, numerous computer clusters, and a stock room. The University Computing Center operates an extensive system of networked scientific workstations and microcomputers with central file servers for research and educational applications. Access to a Cray XT3 MPP supercomputer as well as sets of SMP machines are available through the Pittsburgh Supercomputing Center. The Physics Department is located in Wean Hall, which also houses the science and engineering library.

Table B—Separately Budgeted Research Expenditures by Source of Support

Source of Support	Departmental Research	Physics-related Research Outside Department
Federal government	\$6,393,826	\$262,000
State/local government		
Non-profit organizations		
Business and industry	\$163,566	
Other	\$2,197,524	
Total	\$8,754,916	\$262,000

Table C—Separately Budgeted Research Expenditures by Research Specialty

Research Specialty	No. of Grants	Expenditures (\$)
Astrophysics	20	\$2,341,124
Biophysics	23	\$1,826,970
Condensed Matter Physics	31	\$1,157,331
Nuclear Physics	12	\$1,410,520
Particles and Fields	13	\$1,830,047
Statistical & Thermal Physics	3	\$166,426
Quantum Foundations	4	\$22,498
Total	106	\$8,754,916

FACULTY

Professor

- Briere, Roy A., Ph.D.,** University of Chicago, 1995. *Particles and Fields*. Experimental high energy physics; BES at Beijing.
- Feenstra, Randall M., Ph.D.,** California Institute of Technology, 1982. *Condensed Matter Physics*. Experimental condensed matter physics; semiconductor surfaces.
- Ferguson, Thomas A., Ph.D.,** University of California, Los Angeles, 1978. *Particles and Fields*. Experimental high energy physics; CMS at CERN.
- Franklin, Gregg B., Ph.D.,** Massachusetts Institute of Technology, 1980. Department Head. *Nuclear Physics*. Experimental medium energy/nuclear physics; production and interactions of strange hadrons; strange sea quarks in the nucleon.
- Garoff, Stephen, Ph.D.,** Harvard University, 1977. *Condensed Matter Physics*. Experimental condensed matter physics; surfaces and interfaces.
- Gilman, Frederick, Ph.D.,** Princeton University, 1965. Dean of Mellon College of Science. *Particles and Fields*. Theoretical

elementary particle physics; CP violation, heavy quarks, and leptons.

- Griffiths**, Robert B., Ph.D., Stanford University, 1962. *Quantum Foundations*. Theoretical physics; foundations of quantum mechanics.
- Holman**, Richard F., Ph.D., Johns Hopkins University, 1982. *Particles and Fields*. Theoretical particle physics and cosmology; inflation, dark energy.
- Lösche**, Mathias, Ph.D., Technical U. of Munich, 1986. *Biophysics*. Experimental biological physics; molecular and membrane biophysics.
- Levine**, Michael J., Ph.D., California Institute of Technology, 1963. Director of the Pittsburgh Supercomputer Center. *Particles and Fields*. Theoretical elementary particle physics.
- Majetich**, Sara A., Ph.D., University of Georgia, 1987. *Condensed Matter Physics*. Experimental condensed matter physics; semiconductor and magnetic nanoparticles.
- Meyer**, Curtis A., Ph.D., University of California, Berkeley, 1987. Associate Dean of Mellon College of Science. *Nuclear Physics*. Experimental medium-energy/nuclear physics; meson spectroscopy; search for gluonic excitations with GlueX at JLab.
- Morningstar**, Colin J., Ph.D., University of Toronto, 1991. *Nuclear Physics*. Theoretical medium-energy physics; nonperturbative phenomena in quantum field theories.
- Paulini**, Manfred, Ph.D., University of Erlangen, 1993. *Particles and Fields*. Experimental high-energy physics; CDF at Fermilab; CMS at CERN.
- Peterson**, Jeffrey B., Ph.D., University of California, Berkeley, 1985. *Biophysics*. Experimental astrophysics; observational cosmology.
- Quinn**, Brian P., Ph.D., Massachusetts Institute of Technology, 1984. *Nuclear Physics*. Experimental medium energy/nuclear physics; production and interaction of strange hadrons; strange sea quarks in the nucleon.
- Rothstein**, Ira Z., Ph.D., University of Maryland, College Park, 1992. *Particles and Fields*. Theoretical particle physics and cosmology; LHC theory; gravity waves.
- Russ**, James S., Ph.D., Princeton University, 1966. *Particles and Fields*. Experimental high-energy physics; CDF at Fermilab; particle astrophysics.
- Schumacher**, Reinhard A., Ph.D., Massachusetts Institute of Technology, 1983. *Nuclear Physics*. Experimental medium energy/nuclear physics; production and interactions of strange hadrons; strange sea quarks in the nucleon.
- Suter**, Robert M., Ph.D., Clark University, 1978. *Condensed Matter Physics*. Experimental condensed matter physics; x-ray and neutron scattering studies.
- Swendsen**, Robert H., Ph.D., University of Pennsylvania, 1971. *Condensed Matter Physics*. Theoretical condensed matter physics; computer simulations; statistical mechanics of phase transitions and biological molecules.
- Tristram-Nagle**, Stephanie, Ph.D., University of California, Berkeley, 1981. *Biophysics*. Experimental biophysics; membrane biophysics.
- Vogel**, Helmut, Ph.D., University of Erlangen, 1979. *Particles and Fields*. Experimental high energy physics; CMS at CERN.
- Widom**, Michael, Ph.D., University of Chicago, 1983. *Condensed Matter Physics*. Theoretical condensed matter physics; metal alloys; crystallography; biophysics.

Associate Professor

- Croft**, Rupert, Ph.D., University of Oxford, 1995. *Astrophysics*. Theoretical astrophysics/cosmology; simulations of the evolution of the universe.

- Deserno**, Markus, Ph.D., University of Mainz, 2000. *Biophysics*. Theoretical condensed matter and biophysics; membrane structure and properties.
- Di Matteo**, Tiziana, Ph.D., University of Cambridge, 1998. *Astrophysics*. Theoretical astrophysics/cosmology; cosmological simulations.
- Evilevitch**, Alex, Ph.D., Lund University, 2001. *Biophysics*. Experimental biological physics; physics of viruses.
- Kahniashvili**, Tina, Ph.D., Space Research Institute, Moscow, 1988. *Astrophysics*. Theoretical cosmology/astrophysics, Theory of gravity; studying physical processes in the early universe.

Assistant Professor

- Flauger**, Raphael, Ph.D., University of Texas, 2009. *Astrophysics, Particles and Fields*. Cosmology and particle physics; phenomenology; QFT; early universe/inflation.
- Heinrich**, Frank, Ph.D., University of Leipzig, 2005. *Biophysics*. Experimental biological physics; neutron scattering.
- Ho**, Shirley, Ph.D., Princeton University, 2008. *Astrophysics*. Observational astrophysics/cosmology; Baryon acoustic oscillations; cosmic microwave background; study of large-scale structure.
- Mandelbaum**, Rachel, Ph.D., Princeton University, 2006. *Astrophysics*. Observational astrophysics/cosmology; lensing studies of galaxies and large-scale structure.
- Trac**, Hy, Ph.D., University of Toronto, 2004. *Astrophysics*. Theoretical astrophysics/cosmology; evolution of the dark matter, baryons, and stars.
- Walker**, Matthew, Ph.D., University of Michigan, 2007. *Astrophysics*. Dark matter; galactic dynamics; near-field cosmology.
- Xiao**, Di, Ph.D., University of Texas, Austin, 2007. *Condensed Matter Physics*. Theoretical condensed matter physics; quantum transport; Berry phase.

Emeritus

- Berger**, Luc, Ph.D., University of Lausanne, 1960. *Condensed Matter Physics*. Experimental and theoretical condensed matter physics; studies of metallic ferromagnets.
- Edelstein**, Richard M., Ph.D., Columbia University, 1960. *Particles and Fields*. Experimental high energy physics; dynamics of strong interactions.
- Engler**, Arnold, Ph.D., University of Berne, 1953. *Particles and Fields*. Experimental high energy physics; colliding beams techniques.
- Fetkovich**, John G., Ph.D., Carnegie Mellon University, 1959. Special Assistant to the President for Academic Affairs.
- Kisslinger**, Leonard S., Ph.D., Indiana University, 1956. *Nuclear Physics*. Theoretical nuclear and particle physics; nonperturbative QCD.
- Kraemer**, Robert W., Ph.D., Johns Hopkins University, 1962. *Particles and Fields*. Experimental high energy physics; colliding beams techniques.
- Li**, Ling-Fong, Ph.D., University of Pennsylvania, 1970. *Particles and Fields*. Theoretical elementary particle physics; unified theories of particle interactions.
- Nagle**, John F., Ph.D., Yale University, 1965. *Biophysics*. Experimental and theoretical biological physics; statistical mechanics of phase transitions; biomembranes.
- Rayne**, John A., Ph.D., University of Chicago, 1954. *Condensed Matter Physics*. Experimental condensed matter physics; electronic and magnetic properties of metals and alloys; ultrasonic absorption in solids.
- Schumacher**, Robert T., Ph.D., University of Illinois, 1955. Musical acoustics; magnetic resonance in solids.
- Sekerka**, Robert F., Ph.D., Harvard University, 1965. *Condensed Matter Physics*. Theoretical condensed matter physics; problems in materials science.

Vander Ven, Ned S., Ph.D., Princeton University, 1962. *Condensed Matter Physics*. Experimental condensed matter physics; electron and nuclear spin resonance in solids.

Wolfenstein, Lincoln, Ph.D., University of Chicago, 1949. *Particles and Fields*. Theoretical elementary particle physics; weak interactions and symmetry principles.

Young, Hugh D., Ph.D., Carnegie Mellon University, 1959. *Physics and other Science Education*. Physics education.

Faculty by Courtesy

Anna, Shelley, Ph.D., Harvard University, 2000. Dynamic of soft matter; fluid mechanics.

Greve, David, Ph.D., Lehigh University, 1979. Physics and development of novel sensors.

Islam, Mohammad, Ph.D., Lehigh University, 2000. Structure, dynamics, and self-assembly of soft matter; properties of nanoscale structures.

Maloney, Craig, Ph.D., University of California, Santa Barbara, 2005. Mechanical response of solid-like materials.

Mandal, Maumita, Ph.D., University of Hyderabad, 2004. RNA structure and conformational rearrangements.

McHenry, Michael, Ph.D., Massachusetts Institute of Technology, 1988. Magnetic properties of materials.

Rollett, Anthony, Ph.D., Drexel University, 1987. Microstructure of polycrystalline materials.

Zhu, Jian-Gang, Ph.D., University of California, San Diego, 1983. Magnetic data storage technologies.

DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF

Theoretical

Astrophysics. The largest scale simulations of the structure formation of the universe yet performed; the evolution of galaxies, including galaxy mergers, and the associated supermassive black holes; the nature of dark matter and dark energy; the cosmology-particle physics interface; early universe/inflationary physics. Croft, Di Matteo, Flauger, Kahnishvili, Trac.

Biophysics. Theoretical analysis of biomembranes; Monte Carlo simulations of proteins; elastic continuum theory and differential geometry of fluid membranes, statistical physics, and coarse-grained molecular dynamics simulations of membranes and peptides; structure of viruses and nucleic acids. Deserno, Nagle, Widom.

Computational Physics. Computational physics at Carnegie Mellon is an umbrella that encompasses a rapidly growing and highly interdisciplinary set of activities that are taking place in all areas of the department. Croft, Deserno, Di Matteo, Levine, Meyer, Morningstar, Paulini, Rollett, Suter, Swendsen, Trac, Widom, Xiao.

Condensed Matter Physics. Topological insulators and Berry phases; Monte Carlo studies of complex fluids, biological molecules, disordered solids and phase transitions; modeling of quasicrystals, ferromagnets, incommensurate phases, and quantum transport. Maloney, Nagle, Rollett, Swendsen, Widom, Xiao, Zhu.

Nuclear Physics. Strong and weak nuclear force; formation of hadrons, confinement, exotic forms of matter; Markov-chain and Monte Carlo computation of QCD; lattice gauge theory; QCD sum rules. Kisslinger, Morningstar.

Particles and Fields. Quantum gauge field theories and their applications to experiments; weak interaction phenomenology; CP violation; heavy quark physics; inflationary universe dynamics; topological defects and their applications in cosmology; gravity wave physics; LHC phenomenology. Flauger, Gilman, Holman, Rothstein, Wolfenstein.

Quantum Foundations. Reformulation of quantum theory using consistent histories and decoherence and application of quantum mechanics in computing. Griffiths.

Experimental

Astrophysics. Astrophysics research is integrated within the Bruce and Astrid McWilliams Center for Cosmology, which brings together physicists, computer scientists, and statisticians to advance our understanding of dark matter and dark energy. Institutional member of the Sloan Digital Sky Survey and the Large Synoptic Survey Telescope collaborations. Individuals participate in a number of other ongoing observational cosmology experiments, including those in 21 cm cosmology, development of high-sensitivity receivers at millimeter wavelengths, studies of weak lensing and large-scale structure, early evolution and formation of galaxies, and dark matter via dynamics of dwarf galaxies (near-field cosmology). Ho, Mandelbaum, Peterson, Walker.

Biophysics. Structure and function of biomembranes; NMR studies of the structure of proteins and optical microscopic studies of cell structure; protein-membrane interactions; biofluid mechanics of lung airways; biopolymer dynamics; physics of viruses. Evilevitch, Garoff, Heinrich, Lösche, Nagle, Tristram-Nagle.

Condensed Matter Physics. Properties and applications of nanoparticles and nanostructures; structure of thin organic and metal solid films; structure and properties of liquid/solid interfaces; wetting of fluids on solids; structure of semiconductor and metal surfaces; structure and properties of graphene; influence of surface properties on semiconductor devices; magnetic films for data storage; x-ray scattering from thin films and surfaces; x-ray microscopy for characterization of grain structure and growth in metals; microfluidics; interfacial fluid mechanics; properties and application of nanotubes and nanorods; many of these activities are performed in active collaboration with other departments, institutes, and centers in the science and engineering colleges. Anna, Feenstra, Garoff, Greve, Islam, Majetich, McHenry, Suter, Zhu.

Nuclear Physics. Strong QCD; the spectrum of excited baryons; gluonic excitations of mesons and quark confinement using GlueX at JLab; fundamental form factors of the proton and neutron; strangeness content of the nucleon; electromagnetic interactions with hadronic systems in Hall A at JLab. Franklin, Meyer, Quinn, Reinhard Schumacher.

Particles and Fields. Operation and data analysis with the CMS detector at the LHC collider at CERN; ultra high energy cosmic ray neutrinos; study of heavy quark production and decay properties with CDF at Fermilab; CP violations and quarkonia spin alignment measurements; studies of the properties of charm quarks using the BES experiment in Beijing, China; search for super symmetry fourth-generation quarks and heavy quark production. Briere, Ferguson, Paulini, Russ, Vogel.

View additional information about this department at www.gradschoolshopper.com