General University Information
President: Dr. Farnam Jahanian
Dean of Graduate School: Professor Rebecca Doerge
University website: http://www.cmu.edu
School Type: Private
Setting: Urban
Total Faculty: 1,391
Total Graduate Faculty: 1,391
Total number of Students: 14,528
Total number of Graduate Students: 7,582

Department Information
Department Chairman: Prof. Scott Dodelson, Head
Department Contact: Heather Corcoran, Student Programs Coordinator
Total full-time faculty: 32
Total number of full-time equivalent positions: 31
Full-Time Graduate Students: 87
Female Full-Time Graduate Students: 21
First-Year Graduate Students: 16
Female First-Year Students: 4
Total Post Doctorates: 19

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.html

Application deadlines
Fall admission:
U.S. students: December 15
Int'l. students: December 15

Application fee
There is no application fee required.

Admissions information
For Fall of 2017:
Number of applicants: 302
Number admitted: 59
Number enrolled: 16

Admission requirements
Bachelor’s degree requirements: A bachelor’s degree in Physics or related field is required.
GRE requirements
The GRE is required.
Subjective GRE requirements
The Subjective GRE is required.

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

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 2017–18:
Full-time students: $44,500 annual
Part-time students: $600 per credit
Credit hours per semester to be considered full-time: 36
Deferred tuition plan: No
Health insurance: Available at the cost of $2340 per year.
Other academic fees: $852/year (paid for by the department).
Academic term: Semester
Number of first-year students who received full tuition waivers: 14

Teaching Assistants, Research Assistants, and Fellowships
Number of first-year
Teaching Assistants: 14
Average stipend per academic year
Teaching Assistant: $29,400
Research Assistant: $29,400
Fellowship student: $29,400

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
GRADUATE DEGREE REQUIREMENTS

Master’s: Thirty-two semester hours (96 units) of course work with grade average of B or above are required. There are no thesis or language requirements. One year of residence is required.

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

Thesis: Thesis may be written in absentia.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

The McWilliams Center for Cosmology brings together astrophysicists, particle physicists, computer scientists, and statisticians to advance our understanding of the dark matter and dark energy that dominate the universe. Observational astrophysics is performed using a variety of space-based and ground-based telescopes. Computation for astrophysics is performed on the largest NSF and NASA facilities and using the McWilliams Center 2000 core cluster. Instrumentation for several internationally deployed radio telescopes is developed in laboratories within the center.

The department maintains facilities for condensed matter and biological physics research, including apparatus for X-ray diffraction and reflection, laser spectroscopies, calorimetry, low-temperature magnetic and electrical transport measurements, optical characterization of interfaces, scanning tunneling and atomic force microscopes, low-energy electron microscopy, and sample preparation. Scattering experiments are performed at an in-house X-ray facility, including fixed 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 and nanofabrication 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), IHEP (Beijing, China), and KEK (Tsukuba, Japan). A data analysis facility is maintained on campus, as are laboratories for small projects to develop detection systems.

The nuclear physics group has its own machine shop and machinist, allowing design, construction and testing of large detectors on campus. These are used in our experiments at the Thomas Jefferson National Accelerator Facility (JLab) in Virginia, KATRIN in Germany and Coherent at Oak Ridge. Present work uses the recent 12Gev JLab energy upgrade and includes the GlueX exotic meson search and the Hall A parity violation program and SBS spectrometer. Our efforts in neutrino physics are currently focused on the KATRIN experiment in Germany and we have recently joined an effort at Oak Ridge to measure neutrino scattering (Coherent). The group maintains a 1000-core computer cluster for computational studies and data analysis.

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

<table>
<thead>
<tr>
<th>Source of Support</th>
<th>Departmental Research</th>
<th>Physics-related Research Outside Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal government</td>
<td>$6,123,587</td>
<td>$230,800</td>
</tr>
<tr>
<td>State/local government</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-profit organizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business and industry</td>
<td>$2,106,155</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$8,229,742</td>
<td>$230,800</td>
</tr>
</tbody>
</table>

Table C—Separately Budgeted Research Expenditures by Research Specialty

<table>
<thead>
<tr>
<th>Research Specialty</th>
<th>No. of Grants</th>
<th>Expenditures ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrophysics</td>
<td>35</td>
<td>$1,932,096</td>
</tr>
<tr>
<td>Biophysics</td>
<td>17</td>
<td>$1,194,116</td>
</tr>
<tr>
<td>Condensed Matter Physics</td>
<td>48</td>
<td>$2,043,979</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>16</td>
<td>$1,802,900</td>
</tr>
<tr>
<td>Particles and Fields</td>
<td>7</td>
<td>$950,233</td>
</tr>
<tr>
<td>Quantum Foundations</td>
<td>1</td>
<td>$81,625</td>
</tr>
<tr>
<td>Statistical &amp; Thermal Physics</td>
<td>3</td>
<td>$223,793</td>
</tr>
<tr>
<td>Total</td>
<td>127</td>
<td>$8,229,742</td>
</tr>
</tbody>
</table>

FACULTY

Briere, Roy A., Ph.D., University of Chicago, 1995. *Particles and Fields*. Experimental high-energy physics; Belle II at KEK; BESIII at IHEP (Beijing).
United States: Geographic Listing of Graduate Programs

Pennsylvania


Deserno, Markus, Ph.D., University of Mainz, 2000. *Biophysics*. Theoretical condensed matter and biophysics; membrane structure and properties.


Deserno, Markus, Ph.D., University of Mainz, 2000. *Biophysics*. Theoretical condensed matter and biophysics; membrane structure and properties.


Paulini, Manfred, Ph.D., University of Erlangen, 1993. *Particles and Fields*. Experimental high-energy physics; CMS at CERN.

Peterson, Jeffrey B., Ph.D., University of California, Berkeley, 1985. *Astrophysics*. Experimental astrophysics; observational cosmology.

Quinn, Brian P., Ph.D., Massachusetts Institute of Technology, 1984. *Nuclear Physics*. Experimental medium energy/nuclear physics; nucleon form factors; parity-violating electron scattering and nucleon structure functions.


Schumacher, Reinhard A., Ph.D., Massachusetts Institute of Technology, 1983. *Nuclear Physics*. Experimental medium energy/nuclear physics; photo-and electro-production of hadrons; GlueX and CLAS at JLab.


Associate Professor

Kahniashvili, Tina, Ph.D., Space Research Institute, Moscow, 1988. *Astrophysics*. Theoretical cosmology/astrophysics, Theory of gravity; studying physical processes in the early universe.

Mandelbaum, Rachel, Ph.D., Princeton University, 2006. *Astrophysics*. Observational astrophysics/cosmology; lensing studies of galaxies and large-scale structure.


Xiao, Di, Ph.D., University of Texas, Austin, 2007. *Condensed Matter Physics*. Theoretical condensed matter physics; quantum transport; Berry phase.

Assistant Professor

Alison, John, Ph.D., University of Pennsylvania, 2012. CMS at CERN. *Particles and Fields*. Experimental high-energy physics.


Hunt, Benjamin, Ph.D., Cornell University, 2009. Experimental condensed matter physics; graphene heterostructures.

Katoch, Jyoti, Ph.D., University of Central Florida, 2014. *Condensed Matter Physics*. Experimental condensed matter physics; 2D materials and nanoARPES.


Penco, Riccardo, Ph.D., Syracuse University, 2012. *Particles and Fields*. Theoretical particle physics, condensed matter, and cosmology; effective field theory.


Emeritus


Engler, Arnold, Ph.D., University of Berne, 1953. *Particles and Fields*. Experimental high-energy physics; colliding beams techniques.

Ferguson, Thomas A., Ph.D., University of California, Los Angeles, 1978. *Particles and Fields*. Experimental high-energy physics; CMS at CERN.

Fetkovich, John G., Ph.D., Carnegie Mellon University, 1959. Special Assistant to the President for Academic Affairs.


Holman, Richard F., Ph.D., Johns Hopkins University, 1982. *Particles and Fields*. Theoretical particle physics and cosmology; inflation; dark energy.

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.


Theoretical

Pennsylvania


Russ, James S., Ph.D., Princeton University, 1966. Particles and Fields. Experimental high-energy physics; CDF at Fermilab; CMS at CERN.

Schumacher, Robert T., Ph.D., University of Illinois, 1955. Musical acoustics; magnetic resonance in solids.


Vogel, Helmut, Ph.D., University of Erlangen, 1979. Particles and Fields. Experimental high-energy physics; CMS at CERN.

Faculty by Courtesy


DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF

Theoretical

Astrophysics. The largest scale simulations of the structure formation of the universe yet performed; the formation and evolution of galaxies, and their associated supermassive black holes; the nature of dark matter and dark energy; the cosmology-particle physics interface; early universe/inflationary physics; gravitational waves. Croft, Di Matteo, Dodelson, Kahniashvili, Penco, Rothstein, Trac.

Biophysics. Theoretical and computational studies of biomembranes and proteins; elastic continuum theory and differential geometry of lipid membranes; statistical mechanics and coarse-grained simulation studies of biophysical systems; structure of viruses and nucleic acids. Deserno, Nagle, Widom.

Computational Physics. There is a broad range of computational activity within each of the research groups, including simulations in cosmology, biophysics, and Lattice QCD; tight connections with statistics and machine learning; and pipeline development for analyses. Croft, Deserno, Di Matteo, Dodelson, Koposov, Levine, Mandelbaum, Marom, Meyer, Morningstar, Paulini, Rollett, Suter, Swendsen, Trac, Walker, 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. Marom, Nagle, Penco, Rollett, Rothstein, 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; LHC phenomenology; effective field theories. Gilman, Penco, Rothstein.


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 radio and optical telescopes for intensity mapping, studies of weak lensing and large-scale structure, early evolution and formation of galaxies, and dark matter via detection and dynamics of dwarf galaxies (near-field cosmology). Dodelson, Koposov, Mandelbaum, Peterson, Walker.


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; materials; graphene heterostructures; low-temperature transport measurements under high magnetic fields; 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, Hunt, Islam, Katoch, Majetich, McHenry, Singh, Skowronski, Suter, Viswanathan, Zhu.

Nuclear Physics. Strong QCD; the spectrum of excited baryons; gluonic excitations of mesons and quark confinement using GlueX at JLab; form factors and structure functions of the proton and neutron; parity-violating electron scattering and compton polarimetry in ItalIA at JLab; neutrino mass limits.
at KATRIN; coherent scattering at the Spallation Neutron Source. Franklin, Meyer, Parno, Quinn, Reinhard Schumacher.

Particles and Fields. Operation, data analysis, and R&D for detector upgrade of the CMS experiment at the LHC collider at CERN; search for physics beyond the standard model in the form of supersymmetry and heavy non-standard quarks; study of heavy quark production and decay properties; studies of the properties of charm quarks using the BESIII experiment in Beijing, China; high-precision studies of heavy quark systems at Belle II. Alison, Briere, Paulini, Russ, Vogel.