Department of Physics

Stephen Garoff, Head
Office: Wean Hall 7325
Kunal Ghosh, Assistant Head for Undergraduate Affairs
Office: Wean Hall 7303
Heather Corcoran, Student Programs Coordinator
Student Programs Office: Wean Hall 7319
http://www.cmu.edu/physics

Physics, one of the basic sciences, has its origin in the irrepressible human curiosity to explore and understand the natural world. This fundamental urge to discover has led to the detailed understanding of a remarkable variety of physical phenomena. Our knowledge now encompasses the large-scale movement of galaxies, the minute motions within atoms and nuclei, and the complex structure of the assemblies of molecules that make life possible. The spectacular expansion of our comprehension of the physical world forms an impressive part of the intellectual and cultural heritage of our times. The opportunity to add to this heritage is an important source of motivation for young physicists. The application of discoveries in physics to the solution of complex modern technological problems offers a vast field in which physicists make decisive contributions. The interplay of pure and applied physics has always been fruitful and today ensures many rewarding career opportunities for physics students.

Carnegie Mellon’s undergraduate curriculum in physics has been carefully designed to provide a firm knowledge of the basic principles of physics, an appreciation of a wide range of physical problems of current interest, and the capacity to formulate and solve new problems. In addition to classwork and problem solving, the curriculum includes studying physical phenomena in the laboratory. Physics students are strongly encouraged to go beyond the formal theoretical and experimental course work and become involved in research projects under the guidance of individual faculty members.

Students may choose from a variety of degree options:

- B.S. in Physics
- B.A. in Physics
- B.S. in Physics with Tracks in:
  - Applied Physics
  - Astrophysics
  - Biological Physics
  - Chemical Physics
  - Computational Physics

The objectives and requirements for each of these options are described in the paragraphs below. Each allows considerable latitude in the choice of electives.

Through the judicious choice of elective courses, a double major program combining physics and another discipline can be readily achieved. A minor in physics is also offered for those students who major in other disciplines. The student, with the help of their faculty advisors, can easily build a program that aims at specific career objectives.

The Department maintains an active and wide-ranging program of advising. Beyond aiding in academic planning, the department advisors can also assist students in finding research work during the academic year, technical jobs and internships for the summer, as well as planning and executing the necessary steps for gaining employment or continuing their studies beyond the bachelor’s degree. Whether students follow a standard curriculum or not, they should consult their academic advisor at least once every semester.

B.S. in Physics

B.S. degree candidates can choose studies in not only a wide variety of intermediate and advanced topics in physics but also a range of material in other science or engineering fields. The B.S. degree provides a solid foundation for students wishing to go on to graduate work in physics or any of a large number of fields in pure or applied science or engineering, for which a sound grasp of physics and mathematics is essential. This program also provides excellent preparation for careers in teaching, for work in industrial or governmental research and development, or for other employment in business or industry with a significant scientific component.

Degree Requirements are as follows:

- Carnegie Mellon University Requirements
  - A minimum of 360 units is required.
  - 99-101, 99-102, or 99-103 Computing @ Carnegie Mellon
- MCS Core Science Requirements
  - 33-111 Physics I for Science Students or 33-131 Matter and Interaction I
  - 33-112 Physics II for Science Students or 33-132 Matter and Interactions II
  - 03-121 Modern Biology
  - 09-105 Introduction to Modern Chemistry I
  - 21-120 Differential and Integral Calculus
  - 21-222 Integration, Differential Equations and Approximation
  - MCS Core Courses must be completed by end of junior year.
- MCS Humanities & Social Sciences and Fine Arts Requirements (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - Common Course Requirement (Writing/Expression) (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
    - 33-451
- Distributional Course Requirements
  - 1 course from Category 1: Cognition, Choice and Behavior (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - 1 course from Category 2: Economic, Political and Social Institutions (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - 1 course from Category 3: Cultural Analysis (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
- Electives
  - 4 non-technical courses (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts) of at least 9 units each from any of the departments in H&SS, CFA, or BA.
- Additional Core Physics/Math Courses
  - 33-104 Experimental Physics
  - 33-211 Physics III: Modern Essentials
  - 33-228 Electronics I
  - 33-231 Physical Analysis
  - 33-232 Mathematical Methods of Physics
  - 33-234 Quantum Physics
  - 33-311 Physical Mechanics I
  - 33-338 Intermediate Electricity and Magnetism I
  - 33-340 Modern Physics Laboratory
  - 33-341 Thermal Physics I
  - 21-259 Calculus in Three Dimensions
- Physics Colloquium Courses
  - 33-201 Physics Sophomore Colloquium I
  - 33-202 Physics Sophomore Colloquium II
  - 33-301 Physics Upperclass Colloquium I
  - 33-302 Physics Upperclass Colloquium II
- Physics, Mathematics and Technical Electives
  - 8 courses of at least 9 units each
  - Allowed courses depend on track chosen: see below.
- Free Electives
  - Approximately 26 units: actual number depends on track chosen and satisfying 360 total units
  - A free elective is any Carnegie Mellon course; however, a maximum of 9 units of physical education and/or military science and/or StuCo courses may be taken as free electives.

We offer a Physics Major with or without a track. A track is like a "menu deal" at a fast-food restaurant: when one chooses a track, one gets a package of physics and other required courses and electives. The specialized electives for each of the tracks are described below:

- No Track (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#bsinphysics/notrack)
- Astrophysics (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#bsinphysics/astrophysicstrack)

Student Programs Office: Wean Hall 7319

Office: Wean Hall 7303

Stephen Garoff, Head
Department of Physics

- 99-101, 99-102, or 99-103 Computing @ Carnegie Mellon
- MCS Core Science Requirements
- 03-121 Modern Biology
- 09-105 Introduction to Modern Chemistry I
- 21-120 Differential and Integral Calculus
- 21-222 Integration, Differential Equations and Approximation
- MCS Core Courses must be completed by end of junior year.
- MCS Humanities & Social Sciences and Fine Arts Requirements (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
- Common Course Requirement (Writing/Expression) (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - 33-451
- Distributional Course Requirements
  - 1 course from Category 1: Cognition, Choice and Behavior (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - 1 course from Category 2: Economic, Political and Social Institutions (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - 1 course from Category 3: Cultural Analysis (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
- Electives
  - 4 non-technical courses (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts) of at least 9 units each from any of the departments in H&SS, CFA, or BA.
- Additional Core Physics/Math Courses
  - 33-104 Experimental Physics
  - 33-211 Physics III: Modern Essentials
  - 33-228 Electronics I
  - 33-231 Physical Analysis
  - 33-232 Mathematical Methods of Physics
  - 33-234 Quantum Physics
  - 33-311 Physical Mechanics I
  - 33-338 Intermediate Electricity and Magnetism I
  - 33-340 Modern Physics Laboratory
  - 33-341 Thermal Physics I
  - 21-259 Calculus in Three Dimensions
- Physics Colloquium Courses
  - 33-201 Physics Sophomore Colloquium I
  - 33-202 Physics Sophomore Colloquium II
  - 33-301 Physics Upperclass Colloquium I
  - 33-302 Physics Upperclass Colloquium II
- Physics, Mathematics and Technical Electives
  - 8 courses of at least 9 units each
  - Allowed courses depend on track chosen: see below.
- Free Electives
  - Approximately 26 units: actual number depends on track chosen and satisfying 360 total units
  - A free elective is any Carnegie Mellon course; however, a maximum of 9 units of physical education and/or military science and/or StuCo courses may be taken as free electives.

We offer a Physics Major with or without a track. A track is like a "menu deal" at a fast-food restaurant: when one chooses a track, one gets a package of physics and other required courses and electives. The specialized electives for each of the tracks are described below:

- No Track (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#bsinphysics/notrack)
- Astrophysics (https://coursecatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#bsinphysics/astrophysicstrack)
Some of these courses are included in particular tracks. Then, no additional Physics Breadth Elective need to be chosen.

**Physics Graduate Courses**
- 33-735 Quantum Mechanics I
- 33-736 Quantum Mechanics II
- 33-758 Quantum Computation and Quantum Information Theory
- 33-759 Introduction to Mathematical Physics I
- 33-761 Classical Electrodynamics I
- 33-762 Classical Electrodynamics II
- 33-765 Statistical Mechanics
- 33-767 Biophysics: From Basic Concepts to Current Research
- 33-769 Quantum Mechanics III: Many Body and Relativistic Systems
- 33-770 Field Theory I
- 33-771 Field Theory II
- 33-777 Introductory Astrophysics
- 33-779 Introduction to Nuclear and Particle Physics
- 33-780 Nuclear and Particle Physics II
- 33-783 Solid State Physics

### B.S. in Physics – Sample Schedule (No Track)

#### First Year

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>33-111</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>or 33-131</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>15-110</td>
<td>10-12</td>
</tr>
<tr>
<td></td>
<td>or 15-112</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>21-120</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>99-101</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>76-101</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>33-112</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>or 33-132</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>33-104</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>21-122</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Sophomore Year

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>33-211</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>33-231</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>33-201</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>21-259</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>09-105</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Junior Year

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>33-331</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>33-338</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>33-341</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>33-301</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx</td>
<td>9</td>
</tr>
</tbody>
</table>
B.A. in Physics

The Bachelor of Arts degree in Physics offers a flexible program that allows students to combine the study of Physics with the opportunity to do intensive work in substantive areas such as liberal arts, teaching, business or law. With 82 units of free electives, it is feasible for students to obtain, for example, a double major with a department in the College of Humanities and Social Sciences, the College of Fine Arts, or the Tepper School of Business. It is expected that students will focus their elective courses in a well defined academic area. Students must meet with the Assistant Head for undergraduate Affairs and construct an approved plan of study.

The requirements for the B.A. degree are the same as for the B.S. degree, except that the 8 Physics, Mathematics and Technical Electives in the B.S. program become Free Electives in the BA program.

Degree Requirements are as follows:

- Carnegie Mellon University Requirements
  - A minimum of 360 units is required.
  - 99-101, 99-102, or 99-103 Computing @ Carnegie Mellon
- MCS Core Science Requirements
  - 33-111 Physics I for Science Students or 33-131 Matter and Interaction I
  - 33-112 Physics II for Science Students or 33-132 Matter and Interactions II
  - 03-121 Modern Biology
  - 09-105 Introduction to Modern Chemistry I
- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
- MCS Core Courses must be completed by end of junior year.
- MCS Humanities & Social Sciences and Fine Arts Requirements (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - Common Course Requirement (Writing/Expression)
    - 76-101 Interpretation and Argument
  - Distributional Course Requirements
    - 1 course from Category 1: Cognition, Choice and Behavior (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
    - 1 course from Category 2: Economic, Political and Social Institutions (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
    - 1 course from Category 3: Cultural Analysis (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts)
  - Electives
    - 4 non-technical courses (http://www.cmu.edu/mcs/undergrad/advising/hss-finearts) of at least 9 units each from any of the departments in H&SS, CFA, or BA.

B.S. in Physics / No Track

The 8 Physics, Mathematics and Technical courses for the B.S. in the Physics without a track are as follows:

- Physics Electives
  - 4 courses of at least 9 unit each
    - must be chosen from the Qualifying Physics Electives (https://coursecatalog-new.web.cmu.edu/melloncollegescience/departmentofphysics/#qualifyingelectivesinphysics), at least one of which must be chosen from Physics Breadth Electives
- Math Elective
  - 1 course of at least 9 units
    - chosen from any 21-2xx or higher level courses except 21-350
- Technical Electives
  - 3 courses of at least 9 units each
    - Technical electives are any courses in MCS, SCS, Statistics, CIT, and others explicitly approved by the Assistant Head for Undergraduate Affairs.

B.S. in Physics / Applied Physics Track

The B.S. in Physics/Applied Physics Track is designed primarily for the student who wants to prepare for a career path that takes advantage of the diverse and expanding opportunities for employment in industrial and government laboratories with a B.S. degree. The program provides a solid foundation in the concepts of physics, as well as giving the student the experience and understanding of the application of these concepts. The track is intended to enhance computing and laboratory skills, and to introduce the application of physics to those subjects of particular interest to the student. Since the possible subject areas for study are so varied, the track will be tailored to each student’s needs within the framework described below.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Applied Physics Track are as follows:

- Physics/Technical Courses
  - 33-448 Introduction to Solid State Physics
    - One course (at least 9 units) which strengthens the student’s ability to use the computer as a tool in the research environment
  - Two courses (at least 18 units), at least one of them in another department, which broaden the student’s laboratory skills
  - Two courses (at least 18 units), at least one of them in another department, which give the student experience in applying basic physics principles to a variety of problems
A rigorous foundation in undergraduate physics with courses in Biological Physics and Chemistry.

Details of what may constitute the elective courses in Biological Sciences are decided after consultation with, and approved by, the Assistant Head for Undergraduate Affairs.

B.S. in Physics / Chemical Physics Track

The B.S. in Physics/Chemical Physics Track is designed for students wishing to have a strong grounding in physics along with a specialization in chemical physics or chemistry. It is particularly suitable for those students planning on graduate studies in physics with an emphasis on chemical physics or chemistry. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives that fulfill the requirements of the track.

The Chemical Physics Track incorporates a number of courses which are also requirements for the pre-medical program. Students interested in both the Chemical Physics Track and the pre-medical program should consult both with their Physics Department advisor and the Director of the Health Professions Program for help in planning their programs.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Chemical Physics Track are as follows:

- **Physics Courses**
  - One course of at least 9 units
  - must be chosen from the Qualifying Physics Electives (https://coursecatalog-web.cmu.edu/melloncollegeofscience/departmentofphysics/?qualifyingelectivesinphysics)

- **Math Elective**
  - One course of at least 9 units
  - chosen from any 21-2xx or higher level course except 21-350.

- **Technical Electives**
  - 3 courses of 9 units each
  - Technical electives are any courses in MCS, SCS, Statistics, CIT, and others explicitly approved by the Physics Department.

B.S. in Physics / Astrophysics Track

The B.S. in Physics/Astrophysics Track provides an option for those Physics majors who either want to specialize in this subfield or plan careers in astronomy or astrophysics. Career paths may include postgraduate training in astronomy or astrophysics or proceeding directly to jobs in these fields. The program provides a thorough foundation in the core physics program with electives concentrating in astrophysics.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Astrophysics Track are as follows:

- **Astrophysics Courses**
  - 33-224 Stars, Galaxies and the Universe
  - 33-466 Extragalactic Astrophysics and Cosmology
  - 33-467 Astrophysics of Stars and the Galaxy
  - 1 research course: either 33-350 or 33-451
  - the research topic must be astrophysics related and must be approved by the Assistant Head for Undergraduate Affairs.

- **Math Elective**
  - One course of at least 9 units
  - chosen from any 21-2xx or higher level course except 21-350.

- **Technical Electives**
  - 3 courses of 9 units each
  - Technical electives are any courses in MCS, SCS, Statistics, CIT, and others explicitly approved by the Physics Department.

B.S. in Physics / Biological Physics Track

The B.S. in Physics/Biological Physics Track combines a rigorous foundation in undergraduate physics with courses in Biological Physics and Chemistry. It is particularly suitable for students preparing for post-baccalaureate careers in the expanding areas of biological and medical physics or for graduate study in biophysics. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Biological Physics Track includes a number of courses which are also required for the pre-medical program. Students interested in both the Biological Physics Track and the pre-medical program should consult both with their Physics Department advisor and the Director of the Health Professions Program for help in planning their programs.

The 8 Physics, Mathematics and Technical courses for the B.S. in the Biological Physics Track are as follows:

- **Physics Courses**
  - One course of at least 9 units
  - must be chosen from the Qualifying Physics Electives (https://coursecatalog-web.cmu.edu/melloncollegeofscience/departmentofphysics/?qualifyingelectivesinphysics)

- **Math Elective**
  - One course of at least 9 units
  - chosen from any 21-2xx or higher level course except 21-350.

- **Biological Sciences/Chemistry Courses**
  - 03-231 Biochemistry I
  - 09-217 Organic Chemistry I
  - 09-218 Organic Chemistry II
  - 2 courses (18 units) in Biological Sciences

Details of what may constitute the elective courses in Biological Sciences are decided after consultation with, and approved by, the Assistant Head for Undergraduate Affairs.
Double Major or a Dual Degree in Physics with a Degree in another Department

Physics may be taken as a second major or for a second degree, with another department granting the primary degree. The rules of the Physics Department for these two options are distinct, as discussed below.

Double Major

In order to receive a Double Major in Physics, with another department granting the primary degree — with a B.S. or B.A., alone or with any track — all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled except:

- No units of Technical Electives are required
- No units of Core Physics Electives are required
- No units of Free Electives are required
- No units of Free H&SS/FA courses are required
- The following courses in the MCS core are not required: 03-121 Modern Biology, 09-105 Introduction to Modern Chemistry I
- However, 15-110 Principles of Computing or 15-112 Fundamentals of Programming and Computer Science (or equivalent as pre-approved by the Associate Dean of Mellon College of Science) is still required.

Dual Degree

In order to receive a Dual Degree in another subject and Physics, with another department granting the primary degree — with a B.S. or B.A. alone or with any track — all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled. The non-technical requirement is as per the Mellon College of Science; however, any course used for another department’s or college’s core requirement may be double counted for this purpose. The number of units required is 90 more than the total units required by the department requiring the fewer total units.

Minor in Physics

The Minor in Physics is designed to provide a solid foundation in physics at the introductory level, followed by elective courses which will familiarize the student with areas of modern physics, and the concepts and techniques employed therein. The Physics minor requires seven courses of at least 9 units each, of which four are required and three are electives.

- **Required Courses**
  - Introductory Physics I (one of 33-106, 33-111, 33-131)
  - Introductory Physics II (one of 33-107, 33-112, 33-132)
  - Physics III: Modern Essentials (33-211)
  - Experimental Physics (33-104)
- **Electives**
  - 3 physics electives, chosen from the Qualifying Physics Electives (https://coursescatalog-new.web.cmu.edu/melloncollegeofscience/departmentofphysics/#qualifyingphysics#electives) list
    - choice requires prior approval by the Assistant Head for Undergraduate Affairs

The minor is open to all students of the university, although students with non-calculus based majors should be aware of the mathematics requirements for many physics courses (21-120, 21-122, 21-259).

Faculty

- **DAVID ANDERSON**, Assistant Professor of Physics – Ph.D., University of York (UK); Carnegie Mellon, 2008–.
- **ROY A. BRIERE**, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1999–.
- **RUPERT CROFT**, Associate Professor of Physics – Ph.D., Oxford University; Carnegie Mellon, 2001–.
- **MARKUS DESERNO**, Associate Professor of Physics – Ph.D., University of Mainz, Germany; Carnegie Mellon, 2007–.
- **TIZIANA DI MATTEO**, Associate Professor of Physics – Ph.D., University of Cambridge; Carnegie Mellon, 2004–.
- **ALEX EVLEVITCH**, Associate Professor of Physics – Ph.D., Lund University, Sweden; Carnegie Mellon, 2009–.
- **RANDALL M. FEENSTRA**, Professor of Physics – Ph.D., California Institute of Technology; Carnegie Mellon, 1995–.
- **THOMAS A. FERGUSON**, Professor of Physics – Ph.D., University of California at Los Angeles; Carnegie Mellon, 1985–.
- **RAPHAEL FLAUGER**, Assistant Professor of Physics – Ph.D., University of Texas; Carnegie Mellon, 2009–.
- **GREGG B. FRANKLIN**, Professor of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1984–.
- **STEPHEN GAROFF**, Professor of Physics; Head, Department of Physics – Ph.D., Harvard University; Carnegie Mellon, 1988–.
- **KUNAL GHOSH**, Teaching Professor of Physics, Assistant Head for Undergraduate Affairs, Department of Physics – Ph.D., Iowa State University; Carnegie Mellon, 2001–.
- **FREDERICK J. GILMAN**, Buhl Professor of Physics; Dean, Mellon College of Science – Ph.D., Princeton University; Carnegie Mellon, 1995–.
- **ROBERT B. GRIFFITHS**, University Professor & Otto Stern Professor of Physics – Ph.D., Stanford University; Carnegie Mellon, 1964–.
- **SHIRLEY HO**, Assistant Professor of Physics – Ph.D., Princeton University; Carnegie Mellon, 2012–.
- **RICHARD F. HOLMAN**, Professor of Physics – Ph.D., Johns Hopkins University; Carnegie Mellon, 1987–.
- **GEORGE KLEIN**, Associate Teaching Professor of Physics – Ph.D., New York University; Carnegie Mellon, 1993–.
- **MICHAEL J. LEVINE**, Professor of Physics, Director of Pittsburgh Supercomputer Center – Ph.D., California Institute of Technology; Carnegie Mellon, 1963–.
- **MATHIAS LOSCHE**, Professor of Physics – Ph.D., Technical University of Munich; Carnegie Mellon, 2005–.
- **BARRY B. LUOKKALA**, Teaching Professor of Physics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1980–.
- **SARA A. MAJETICH**, Professor of Physics – Ph.D., University of Georgia; Carnegie Mellon, 1990–.
- **RACHEL MANDELBAM**, Assistant Professor of Physics – Ph.D., Princeton University; Carnegie Mellon, 2012–.
- **CURTIS A. MEYER**, Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1993–.
- **COLIN J. MORNNGSTAR**, Professor of Physics – Ph.D., University of Toronto; Carnegie Mellon, 2000–.
- **MANFRED PAULINI**, Professor of Physics – Ph.D., University of Erlangen, Germany; Carnegie Mellon, 2000–.
- **JEFFREY B. PETERSON**, Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1993–.
- **BRIAN P. QUINN**, Professor of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988–.
- **IRA Z. ROTHSTEIN**, Professor of Physics – Ph.D., University of Maryland at College Park; Carnegie Mellon, 1997–.
- **JAMES S. RUSS**, Professor of Physics – Ph.D., University of California, Berkeley; Carnegie Mellon, 1967–.
- **REINHARD A. SCHUMACHER**, Professor of Physics – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1987–.
- **ROBERT M. SUTER**, Professor of Physics – Ph.D., Clark University; Carnegie Mellon, 1981–.
- **ROBERT H. SWENDESEN**, Professor of Physics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1984–.
- **HY TRAC**, Assistant Professor of Physics – Ph.D., University of Toronto; Carnegie Mellon, 2010–.
- **HELMUT VOGEL**, Professor of Physics – Ph.D., University of Erlangen-Nuremberg; Carnegie Mellon, 1963–.
MATTHEW WALKER, Assistant Professor of Physics – Ph.D., University of Michigan; Carnegie Mellon, 2013–.

MICHAEL WIDOM, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1985–.

KRISTINA WOODS, Assistant Professor of Physics – Ph.D., Stanford University; Carnegie Mellon, 2007–.

DI XIAO, Assistant Professor of Physics – Ph.D., University of Texas, Austin; Carnegie Mellon, 2012–.

Emeriti Faculty

LUC BERGER, Professor of Physics, Emeritus – Ph.D., University of Lausanne, Switzerland; Carnegie Mellon, 1960–.

RICHARD M. EDELSTEIN, Professor of Physics, Emeritus – Ph.D., Columbia University; Carnegie Mellon, 1960–.

ARNOLD ENGLER, Professor of Physics, Emeritus – Ph.D., University of Berne, Switzerland; Carnegie Mellon, 1962–.

JOHN G. FETKOVICH, Professor of Physics, Emeritus – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1959–.

RICHARD GRIFFITHS, Professor of Physics, Emeritus – Ph.D., University of Leicester, U.K.; Carnegie Mellon, 1996–.

LEONARD S. KISSLINGER, Professor of Physics, Emeritus – Ph.D., Indiana University; Carnegie Mellon, 1969–.

ROBERT W. KRAEMER, Professor of Physics, Emeritus – Ph.D., Johns Hopkins University; Carnegie Mellon, 1965–.

LING-FONG LI, Professor of Physics, Emeritus – Ph.D., University of Pennsylvania; Carnegie Mellon, 1974–.

JOHN F. NAGLE, Professor of Physics, Emeritus – Ph.D., Yale University; Carnegie Mellon, 1967–.

JOHN A. RAYNE, Professor of Physics, Emeritus – Ph.D., University of Chicago; Carnegie Mellon, 1963–.

ROBERT T. SCHUMACHER, Professor of Physics, Emeritus – Ph.D., University of Illinois; Carnegie Mellon, 1957–.

ROBERT F. SEKERKA, University Professor of Physics and Mathematics, Emeritus – Ph.D., Harvard; Carnegie Mellon, 1969–.

NED S. VANDER VEN, Professor of Physics, Emeritus – Ph.D., Princeton University; Carnegie Mellon, 1961–.

LINCOLN WOLFENSTEIN, University Professor of Physics, Emeritus – Ph.D., University of Chicago; Carnegie Mellon, 1948–.

HUGH D. YOUNG, Professor of Physics, Emeritus – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1956–.

Joint Appointments and Courtesy Appointments

SHELLEY ANNA, Associate Professor of Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 2003–.

DAVID GREVE, Professor of Electrical & Computer Engineering – Ph.D., Lehigh University; Carnegie Mellon, 1982–.

MOHAMMAD F. ISLAM, Assistant Professor of Materials Science & Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2005–.

CRAIG MALONEY, Assistant Professor of Civil and Environmental Engineering – Ph.D., University of California, Santa Barbara; Carnegie Mellon, 2007–.

MAUMITA MANDAL, Assistant Professor of Chemistry – Ph.D., Hyderabad, India; Carnegie Mellon, 2009–.

MICHAEL E. MCHENRY, Professor of Materials Science and Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–.

ANTHONY D. ROLLETT, Professor of Materials Science & Engineering – Ph.D., Drexel University; Carnegie Mellon, 1995–.

JIAN-GANG ZHU, Professor of Electrical and Computer Engineering – Ph.D., University of California San Diego; Carnegie Mellon, 1997–.