

CASE WESTERN RESERVE UNIVERSITY

DEPARTMENT OF PHYSICS

Cleveland, Ohio 44106-7079

<http://physics.cwru.edu>

General University Information

President: Barbara Snyder
Dean of Graduate School: Charles E. Rozek
University website: <http://www.cwru.edu>
Control: Private
Setting: Urban
Total Faculty: 3,360
Total Graduate Faculty: 3,360
Total number of Students: 11,340
Total number of Graduate Students: 6,219

Department Information

Department Chair: Prof. Kathleen Kash, Chair
Department Contact: Corbin E. Covault, Director of the Graduate Program
Total full-time faculty: 25
Total number of full-time equivalent positions: 20
Full-Time Graduate Students: 61
First-Year Graduate Students: 17
Female First-Year Students: 2
Total Post Doctorates: 15

Department Address

Rockefeller Building
2076 Adelbert Road
Cleveland, OH 44106-7079
Phone: (216) 368-4000
Fax: (216) 368-4671
E-mail: admissions@phys.case.edu
Website: <http://physics.cwru.edu>

ADMISSIONS

Admission Contact Information

Address admission inquiries to: Corbin Covault, Admissions Director, Physics., Case Western Reserve University, 2076 Adelbert Road, Cleveland, OH 44106-7079.
Phone: (216) 368-8779
E-mail: admissions@phys.case.edu
Admissions website: <http://www.phys.case.edu/grad/apply.php>

Application deadlines

Fall admission:
U.S. students: January 15 *Int'l. students:* January 15

Application fee

There is no application fee required.
Applications are not generally accepted for Spring semester admission. Advanced graduate transfer students who are seeking to matriculate in January for Spring semester should contact the Director of the Graduate Program (grad_dir@phys.cwru.edu) prior submitting an application.

Admissions information

For Fall of 2016:
Number of applicants: 120
Number admitted: 10
Number enrolled: 3

Admission requirements

Bachelor's degree requirements: Bachelor's degree in Physics, Mathematics, or related field is required.
Minimum undergraduate GPA: 3.0

GRE requirements

The GRE is recommended.
All applicants are strongly encouraged to complete the GRE General Test and to arrange to have scores submitted directly to CWRU. The inclusion of GRE scores will considerably strengthen any application. No minimum score is required.

Advanced GRE requirements

The Advanced GRE is recommended.
All applicants are strongly encouraged to complete the GRE Physics Subject Test and to arrange to have scores submitted directly to CWRU. The inclusion of GRE scores will considerably strengthen any application. GRE Physics subject test scores are expected from all domestic applicants who are applying with bachelor's degrees only. Advanced students may submit a record of graduate coursework and graduate level research experience in lieu of GRE Physics subject test results. No minimum score is required.

TOEFL requirements

The TOEFL exam is required for students from non-English-speaking countries.
PBT score: 557
iBT score: 90

Other admissions information

Additional requirements: No minimum acceptable GRE score is specified.
Undergraduate preparation assumed: Taylor, Classical Mechanics; Griffiths, Electrodynamics; Kittel, Thermal Physics; Griffiths, Quantum Mechanics; or equivalent textbooks; one or two years of advanced laboratory courses.

TUITION

Tuition year 2016–17:
Full-time students: \$1,774 per credit
Part-time students: \$1,774 per credit
All admitted PhD students will receive tuition waivers for at least one full year.
Credit hours per semester to be considered full-time: 9
Deferred tuition plan: Yes
Health insurance: Available
Other academic fees: Health insurance will be made fully reimbursable at no net cost to incoming graduate students.
Academic term: Semester
Number of first-year students who received full tuition waivers: 3

Teaching Assistants, Research Assistants, and Fellowships

Number of first-year
Teaching Assistants: 3
Average stipend per academic year
Teaching Assistant: \$24,300
Research Assistant: \$24,300
Fellowship student: \$24,300
TAs, RAs, and Fellows in the Ph.D. program are generally eligible for full tuition support.

FINANCIAL AID

Application deadlines

Fall admission:
U.S. students: January 15 *Int'l. students:* January 15

Loans

Loans are available for U.S. students.
Loans are available for international students.
GAPSFAS application required: No
FAFSA application required: No

For further information

Address financial aid inquiries to: Director of Admissions, Department of Physics, Case Western Reserve University, 2076 Adelbert Road, Cleveland, OH 44106-7079.
Phone: (216) 368-8779
E-mail: admissions@phys.case.edu
Financial aid website: <http://physics.cwru.edu>

HOUSING**Availability of on-campus housing**

Single students: No
Married students: No

For further information

Address housing inquiries to: Dean, Graduate Studies, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44016.
Phone: (216) 368-8779
E-mail: admissions@phys.case.edu
Housing aid website: <http://gradstudies.case.edu/prospect/area/housing.html>

Table A—Faculty, Enrollments, and Degrees Granted

Research Specialty	2015–2016 Faculty	Enrollment Spring 2016		Number of Degrees Granted 2014 (2000–2014)		
		Mas-ter's	Doc-torate	Mas-ter's	Terminal Master's	Doc-torate
Biophysics	2	–	3	–	2(8)	–(4)
Condensed Matter Physics	13	–	25	–(2)	–	6(45)
Cosmology and Particle Astrophysics	7	–	23	–	–(2)	5(23)
Medical Imaging and Biophysics	3	–	8	–	–	1(13)
Other	2	4	2	–	–	–
Total	25	4	61	–(2)	2(10)	12(85)
Full-time Grad. Stud.	–	4	61	–	–	–
First-year Grad. Stud.	–	–	17	–	–	–

GRADUATE DEGREE REQUIREMENTS

Master's: Twenty-seven graduate credit hours in approved program including six required hours; Master's exam required; thesis option; no residence or language requirement.

Doctorate: Up to 36 hours of coursework is required (may be reduced by graduate coursework done elsewhere); comprehensive and topical exams, dissertation, and dissertation exam required; one-year residency; no language exam required. See <http://www.phys.cwru.edu/grad/phd.php>.

Thesis: Thesis may be written in absentia.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

A wide variety of facilities and programs are available within the department, and in addition there are collaborative programs with other departments, including Macromolecular Science, Chemistry, Astronomy, Materials Science, and the Medical School.

In astrophysics research, experiments in collaboration with other universities are being performed to search for high-energy cosmic rays and to explore the Cosmic Microwave Background. High-energy physics experiments are undertaken at various national laboratories. Theoretical work on astrophysics and cosmology, as well as particle, condensed matter physics, and quantum computing, covers a large number of research topics.

Condensed matter studies include measurements of dielectric; optical and nonlinear optical properties; thin-film properties; nanoscopic physics; quantum computing; liquid crystal and complex fluid properties; semiconductor crystal growth; quantum wells, wires, and dots; other nanoscopic structures; spintronics; organic electronics; and photovoltaics.

A wide range of facilities is available in surface physics and in optics. Among the collaborative programs are experimental and theoretical studies of phase transitions in polymers and of liquid crystals, photovoltaic materials, surface physics, the physics of imaging, fluid physics, dark matter detection, and measurements of fundamental parameters in cosmology.

Departmental computing facilities are extensive and are used in both research and courses. Weekly specialized seminars in particle/astrophysics and condensed matter physics take place, in addition to a weekly departmental colloquium.

The Physics Department has been recognized six times by the U.S. Department of Education as meeting vital national needs. Special graduate fellowships may be available.

In addition to a traditional physics program, the Department maintains a Physics Entrepreneurship Masters degree program. The program is designed to empower physicists as entrepreneurs and to enable students and graduates to build on their physics skills to start new high-tech businesses or to launch new product lines in existing companies.

Special Programs Center for Education and Research in Cosmology and Astrophysics: A new center created in collaboration with the Cleveland Museum of Natural History's Shafraan Planetarium and CWRU's Astronomy Department to promote research and education in cosmology and astrophysics. <http://cerca.case.edu>

Institute for Advanced Materials: The Institute for Advanced Materials brings together internationally recognized faculty researchers to engage in multi-disciplinary efforts on a broad range of materials that not only are ubiquitous in everyday life, but are cornerstones to many key technology areas. Specifically, IAM focuses on strategic research that impacts national needs in human health, energy, and the environment. The four focus areas are: Fundamental Materials Research, Materials for Human Health, Materials for Energy, and Materials for Sustainability. <http://iam-case.edu>

The Institute for the Science of Origins ISO is a collaborative team of faculty members and researchers from diverse scientific disciplines seeking to understand how complex systems emerge and evolve, from the universe to the mind, from microbes to humanity. <http://www.case.edu/origins>

The Michelson Postdoctoral Lectureship is an annual prize sponsored by Case Western Reserve University. It is awarded to an outstanding recent Physics Ph.D. based on an international competition. The winner spends one week in residence in the Department, and delivers several seminars and a departmental colloquium on his/her research.

Physics Entrepreneurship Masters Degree: To empower physicists as entrepreneurs and enable graduate students to build on their physics skills to start new high-tech businesses or to launch new product lines in existing companies.

Workshops and Conferences: The Department regularly holds national and international meetings on a variety of topics. Recent conferences have included: The Future of Cosmology, Future Physics and Future Facilities, The Cosmic Microwave Background, Great Lakes Cosmology Workshop, the American Vacuum Society Conference, International Workshop on MRI, Einstein’s Legacy, and Confronting Gravity.

Outreach: The Department works with high school teachers and students to improve science education locally and nationally. The Department also hosts a Web site of a national program in astronomy education called Ask an Astronomer.

Recent Books by Faculty include Magnetic Resonance Imaging: Physical Properties and Sequence Design by Robert Brown, and A Quantum Approach to Condensed Matter Physics Philip by L. Taylor.

International Programs: The department spearheaded three university-wide student and faculty exchange programs with the University of Calabria, Italy; Nagaoka University of Science and Technology, Japan; the Université Pierre et Marie Curie U. Paris 6, France, and Brazil.

Table B—Separately Budgeted Research Expenditures by Source of Support

Source of Support	Departmental Research	Physics-related Research Outside Department
Federal government	\$12,183,170	
State/local government	\$3,000,000	
Non-profit organizations	\$2,500,696	
Business and industry	\$415,453	
Other	\$856,042	
Total	\$18,955,361	

Table C—Separately Budgeted Research Expenditures by Research Specialty

Research Specialty	No. of Grants	Expenditures (\$)
Cosmology and Particle Astrophysics	21	\$5,845,846
Condensed Matter Physics	22	\$7,251,128
Medical Imaging Physics and Biophysics	4	\$3,804,541
Other	4	\$2,053,846
Total	51	\$18,955,361

FACULTY

Professor

- Alexander, Iwan, Ph.D.,** Washington State University, 1981. Joint appointment with mechanical engineering. Fluid physics; microgravity.
- Brown, Robert W., Ph.D.,** Massachusetts Institute of Technology, 1968. *Medical, Health Physics, Particles and Fields.* Theoretical physics; elementary particles; imaging physics.
- Chottiner, Gary S., Ph.D.,** University of Maryland, 1980. *Condensed Matter Physics, Surface Physics.* Experimental condensed matter physics; surface physics.
- Covault, Corbin, Ph.D.,** Harvard University, 1991. *Astrophysics, Atmosphere, Space Physics, Cosmic Rays.* Experimental high-energy astrophysics, particle interactions, cosmic rays.
- Kash, Kathleen, Ph.D.,** Massachusetts Institute of Technology, 1982. *Atomic, Molecular, & Optical Physics.* Experimental condensed matter physics; optics; mesoscopic physics.
- Lambrecht, Walter R. L., Ph.D.,** Ghent University, 1980. *Atomic, Molecular, & Optical Physics, Condensed Matter*

Physics, Theoretical Physics. Theoretical condensed matter physics; electronic structure of materials.

- Luck, Earle, Ph.D.,** University of Texas, 1977. Joint appointment with astronomy. *Astronomy.* Stellar and galactic chemical evolution; stellar abundance analysis; spectrum synthesis techniques.
- Mihos, Christopher, Ph.D.,** University of Michigan, 1992. Joint appointment with astronomy. *Astronomy, Astrophysics, Computational Physics, Cosmology & String Theory.* Observational and computational astrophysics; galactic dynamics; galaxy clusters; galaxy evolution.
- Morrison, Heather, Ph.D.,** Australian National University, 1988. Joint appointment with astronomy. *Astronomy, Astrophysics.* Galaxy structure, formation, and evolution, especially Milky Way and Local Group.
- Petschek, Rolfe G., Ph.D.,** Harvard University, 1981. *Condensed Matter Physics, Statistical & Thermal Physics, Theoretical Physics.* Theoretical physics; statistical physics; condensed matter physics.
- Rosenblatt, Charles, Ph.D.,** Harvard University, 1978. *Condensed Matter Physics, Fluids, Rheology, Optics.* Experimental condensed matter physics; liquid crystals and complex fluids; optics; microgravity; fluid physics.
- Ruhl, John, Ph.D.,** Princeton University, 1993. *Astrophysics, Cosmology & String Theory.* Experimental particle astrophysics, cosmic microwave background.
- Singer, Kenneth D., Ph.D.,** University of Pennsylvania, 1981. *Atomic, Molecular, & Optical Physics, Condensed Matter Physics, Nano Science and Technology, Optics.* Experimental physics; nonlinear optics; organic electronics; photovoltaics; nanophysics.
- Starkman, Glenn, Ph.D.,** Stanford University, 1988. *Astrophysics, Cosmology & String Theory, Particles and Fields, Theoretical Physics.* Theoretical physics; cosmology; particle physics; astrophysics.
- Strangi, Guiseppe, Ph.D.,** University of Calabria. *Atomic, Molecular, & Optical Physics, Condensed Matter Physics, Nano Science and Technology, Optics.* Experimental condensed matter physics optics and photonics of soft condensed matter DFB and random lasing opto-plasmonics in nanostructured metamaterials.
- Taylor, Cyrus C., Ph.D.,** Massachusetts Institute of Technology, 1984. *Applied Physics, Particles and Fields, Theoretical Physics.* Theoretical physics, theoretical and experimental elementary particle physics; physics of entrepreneurship.
- Taylor, Philip L., Ph.D.,** University of Cambridge, 1962. *Condensed Matter Physics, Theoretical Physics.* Theoretical condensed matter physics; physics of polymers and liquid crystals.

Associate Professor

- Gao, Xuan, Ph.D.,** Columbia University, 2003. *Condensed Matter Physics, Nano Science and Technology.* Experimental condensed matter physics; applied physics; electronic properties of low dimensional nanostructures; semiconductor nanowires; nanosensors.
- Jankowsky, Eckhard, Ph.D.,** Dresden Institute of Technology, 1996. Joint appointment with biochemistry. Experimental biophysics; single molecule fluorescence; enzyme kinetics.
- Martens, Michael A., Ph.D.,** Case Western Reserve University, 1991. *Medical, Health Physics.* Imaging physics. Industrial Physics Magnetic Nanoparticle Imaging High Energy Particle Physics Accelerator Physics.
- Mathur, Harsh, Ph.D.,** Yale University, 1994. *Astrophysics, Condensed Matter Physics, Cosmology & String Theory, Theoretical Physics.* Theoretical condensed matter physics; localization and mesoscopic physics; cosmology and particles.

Zehavi, Idit, Ph.D., Hebrew University of Jerusalem, 1999. Joint appointment with astronomy. *Cosmology & String Theory*. Theoretical astrophysics; cosmology; large-scale structure; galaxy and structure formation.

Assistant Professor

Berezovsky, Jesse, Ph.D., University of California, Santa Barbara, 2007. *Atomic, Molecular, & Optical Physics, Condensed Matter Physics, Quantum Foundations*. Experimental condensed matter; transport, quantum coupling of spins and photons; quantum information.

de Rham, Claudia, Ph.D., University of Cambridge, 2005. *Astrophysics, Cosmology & String Theory, Relativity & Gravitation, Theoretical Physics*. Theoretical cosmology and particle physics. Modified gravity.

Hinczewski, Micheal, Ph.D., Massachusetts Institute of Technology, 2005. *Biophysics, Statistical & Thermal Physics, Theoretical Physics*. Soft matter: motor proteins, single-molecule force spectroscopy, biopolymers, cell adhesion, signaling networks.

Tolley, Andrew J., Ph.D., University of Cambridge, 2003. *Astrophysics, Cosmology & String Theory, Relativity & Gravitation, Theoretical Physics*. Theoretical cosmology and particle physics; dark energy.

Visiting Assistant Professor

Christenson, Cory, Ph.D., University of Arizona, 2001. *Atomic, Molecular, & Optical Physics, Condensed Matter Physics, Materials Science, Metallurgy, Nano Science and Technology*. Experimental physics; optical properties of materials.

Instructor

Caner, Ed, M.S., Case Western Reserve University, 2003. Director, STEP/PEP: Master's in Entrepreneurship. *Applied Physics*. Science and Technology; physics entrepreneurship.

Copi, Craig J., Ph.D., University of Chicago, 1996. *Astrophysics, Cosmology & String Theory, Theoretical Physics*. Particle astrophysics, Cosmic microwave background, early Universe.

Driscoll, Diana, Ph.D., Case Western Reserve University, 2001. Director of Introductory Laboratories. *Physics and other Science Education*. Science Education.

Kernan, Peter J., Ph.D., The Ohio State University, 1993. *Astrophysics, Computational Physics, Theoretical Physics*. Particle Astrophysics, scientific computing.

DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF

Theoretical

Biophysics. Soft matter: motor proteins, single-molecule force spectroscopy, biopolymers, cell adhesion, signaling networks. Hinczewski.

Cosmology. Dark Matter, Dark Energy, cosmological perturbations, modified gravity, topology, constraints from cosmic microwave background, early Universe, inflation, extra dimensions, strings, branes. de Rham, Starkman, Tolley.

Electronic Properties of Metals and Semiconductors. Electronic properties of metals and semiconductors; photovoltaics, crystal growth; transport properties in ordered and disordered ma-

terials; band structure; deformation potentials; localization, thermo-electricity; interface and surface physics; lattice vibrations. Lambrecht, Mathur, Petschek, Philip Taylor.

Imaging Physics. Algorithm development; bio-data acquisition and analysis; rf coil theory; inverse scattering theory; diagnostic imaging. Brown, Martens.

Liquid Crystals. Phase transitions, dynamics, symmetry and surface effects, nonlinear behavior. Petschek, Philip Taylor.

Particle Astrophysics. Cosmology and Gravitational Physics. Neutrino astrophysics; early universe cosmology; dark matter; dark energy; large-scale structure; gravitational lensing; black hole evaporation; stellar evolution; cosmic strings; cosmic microwave background. de Rham, Mathur, Starkman, Cyrus Taylor, Tolley.

Particle Physics. Electroweak theory; standard model; cosmology; black hole physics; superstring theory SSC physics; supersymmetry, field theories at finite temperature; quark-gluon plasma; diffractive excitation mechanisms. de Rham, Mathur, Starkman, Cyrus Taylor, Tolley.

Polymer Physics/Science. Equations of state; phase transitions; dynamical behavior; piezoelectric effects; polymer liquid crystals. Petschek, Philip Taylor.

Relativity & Gravitation. Relativity and Gravitation in Cosmology, early universe, modified gravity. de Rham, Starkman, Tolley.

Statistical & Thermal Physics. Statics and dynamics of phase transitions; pattern formation and dendritic growth; liquid crystals, polymeric liquid crystals, complex fluids; oscillatory chemical reactions; membrane noise. Petschek, Philip Taylor.

Experimental

Electronic Structure of Materials. Electronic structure of metals and alloys; surfaces; crystal growth; thin films; amorphous films; dielectric and cohesive properties; dielectric and mechanical relaxation; organic electronics; transport properties of nano-structures, quantum wells, mesoscopic systems, and fuel cells; soft matter. Berezovsky, Gao, Kash, Strangi.

Experimental Cosmology and Particle Astrophysics. Cosmic microwave background; high-energy cosmic rays; gamma ray astrophysics. Covault, Ruhl.

Fluid Physics. Interface instabilities; magnetic levitation. Rosenblatt.

High Energy Particle Physics. Collider physics; hadronic interactions. Covault, Cyrus Taylor.

Liquid Crystals and Complex Fluids. Phase transitions; optical, magnetic, and electrical properties; microgravity; nanostructured LCs, symmetry effects. Chottiner, Rosenblatt.

Nanoscale Physics. Quantum dots, wires, molecular electronics, nanoscale surface modification, nanowires, and sensors. Berezovsky, Gao, Kash, Rosenblatt, Singer, Strangi.

Optical Properties of Materials. Linear and nonlinear optical properties of organic, polymeric materials, and mesoscopic systems, photovoltaics, ultrafast spectroscopy. Berezovsky, Kash, Rosenblatt, Singer, Strangi.

Polymer Physics/Science. Phase transformations; dielectric properties; magnetic and electric field effects; optical mechanical properties. Rosenblatt, Singer.

Surface Physics. Surface magnetization; secondary electron emission; surface analysis; physical and chemisorption. Chottiner.

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