RENSSELAER POLYTECHNIC INSTITUTE

DEPARTMENT OF PHYSICS, APPLIED PHYSICS, AND ASTRONOMY

Troy, New York 12180-3590
https://science.rpi.edu/physics

General University Information

President: Shirley A. Jackson
Dean of Graduate School: Stanley M. Dunn
University website: http://www.rpi.edu/index.html
School Type: Private
Setting: Suburban
Total Faculty: 500
Total number of Students: 7,962
Total number of Graduate Students: 1,334

Department Information

Department Chair: Prof. Vincent Meunier, Head
Department Contact: Joan Perras, Assistant to the Department Head
Total full-time faculty: 26
Total number of full-time equivalent positions: 22
Full-Time Graduate Students: 38
Female Full-Time Graduate Students: 4
First-Year Graduate Students: 8
Total Post Doctorates: 7

Department Address

110 8th Street
Troy, NY 12180-3590
Phone: (518) 276-6310
Fax: (518) 276-6680
E-mail: perraj@rpi.edu
Website: https://science.rpi.edu/physics

ADMISSIONS

Admission Contact Information

Address admission inquiries to: Graduate Admissions, Rensselaer Polytechnic Institute, 110 8th Street, Troy, New York 12180-3590
Phone: (518) 276-6216
E-mail: gradadmissions@rpi.edu
Admissions website: http://admissions.rpi.edu/graduate/

Application deadlines

Fall admission:
U.S. students: January 1 *Int'l. students*: January 1
Spring admission:
U.S. students: August 15 *Int'l. students*: August 15

Application fee

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

Admissions information

For Fall of 2020:
Number of applicants: 158
Number admitted: 34
Number enrolled: 8

Admission requirements

Bachelor's degree requirements: Bachelor's degree is required with courses and grades demonstrating ability and preparation adequate for graduate study in Physics. Remedial courses available as needed.
Minimum undergraduate GPA: 3.2

GRE requirements

The GRE is required.
Minimum accepted GRE scores:
Quantitative score: 146
Verbal score: 156
Analytical score: 4.0
The above are the suggested minimum.

GRE Physics requirements

The GRE Physics is not required.
The GRE Physics is optional for Spring and Fall 2021 admissions due to covid-19 situation.

TOEFL requirements

The TOEFL exam is required for students from non-English-speaking countries.
Minimum accepted TOEFL scores:
PBT score: 600
iBT score: 100
The above are the suggested minimum.

Other admissions information

Undergraduate preparation assumed: Students are normally expected to have taken intermediate-level courses in mechanics, electricity and magnetism, quantum physics, statistical mechanics, and experimental physics. Typical texts are Marion and Thornton, Griffiths, Brehm and Mullin, Stowe, and Liboff. However, students may take a limited number of remedial courses after enrollment where inadequate preparation has been available, but where other courses and grade records indicate adequate ability.

TUITION AND ASSISTANTSHIPS

Teaching Assistants, Research Assistants, and Fellowships

Number of first-year
Teaching Assistants: 8
Average stipend per academic year
Teaching Assistant: $23,500
Research Assistant: $23,500
Fellowship student: $35,250
The average fellowship amount is based on the institutes Rensselaer Graduate Fellowship for the past academic year. In addition to the stipend, the fellowship pays standard health center and activity fees.

Tuition year 2020–21:

Tuition for in-state residents
Full-time students: annual
Part-time students: per credit
Full-time students: $55,600 annual
Part-time students: $2,320 per credit
Credit hours per semester to be considered full-time: 12
Deferred tuition plan: No
Health insurance: Available at the cost of $1,228 per year.
Other academic fees: Fees & Insurance: $2,636. Estimated Living Expenses: $14,882. Books and Supplies: $2,994.
Academic term: Semester
Number of first-year students who received full tuition waivers: 8

FINANCIAL AID

Application deadlines

Fall admission:
U.S. students: February 1 *Int'l. students*: February 1
Spring admission:
U.S. students: November 1 *Int'l. students*: November 1

Loans

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

For further information

Address financial aid inquiries to: Office of Financial Aid.
Phone: (518) 276-6813
E-mail: finaid@rpi.edu
Financial aid website: http://admissions.rpi.edu/aid/index.html

HOUSING

Availability of on-campus housing

Single students: Yes
Married students: Yes
Childcare Assistance: Yes

For further information

Address housing inquiries to: Office of Residence Life, Rensselaer Polytechnic Institute, 110 8th Street, Troy, New York 12180-3590.
Phone: (518) 276-6284
E-mail: res_life@rpi.edu
Housing aid website: http://reslife.rpi.edu/setup.do

Table A—Faculty, Enrollments, and Degrees Granted

Research Specialty	2018–2019 Faculty	Enrollment Spring 2019 Master's	Enrollment Spring 2019 Doctorate	Number of Degrees Granted 2017–2018 (2013–2018) Master's	Number of Degrees Granted 2017–2018 (2013–2018) Terminal Master's	Number of Degrees Granted 2017–2018 (2013–2018) Doctorate
Astronomy and Astrophysics	4	1	5	–	2(20)	–(2)
Condensed Matter Physics	9	–	19	–(4)	1(16)	6(25)
Optics	7	4	8	1(3)	3(10)	–(9)
Particles and Fields	4	–	2	–(2)	–(2)	–(6)
Total	24	6	33	1(9)	6(48)	6(42)
Full-time Grad. Stud.	–	5	34	–	–	–
First-year Grad. Stud.	–	5	6	–	–	–

GRADUATE DEGREE REQUIREMENTS

Master's: Thirty credit hours with a minimum GPA of 3.0; one academic year (2 semesters) residency minimum. No foreign language and no comprehensive exams are required. Thesis or research projects are required (six to nine credit hours for a thesis or three credit hours for a research project), but may be waived for students who pass Ph.D. candidacy exam. A maximum of six credit hours can be transferred from other institutions.

Doctorate: Seventy-two credit hours (typically including 30-45 credit hours of research) with a minimum GPA of 3.0 are required. There is a three academic year (six semesters) residency minimum. No foreign language is required. Qualifying examination (10 hours, written), covering advanced undergraduate-level material, must be passed by end of first year. Qualifying exams may be waived for high physics GRES score or high performance in classes at Rensselaer. Candidacy exam (oral, on physics related to proposed thesis research area), written dissertation, and thesis defense required.

SPECIAL EQUIPMENT, FACILITIES, OR PROGRAMS

Astronomy and Astrophysics

Students' thesis research in astronomy and astrophysics enjoys access to world-class ground-based telescopes located at observing sites in the southern hemisphere and China. Our faculty cooperates with the international Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), the Sloan Digital Sky Survey, and the very popular MilkyWay@Home project.

For students' education in observational astronomy and for public outreach, the department maintains the Hirsch Observatory. It houses a fully automated Boller and Chivens 16″ Cassegrain Telescope, a Quantum Scientific Imaging (QSI) imaging camera with filter wheel, and a Santa Barbara Instrument Group (SBIG) spectrograph. Many smaller telescopes are also available to students.

Biological Physics, Condensed Matter and Optics

State-of-the art equipment for graduate students' experimental research in optics and condensed matter physics is provided in the physics department. The equipment includes optical, electronic, and cryogenic instruments, surface science techniques and materials growth equipment. Examples are Atomic Force Microscopy, Auger Electron Spectroscopy, Ellipsometry, High-Resolution Low Energy Electron Diffraction, Reflection High-Energy Electron Diffraction, X-Ray Crystallography, and Super-Resolution Microscopy. Also available for research are terahertz radiation sources and ultrafast laser systems. Students engage in absorption, light scattering, and photoluminescence spectroscopy using systems operating from the terahertz frequency band to the ultraviolet part of the electromagnetic spectrum.

Students interested in nanofabrication will find excellent facilities in Rensselaer's Micro and Nano-Fabrication Clean Room (MNCR). This is a state-of-the-art, 5,700-square-foot, Class 100 multi-user facility which supports research and education in nanotechnology, biotechnology, microelectronics, solid state lighting, energy, and other fields. The MNCR offers infrastructure for end-to-end device fabrication, characterization, metrology and testing by the graduate student user on substrates ranging from a few millimeters in size to full wafers 200 mm in diameter for high-speed electronics, power devices, integrated circuits, microsystems, and other applications. Fabrication of structures as small as 20 nm is possible in the MNCR, and structures as small as 1.5 nm can be achieved. In addition, the facility has several dedicated staff members to provide process solutions, training, and teaching.

The Center for Biotechnology and Interdisciplinary Research on our campus offers extensive and high-quality facilities for students' experimental research in biological physics at the molecular, cellular, and tissue level.

Students conducting research in theoretical biological and condensed matter physics use Rensselaer's own supercomputer. The Blue Gene/Q is one of the world's most powerful university-based supercomputers. Theoretical methods implemented by our students on this machine and other computers are density functional theory calculations, Monte-Carlo Simulations as well as classical and quantum mechanical molecular dynamics simulation.

In addition, the Department's research activities are affiliated with numerous research centers on campus: The Center for Computational Innovations, the Center for Future Energy Systems,

the Center for Materials, Devices and Integrated Systems, the Network Science and Technology Center, the Institute for Data Exploration and Applications, the Rensselaer Nanotechnology Center, the Scientific Computation Research Center, the Smart Lighting Engineering Research Center, and the Data Science Research Center.

Particle and Fields

Rensselaer research in particle astrophysics is involved in one of the leading experiments that could detect WIMP dark matter, the XENON experiment in the Gran Sasso Mountain in central Italy.

Students pursuing thesis research in theoretical particle physics apply lattice field theories and implement the calculations on the Blue Gene/Q supercomputer.

Theoretical—Nonlinear Dynamics and Complex Networks

One of the major developments of the last two decades has been the ever-increasing interconnectivity of a broad class of information networks, including physical and data network types arising in telecommunication, social networks, and transportation and energy infrastructures. This interconnectivity has led to immense temporal and spatial complexity in modern networks and a critical need for basic mathematical theory and statistical modeling of complex interacting networks. Our current research in this direction includes structure and dynamics of social, information, and biological networks and applications to social dynamics, network vulnerability, epidemic models, and synchronization problems. On-campus collaborations and facilities are at the Network Science and Technology Center (NeST).

Table B—Separately Budgeted Research Expenditures by Source of Support

Source of Support	Departmental Research	Physics-related Research Outside Department
Federal government	$2,136,435	
State/local government		
Non-profit organizations		
Business and industry		
Other		
Total	$2,136,435	

Table C—Separately Budgeted Research Expenditures by Research Specialty

Research Specialty	No. of Grants	Expenditures ($)
Astronomy and Astrophysics	8	$149,658
Condensed Matter Physics	20	$1,357,824
Nonlinear Dynamics and Complex Systems	5	$294,672
Optics	8	$235,748
Particles and Fields	2	$98,532
Total	43	$2,136,434

FACULTY

Professor

Giedt, Joel, Ph.D., University of California, Berkeley, 2002. Department Associate Head. *Computational Physics, Cosmology & String Theory, High Energy Physics, Particles and Fields, Theoretical Physics*. Particle phenomenology, lattice field theory, string compactifications, high energy mathematical and computational physics, topological phases of matter, many-body theory and quantum information science.

Jackson, Shirley A., Ph.D., Massachusetts Institute of Technology, 1973. President, Rensselaer Polytechnic Institute. *Particles and Fields*. Theoretical elementary particle physics.

Korniss, Gyorgy, Ph.D., Virginia Tech, 1997. *Computational Physics, Computer Science, Condensed Matter Physics, Nonlinear Dynamics and Complex Systems, Statistical & Thermal Physics*. Statistical mechanics; dynamics in complex systems and networks.

Lin, Shawn-Yu, Ph.D., Princeton University, 1992. *Optics*. Design, nanofabrication, and experimental testing of active 3D photonic crystals.

Lu, Toh-Ming, Ph.D., University of Wisconsin, Madison, 1976. Associate Director, Center for Integrated Electronics; Ray Palmer Baker Distinguished Professor. *Materials Science, Metallurgy, Nano Science and Technology, Solid State Physics, Surface Physics*. Thin films and interfaces.

Meunier, Vincent, Ph.D., University of Namur, 1999. Department Head; Gail and Jeffrey L. Kodosky ’70 Constellation Professor of Physics, Information Technology, and Entrepreneurship. *Computational Physics, Condensed Matter Physics, Materials Science, Metallurgy, Nano Science and Technology, Solid State Physics, Surface Physics*. Computational solid state physics, electronic transport, energy storage, and low-dimensional structures; nano science.

Newberg, Heidi, Ph.D., University of California, Berkeley, 1992. Director, Hirsch Observatory. *Astronomy, Astrophysics, Computational Physics*. Astrophysics, computational astronomy, and Galactic structure.

Persans, Peter D., Ph.D., University of Chicago, 1982. *Applied Physics, Condensed Matter Physics, Materials Science, Metallurgy, Optics, Physics and other Science Education, Solid State Physics*. Spectroscopy of semiconductors, thin films, optical materials.

Schroeder, John, Ph.D., Catholic University of America, 1974. *Biophysics, Condensed Matter Physics, Solid State Physics*. Physics and biological physics high pressure.

Shur, Michael, Ph.D., A. F. Ioffe Institute, 1967. Patricia W. and C. Sheldon Roberts ’48 Chaired Professor in Solid State Electronics; Professor of Electrical, Computer, and Systems Engineering; Professor of Physics, Applied Physics and Astronomy; Director, Center for Broadband Data Transport Science and Technology (Primary appointment with ECSE). *Applied Mathematics, Applied Physics, Condensed Matter Physics, Nano Science and Technology, Solid State Physics*. Semiconductor physics, ballistic transport, terahertz radiation, smart lighting, LED’s.

Terrones, Humberto, Ph.D., University of London, 1992. Rayleigh Endowed Chair of Theoretical Physics. *Condensed Matter Physics, Nano Science and Technology, Solid State Physics, Other*. Theory, experiment, and characterization of 2D materials and complex atomic structures.

Wang, Gwo-Ching, Ph.D., University of Wisconsin, Madison, 1978. Travelstead Institute Chair. *Applied Physics, Condensed Matter Physics, Surface Physics*. Growth and characterization of nanostructures and thin films.

Wetzel, Christian M., Ph.D., Technical University, Munich, 1993. *Applied Physics, Condensed Matter Physics, Electrical Engineering, Energy Sources & Environment, Engineering Physics/Science, Low Temperature Physics, Materials Science, Metallurgy, Nano Science and Technology, Optics, Solid State Physics*. III-V nitride semiconductor physics, materials and devices in particular for lighting, photovoltaics, and electronics.

Zhang, Shengbai, Ph.D., University of California, Berkeley, 1989. Gail and Jeffrey L. Kodosky ’70 Senior Constellation Professor of Physics, Information Technology, and Entrepreneurship. *Condensed Matter Physics*. Computational condensed matter theory, lower-dimension materials, topological

insulators, excitonic insulators, defects in optoelectronic and photovoltaic materials, and physics and chemistry of catalytic nano materials.

Associate Professor

Wilke, Ingrid, Ph.D., ETH Zuerich, 1993. *Applied Physics, Optics, Solid State Physics*. Ultrafast optics, photonics, optoelectronics and terahertz science and technology.

Assistant Professor

Brown, Ethan, Ph.D., University of California, Los Angeles, 2010. *Nuclear Physics, Particles and Fields*. Experimental particle astrophysics, dark matter direct detection, neutrinoless double beta decay, liquid xenon detectors, novel radiation detectors.

N'Gom, Moussa, Ph.D., University of Michigan, Ann Arbor, 2009. *Applied Physics, Atomic, Molecular, & Optical Physics, Optics, Quantum Foundations*. Quantum optics, ultrafast optics, light modulation, quantum entanglement, plasmonics, nanostructures.

Rhone, Trevor D., Ph.D., Columbia University, 2012. *Applied Mathematics, Applied Physics, Chemical Physics, Computational Physics, Computer Science, Condensed Matter Physics, Electromagnetism, Low Temperature Physics, Materials Science, Metallurgy, Nano Science and Technology, Solid State Physics, Surface Physics*. Computational solid state physics, magnetic materials, two-dimensional materials, nano science, catalysis, battery materials, machine learning, artificial intelligence.

Wertz, Esther A., Ph.D., Université Paris-Sud 11, 2010. *Atomic, Molecular, & Optical Physics, Condensed Matter Physics, Electromagnetism, Nano Science and Technology, Optics*. Light-matter interactions of single molecules with plasmonic nanostructures; super-resolution microscopy.

Professor of the Practice

Washington, Morris, Ph.D., New York University, 1976. Associate Director, Center for Integrated Electronics. *Condensed Matter Physics*. Photonic and electronic devices.

Affiliate Professor

Szymanski, Boleslaw, Ph.D., The Institute of Computer Science, the Polish Academy of Sciences, 1976. Claire and Roland Schmitt Distinguished Professor of Computer Science; Founding Director, Institute Center for Network Science and Technology. *Computational Physics, Computer Science, Condensed Matter Physics, Nonlinear Dynamics and Complex Systems, Statistical & Thermal Physics*. Network science, computer and sensor networks; distributed and parallel computing.

Affiliate Associate Professor

Huang, Zhaoran (Rena), Ph.D., Georgia Institute of Technology, 2003. Associate Professor, Electrical, Computer, and Systems Engineering. *Applied Physics, Electromagnetism, Nano Science and Technology, Optics, Solid State Physics*. Optoelectronic devices, integration and packaging, 3D integrated microsystems, lightwave circuits, integrated slow wave structures, photodetectors, electro-optic modulators, and laser diodes.

Affiliate Assistant Professor

Chakrapani, Vidhya, Ph.D., Case Western Reserve University, 2007. Assistant Professor, Dept of Chemical & Biological Eng. *Applied Mathematics, Energy Sources & Environment, Engineering Physics/Science, Materials Science, Metallurgy, Nano Science and Technology, Optics, Solid State Physics, Surface Physics*. Semiconductor photochemistry, solar energy conversion, advanced materials.

Sundararaman, Ravishankar, Ph.D., Cornell University, 2013. Assistant Professor, Materials Science and Engineering. *Chemical Physics, Computational Physics, Condensed Matter Physics, Nano Science and Technology, Optics, Solid State Physics*. Computational materials science, nanomaterials, energy conversion and storage, electrochemistry, plasmonics and nanophotonics.

Lecturer

Ciolek, Glenn E., Ph.D., University of Illinois at Urbana-Champaign, 1993. *Astrophysics, Computational Physics, Plasma and Fusion, Theoretical Physics*. Star formation, interstellar medium, plasma astrophysics, magnetohydrodynamics, interstellar dust, shock waves and nonlinear flows, computational astrophysics.

Georg, Julian, Ph.D., Syracuse University, 2018. *Cosmology & String Theory*. Early universe physics: inflation, reheating, primordial black holes; UV completion.

Kim, Yong Sung, Ph.D., Iowa State University, 2006. *Computational Physics, Condensed Matter Physics, Electromagnetism, Nano Science and Technology, Optics, Solid State Physics*. Computational photonics, photonic crystal, nano optical devices.

Martin, Charles H., Ph.D., Rensselaer, 2016. *Astronomy, Astrophysics*. Astronomy and Astrophysics; Milky Way Halo Substructure and Tidal Stream.

Michael, Joseph D., Ph.D., Rensselaer Polytechnic Institute, 1988. *Accelerator, Applied Physics, Atomic, Molecular, & Optical Physics, Electrical Engineering, Electromagnetism, Engineering Physics/Science, Optics, Physics of Beams, Plasma and Fusion*.

DEPARTMENTAL RESEARCH SPECIALTIES AND STAFF

Theoretical

Astrophysics. Current research focuses on determining the location of dark matter in the Milky Way. N-body simulations of the tidal disruption of dwarf galaxies in the Milky Way halo are performed, using MilkyWay@home, a 0.5 Peta-FLOPS volunteer computing platform built in-house. The simulations are compared to actual Milky Way data to determine the best parameters for the simulations, thus constraining the amount and distribution of dark matter in the halo. Also are tested predictions of dark matter distribution for particular dark matter particles against the measured positions and motions of stars in the Milky Way. Newberg.

Condensed Matter Physics. Theoretical and computational studies performed include the electronic structure of nanostructured material, models for the structure and electronic properties of surfaces and interfaces and the binding and mobility of adsorbed atoms on metal surfaces, molecular electronics and spintronics, as well as effort to develop understanding of far-from-equilibrium physics. Active research activities also include a number of other aspects of condensed matter physics research such as studies devoted to light-material interactions for solar-energy harvesting, photo catalysis, energy conversion, sensing, and structural transformation in inorganic and organic semiconductors. Many-body interactions encountered in electron-phonon coupling for excited-state energy relaxation, and superconductivity are also parts of the research portfolio. The researchers pay particular attention to emerging materials such as low-cost solar cell materials, topological insulators, porous nanostructures, two-dimensional layered structures, and van der Waals solids with exotic electronic structures and defect properties for applications in electronics, optoelectronics, spintronics, and beyond. Finally, significant activities are realized on the physics of surfaces and the phys-

ics, chemistry, and dynamics of interfaces between solids and between solid and liquid. The various condensed matter theory efforts rely significantly on large-scale supercomputing approaches, using resources from Rensselaer's Center for Computational Innovations. Meunier, Terrones, Zhang.

Particle Physics. Activities in this area primarily focus on investigations on beyond the standard model applications of lattice field theory. This includes strongly coupled supersymmetric systems such as arise in hidden sector models of spontaneous supersymmetry breaking. We have also studied models of compositeness in the Higgs sector of the Standard Model, with electroweak symmetry broken by strong dynamics of a new gauge force. This has led us into developing software for the study of resonance properties from first principles, which is also useful for lattice quantum chromodynamics. A key focus of ongoing research is dualities in gauge theories, such as S-duality (electric/magnetic) in N=4 super-Yang-Mills, and gauge/gravity dualities (AdS/CFT). This allows us to study quantum gravity in numerical simulations. Much of our work has an eye toward string-inspired particle phenomenology, which we have worked on in the past. Giedt.

Stochastic Dynamics on Complex Networks. One of the major developments of the last two decades has been the ever-increasing interconnectivity of a broad class of information networks, including physical and data network types arising in telecommunication, social networks, and transportation and energy infrastructures. This interconnectivity has led to immense temporal and spatial complexity in modern networks and a critical need for basic mathematical theory and statistical modeling of complex interacting networks. Rensselaer's current research in this direction includes structure and dynamics of social, information, and biological networks and applications to social dynamics, network vulnerability, epidemic models, and synchronization problems. On-campus collaborations and facilities are at the Network Science and Technology Center (NeST). Korniss, Szymanski.

Experimental

Astrophysics. Experimental research in the astrophysics group focuses on near-field cosmology, in which local galaxies are studied as examples to understand the properties of the Universe, including dark matter and dark energy. A particular focus is on the dynamics and structure of the Milky Way as revealed by large, international photometric and spectroscopic surveys such as the Sloan Digital Sky Survey (SDSS) and the Large Area Multi-Object Spectroscopic Telescope (LAMOST), and by astrometric surveys such as Gaia. Dwarf galaxies are ripped apart by tidal forces in the Milky Way into tidal streams. These streams are used to constrain the processes by which the Milky Way galaxy formed, and the distribution of the dark matter within it. The dwarf galaxies also excite wavelike structures in the Milky Way disk that could explain how spiral galaxy structure is formed and sustained. Newberg.

Condensed Matter Physics. The experimental condensed matter research distinguishes between the bulk of matter, its surface and interface, and proceeds in close partnership with theory and computational studies. Of interest are new concepts, materials, and techniques for nanotechnology and green technology such as renewable energy, energy conservation and conversion, storage, and delivery. Some projects are interdisciplinary and take part in dedicated Centers across the Institute, including the Center for Computational Innovation (CCI), which hosts one the fastest supercomputers in Academia. One fundamental research area is machine learning applied to energy-related material. Another aspect of current study is low-dimensional materials systems, including 2D layered materials and one-dimensional nanoribbons. Another project aims at improving our understanding of materials, their structure, and devices. Experimentally, the metals, semiconductors, and insulators are prepared in thin film deposition (including oblique angle deposition) and epitaxial growth (including van der Waals epitaxy). Their structural, electronic transport, spin, and optical properties are characterized and compared to theoretical and computational investigations. Other studies include wide band gap semiconductors, photonic crystals, polymers, semiconductor nanoparticle composites, dielectrics, magnetic, metallic thin films, two-dimensional layered materials, plasmonics and nanostructures. The department makes use of state-of-the-art characterization techniques such as electron, x-ray, ultraviolet, visible, infrared, Raman, terahertz, and scanning probe spectroscopies and microscopies. Local facilities include the Mirco and Nano Fabrication Clean Room and the Electron Microscope Laboratory. Lu, Shur, Terrones, Wang, Washington, Wetzel.

Optical Physics. Research in optical physics covers a wide range of activities related to photons and their interaction with various materials. Experimental and theoretical research is ongoing to provide innovative solutions to today's problems in both fundamental and application. The goals are the development of novel nanoelectronic and nanophotonic devices, creative solutions for homeland security, renewable energies, biological and biomedical investigations, solar harvesting, and smart lighting. Research includes photonic crystals, plasmonics, photonic nanostructures, light emitting diodes, terahertz photonics, spectroscopy, imaging, chemical and biological sensing and identification, ultrafast and nonlinear phenomena, the development of novel ultrafast spectroscopic techniques, development of novel optical materials including wideband gap and narrow band gap semiconductors, nanowires and their arrays, semiconducting quantum dots and quantum wells. One such research effort aims to understand the fundamental interactions between single quantum emitters and plasmonic nano-antennas. By studying the changes in the single molecule emission properties through super-resolution imaging, we can learn about the interactions of the fluorophore with its environment at the nanometer scale. Major facilities include ultrafast lasers and ultrafast and terahertz spectroscopy systems, a micro and nanofabrication clean room for semiconductor processing, linear and nonlinear optical absorption, luminescence, and super-resolution microscopy. Lin, Persans, Schroeder, Wertz, Wetzel, Wilke.

Particle Astrophysics. Rensselaer research in particle astrophysics is involved in one of the leading experiments that could detect WIMP dark matter, the XENON experiment in the Gran Sasso Mountain in central Italy. Students also perform R&D for neutrino and dark matter experiments the high purity xenon laboratory at Rensselaer. The nature and structure of matter and energy remains one of mankind's leading research frontiers. The faculty members involved in this area are engaged in experimental and theoretical studies of the fundamental interactions of matter at sub-femtometer distances. Another research focus is on the direct detection of dark matter with the XENON1T experiment operated in the LNGS laboratory in Italy, and the search for neutrinoless double beta decay with the nEXO experiment. Research & development efforts for these and future experiments address xenon purification techniques to operate the most radiopure detectors in the world. Brown.