

III-V semiconductor structures and devices. World-class electron microscopy facilities are also available. Members of the physics department also participate in Lehigh's Emulsions Polymer Institute, the Institute for Functional Materials and Devices, and the Institute for Data, Intelligent Systems, and Computation.

Extensive up-to-date computer facilities are available on campus and in the department. High Performance Computing facilities (<http://www.lehigh.edu/computing/hpc/>), can be accessed directly from graduate student and faculty offices through a high speed backbone. Access to the Extreme Science and Engineering Discovery Environment (XSEDE) is available through computing time allocations to Lehigh faculty.

## THE UNIVERSITY

Lehigh is an independent, co educational university located in Bethlehem, Pennsylvania. Founded in 1865, the University now has approximately 4,870 undergraduates and graduate students 2,250 within its four major Colleges: Arts and Sciences, Engineering and Applied Science, Business and Economics, and Education. There are over 450 full-time faculty members.

Most of the University's more than one hundred buildings are located on a 360 acre wooded campus on the north slope of South Mountain, overlooking the historic City of Bethlehem. Bethlehem is seventy miles north of Philadelphia and seventy-five miles southwest of New York City, making the cultural, entertainment, and transportation facilities of these cities easily accessible. Founded by Moravians seeking religious freedom in 1741, Bethlehem has its own rich cultural heritage. Dozens of historic buildings and locales have been remarkably well preserved and are in current use, giving the community a charming colonial atmosphere. The Lehigh Valley is also an important commercial and industrial center, with administrative, research, and manufacturing facilities for several major companies.

## PHYSICS FACULTY

### PROFESSORS

**Volkmar Dierolf**, Chair (Ph.D., University of Utah, '92)

Experimental solid state physics and near field optics.

**Ivan Biaggio**, (Ph.D., Swiss Federal Institute of Technology, ETH,

'93) Experimental solid state physics and nonlinear optics.

**Gary G. DeLeo**, (Ph.D., University of Connecticut, '79)

Theoretical solid state physics; astrophysics.

**Yong W. Kim**, (Ph.D., University of Michigan, '68) Statistical

physics and kinetic theory of fluctuations, transients and disorder in plasma, fluids and metallic solids.

**H. Daniel Ou Yang**, (Ph.D., UCLA, '85) Complex fluids, soft matter and biophysics.

**Jeffrey M. Rickman**, (Ph.D., Carnegie Mellon University, '89)

Computational solid state physics.

**Michael Stavola**, (Ph.D., University of Rochester, '80) Optical spectroscopy of solids, defects in semiconductors.

**Jean Toulouse**, (Ph.D., Columbia University, '81) Experimental solid state physics and fiber optics.

**Dimitrios Vaylonis**, (Ph.D., Columbia University, '00)

Theoretical cell biophysics.

### ASSOCIATE PROFESSORS

**Jerome C. Licini**, Associate Chair (Ph.D., M.I.T., '87) Physics education research.

**M. Virginia McSwain**, (Ph.D., Georgia State University, '04) Observational astrophysics.

**Joshua Pepper**, (Ph.D., Ohio State University, '07) Theoretical and observational astrophysics of stars and exoplanets; astronomical surveys.

### ASSISTANT PROFESSORS

**Sera Cremonini**, (Ph.D., Brown University, '06) String theory and high energy theory.

**Chinedu Ekuma**, (Ph.D., Louisiana State University, '15) Theoretical and computational condensed matter and materials physics.

**Aurelia Honerkamp-Smith**, (Ph.D., University of Washington, '10) Physics of biological membranes.

**Rosi Reed**, (Ph.D., University of California, Davis, '11) Experimental high energy nuclear physics.

**Bitan Roy**, (Ph.D., Simon Fraser University, '11) Theoretical condensed matter physics.

**Ariel Sommer**, (Ph.D., M.I.T., '13) Experimental atomic physics.

### PROFESSORS OF PRACTICE

**Paola Cereghetti**, (Ph.D., Swiss Federal Institute of Technology (ETH), '00).

### EMERITI FACULTY

**James D. Gunton**, (Ph.D., Stanford University, '67) Condensed matter theory.

**A. Peet Hickman**, (Ph.D., Rice University, '73) Theoretical atomic, molecular, and optical physics.

**John P. Huennekens**, (Ph.D., University of Colorado, '82) Experimental atomic, molecular, and optical physics.

**W. Beall Fowler**, (Ph.D., University of Rochester, '63) Theory of electronic and optical properties of insulating solids.

**George E. McCluskey, Jr.** (Ph.D., University of Pennsylvania, '65) Theoretical astrophysics.

**Russell A. Shaffer**, (Ph.D., Johns Hopkins University, '62) Theory of elementary particles.

### FOR ADDITIONAL INFORMATION CONTACT:

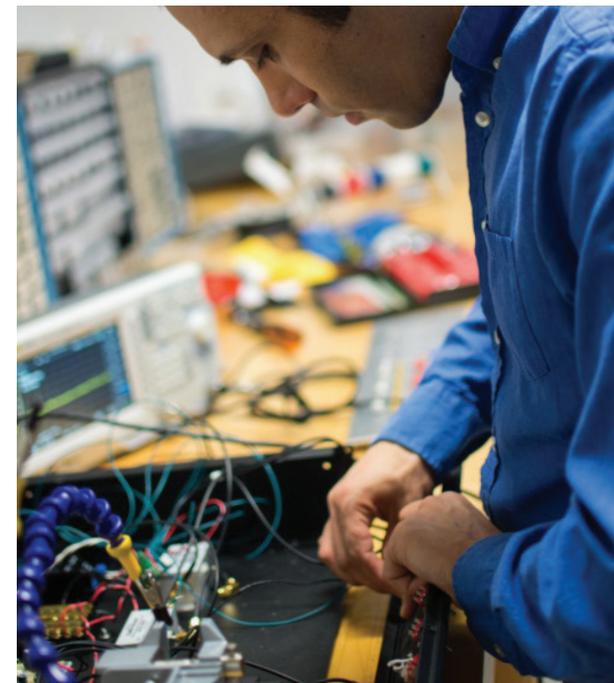
Graduate Admissions Officer  
Department of Physics, Lewis Laboratory  
Lehigh University  
16 Memorial Drive, East  
Bethlehem, PA 18015-3182  
(610) 758-3931  
e-mail: [physics@lehigh.edu](mailto:physics@lehigh.edu)

Lehigh University home page: [www.lehigh.edu](http://www.lehigh.edu)  
Physics Department home page: [www.physics.cas2.lehigh.edu](http://www.physics.cas2.lehigh.edu)

It is the policy of Lehigh University to provide equal opportunity on the basis of merit and without discrimination because of race, color, religion, sex, age, national origin, handicap, or veteran status.

Revised Fall 2018

# Graduate Study and Research in Physics



## CURRENT RESEARCH ACTIVITIES

- **Astronomy and Astrophysics.** Current research involves theoretical and observational studies of stars and planets. Particular areas of interest in stellar astrophysics are young open clusters, binary stars, X-ray binaries, the formation of disks in Be stars, and stellar pulsations. Research on planets involves the discovery and characterization of exoplanets orbiting bright stars and the search for extraterrestrial life.
- **Atomic, Molecular, and Optical Physics.** Current research investigates the physics of quantum many-body systems through studies of ultracold atomic gases. Topics include superfluidity, spin and heat transport, and thermodynamics of strongly-interacting Fermi gases. Experiments employ laser cooling and optical trapping to produce quantum degenerate atomic gases, and tailored optical potentials, radiofrequency spectroscopy and other techniques to perform measurements. Research also includes thermalization and condensation of photons in dye media confined within a narrow optical cavity.
- **Biophysics.** Researchers in the physics department employ experimental as well as mathematical and computational modeling to study the organization and dynamics of biological systems. They are involved in interdisciplinary collaborations with researchers in biology, bioengineering and related fields. Areas of research involve experimental and theoretical studies of mechanical properties of cells and biomaterials using techniques such as optical tweezers and optical microscopy; modeling studies of cell division, cell motion, polarized growth, and mating; physics of cytoskeletal self-organization; and experimental study of lipid membranes using microfluidics and confocal microscopy.
- **Computational Physics.** Many of the fields of physics research at Lehigh involve the use of state-of-the-art computers to address large-scale computational problems. Researchers in the physics department employ computational approaches to model complex many-body systems in condensed matter, biological, and quantum systems; the detection of variable signals in large astronomical surveys; coarse-grained models of biological systems with molecular dynamics, statistical, and continuum methods. The computational research is performed at both high performance computing facilities on campus and in national facilities.
- **Condensed Matter Physics.** Areas of interest include the optical and electronic properties of defects in semiconductors and insulators; collective dynamics of disordered solids; structural phase transitions in ferroelectrics and superconducting crystals; organic molecular crystals; exciton dynamics, singlet-triplet conversion, and in general the physics of electronic and optoelectronic devices; the quantum physics of matter, fields, and their interactions at the nanoscale; surfaces, interfaces and heterostructures; emergent physics in low-dimensional materials; strongly correlated electronic systems, topological phases of matter, unconventional superconductivity, and classical and quantum phase transitions.

• **High Energy Nuclear Experimental Physics.** Current research involves the study of relativistic heavy-ion collisions at the Solenoidal Tracker at RHIC (STAR) and sPHENIX experiments at Brookhaven National labs. This field of research focuses on the study of matter under extreme conditions of temperature, density, and pressure, where the quarks and gluons that make up normal nuclear matter are no longer confined into hadrons. This deconfined matter is called the quark gluon plasma (QGP), and experiments use high-energy probes, such as particle jets and heavy flavor quarks, to determine how quarks and gluons lose energy in this medium.

• **High Energy Theory.** String theory, quantum field theory and cosmology. Areas of interest include the connection between gravitational theories and quantum field theories, holographic gauge/gravity dualities, the behavior of strongly correlated quantum phases of matter, and the evolution of the early universe.

• **Nonlinear Optics and Photonics.** Research topics include nonlinear light-matter interaction that enables the control of light with light, four-wave mixing, phase conjugation, and wavelength conversion. We develop materials for second- and third-order nonlinear optics in particular organic molecular assemblies, and in general study materials and effects for photonics and optoelectronics. Examples include single crystals in glass, photonic crystals, holey and other specialty fibers, waveguides, resonant Brillouin scattering, and ferroelectric domain patterning for quasi phase matching. There is also considerable work on applications of photonics to biological systems, near-field optics, and thermal radiation.

• **Plasma Physics.** Laboratory studies of collisional and collisionless phenomena in supercritical laser-produced plasmas. Laboratory simulation of supernova emissions in the mid-infrared by excitation of interstellar nano-crystallites by strong shock waves in a new cryogenic diaphragm-less shock tube facility.

• **Soft Condensed Matter and Complex Fluids.** Biopolymer networks, biomembranes, and colloidal suspensions are investigated using experimental techniques such as confocal microscopy, laser tweezers, electro-osmotic control, microfluidics, in combination with image analysis and computational modeling. Research areas include phase separation on cell membranes, microrheology of macromolecules and living cells, generalized sedimentation equilibrium of colloidal suspensions, active colloidal suspensions far from equilibrium, diffusion in complex and/or crowded environments, and formation and evolution of nanoscale complexes in solutions.

• **Statistical Physics.** Research includes equilibrium and non-equilibrium fluctuations in gases and liquids; genesis and dynamics of disorder in 2-D solids near percolation threshold; and modeling of transport in disordered metallic solids under thermal forcing.

## THE GRADUATE PROGRAM

Approximately 40 graduate students are enrolled in the Physics department, which has 18 faculty members. The department offers programs in physics leading to the M.S. and Ph.D. degrees. These

programs may be structured to prepare students for careers in industrial or academic research or in college or university teaching.

The master's degree program requires thirty credit hours, including a research project normally done during the summer after the first year. The Ph.D. degree program requires a minimum of 39 credit hours of course work, including a variety of specialized courses in consultation with their dissertation committee. The student normally takes Ph.D. qualifying examinations during the second year. A dissertation, based on original work, is required for the Ph.D.

## FINANCIAL AID

Entering physics graduate students are supported as half-time teaching assistants starting at \$28,764 (2018-19) one-year stipend) plus tuition remission. Students making satisfactory progress are normally supported through the attainment of the Ph.D. degree. Lehigh University offers health insurance to all full-time graduate students, and a subsidy that currently covers 50% of the annual premium.

## ACCOMMODATIONS

Graduate students at Lehigh live in a wide variety of accommodations. These range from apartments and rooms within walking distance of campus to country houses and modern garden apartments within a few miles. Living expenses are reasonable, especially if accommodations are shared. The university operates a 148-unit, five-building garden apartment complex for married and graduate students, with free bus service to the main campus provided every half hour.

## FACILITIES/RESOURCES

Research facilities are housed in the Sherman Fairchild Center for the Physical Sciences, containing Lewis Laboratory, the Sherman Fairchild Laboratory for Solid State Studies, and a large connecting research wing. Resources include a machine shop, electronics shop, and networked computer facilities.

Lehigh researchers in astrophysics are involved in a number of worldwide astrophysics surveys and collaborations, including the KELT exoplanet survey, the NASA K2 and TESS missions, LSST, and WFIRST. Lehigh researchers in experimental high energy nuclear physics participate in collaborations affiliated with the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab. These include the Solenoidal Tracker at RHIC (STAR) and the sPHENIX collaborations.

Instruments used for experimental studies include a wide variety of laser systems, spectrometers, and microscopes. Examples include femtosecond and picosecond pulsed and dye lasers, various spectrometers (Raman and Fourier-transform), a facility for luminescence microscopy, a cell culture facility, and a laser-tweezers system for studies of cells and complex fluids. The Fairchild Laboratory also houses a processing laboratory where advanced Si devices can be fabricated and studied.

Several physics professors are also members of interdisciplinary initiatives that offer a wide range of state-of-the-art facilities including a fiber drawing tower, waveguide and fiber characterization labs, and a new epitaxy facility for the growth of