Graduate Studies in Physics

@ Temple University

exploring nature at the frontier of science
General Info

Temple University is located in Philadelphia, PA. Temple University’s 17 schools and colleges, nine campuses, hundreds of degree programs and more than 37,000 students combine to create one of the most comprehensive and diverse learning environments in the USA.

About the Physics Department

The Physics Department was recently relocated to a new $150-million facility, the Science Education and Research Center (SERC) building. The primary research areas in the department involve condensed matter physics, nuclear and particle physics, and atomic, molecular and optical physics.

Message from the Dept. chair

Thank you for your interest in the Physics Graduate Program at Temple University. Our faculty conduct world class research in Applied Physics, Atomic & Molecular Physics, Condensed Matter Physics, and Nuclear Physics, with a strong component of high performance computing. I look forward to meeting you and telling you more about the exciting opportunities we offer.
The Science Education and Research Center, home of the Physics Department, is one of the largest buildings devoted exclusively to scientific research in the Philadelphia region. The seven-story structure includes research and teaching labs, open spaces to foster collaboration, and high-tech equipment such as clean rooms and a low-vibration scanning tunneling microscope facility.

With 247,000 square feet for research, learning and teaching, home to 7 Research Centers and Institutes, 52 research labs and 16 teaching labs, SERC offers the ideal environment for our research efforts in the fields of AMO, condensed matter, and nuclear physics, as well as for collaborative and interdisciplinary research. Here, leading-edge researchers, state of the art facilities and high caliber scholars come together to unravel nature’s greatest puzzles and to pioneer discoveries that will advance our knowledge of the cosmos and will have a profound impact on society.
Physics Research at Temple University

Condensed Matter

Experimental Faculty
- Alexander Gray
- Maria Iavarone
- Rongjia Tao
- Darius Torchinsky
- Xiaoxing Xi

Theoretical Faculty
- John Perdew
- Peter Riseborough
- Adrienn Ruzsinszky
- Xifan Wu
- Qimin Yan

Electronic Correlations
High Tc superconductivity
Topological Materials
Fluids
Solid-State Theory
Density Functional Theory
Time dependent density functional theory/Green’s function methods
Molecular dynamics
First-principles computational physics
Computational Materials Science
Electronic and photonic thin films
X-ray spectroscopy and imaging
Ultrafast phenomena and nonlinear Optics
Scanning probe microscopy
Hard x-ray photoelectron spectroscopy

Nuclear Physics

Experimental Faculty
- Jeff Martoff
- Jim Napolitano
- Nikos Sparveris
- Bernd Surrow

Theoretical Faculty
- Martha Constantinou
- Andreas Metz

Nucleon structure
Nuclear few-body systems
Hadron spectroscopy and structure
Electroweak interactions
Neutrinos
Fundamental symmetries
High-energy collider physics of strong interactions
Dark matter
Lattice gauge theories
Physics beyond the Standard Model

AMO Physics

Experimental Faculty
- A. Marjatta Lyyra

Molecular quantum optics:
Coherence and quantum interference effects
Atomic, Molecular and Optical Physics

Our department has a strong component of research Atomic, Molecular and Optical Physics including both experiment and theory. Professors A. Marjatta Lyyra and Ergin H. Ahmed are Co-Principal Investigators of the experimental AMO group. Other associated AMO experimental faculty includes Professors Tao, Torchinsky and Kotochigova. Professor Svetlana Kotochigova leads the AMO theory group. Other associated AMO theory faculty includes Profs. Romanov and Tao.

AMO Experiment

Our group uses coherence effects in the interaction of light with matter as a quantum state control mechanism with multiple resonance high resolution spectroscopic excitation. The emerging area of quantum magnetism with magnetic molecules such as the Erbium dimer will involve applying our high-resolution spectroscopic capabilities to study the electronic structure of these molecules in preparation for applications involving optical lattices. Our research funding by the National Science Foundation also supports undergraduate research shown below. Professor Lyyra also contributed to the National Academy of Science Decadal Review of AMO Physics (https://www.nationalacademies.org/our-work/decadal-assessment-and-outlook-report-on-atomic-molecular-and-optical-science)

AMO Theory

The research focus of of Dr. Kotochigova includes Ultracold Chemical Reactions, Controlling Polar Molecules, Atom-Ion Charge-Exchange Reactions and Magnetic Lanthanides such as the Erbium dimer, which shares with the AMO Experimental Group in the department.
Experimental Condensed Matter Physics Research

Research at Temple University encompasses both hard and soft condensed matter. Our interests are focused on: understanding the mechanisms of emergent behavior in strongly correlated systems and the low-energy ordered states of quantum materials through low temperature Scanning Tunneling Microscopy and Spectroscopy; nonlinear optical and ultrafast time-resolved spectroscopy; development of new advanced x-ray spectroscopic and scattering techniques for studying electronic properties of quantum materials; and thin film growth of quantum materials through atomic layer-by-layer laser molecular-beam epitaxy and chemical vapor deposition. Study of soft matter is focused on the manipulation of the viscoelastic behavior of complex fluids through novel application of electro- and magnetorheometry.

Theoretical and Computational Condensed Matter Physics Research

The focus of theoretical/computational research is to develop theories and computational tools to understand the collective phenomena in solid state compounds and liquids. We develop density functionals that are rooted in physical principles and that can recognize and assign appropriate descriptions to covalent, metallic, and weak bonds. We apply density functional theory and beyond in the field of computational condensed matter physics and computational materials science, with the aim to discover and design novel materials with exotic properties and understand their dynamical behaviors using molecular dynamics studies. We are also interested in other quantum materials and phenomena including superconductivity, quantum transitions, etc. Machine learning appears as an important component in our research; in understanding water networks, structure-property relations of crystals, and optical response of low-dimensional materials.
Experimental Nuclear Physics Research

Fundamental symmetries, neutrino interactions, and elementary particles. Current research projects include the measurement of neutrino oscillations at the Daya Bay Nuclear Power Plant, a search for sterile neutrinos at the High Flux Isotope Reactor at Oak Ridge National Laboratory, and precision electroweak scattering experiments.

Study of the nucleon structure and of the few-body nuclear systems at the Thomas Jefferson National Accelerator Facility (Jefferson Lab), at the MAMI Microtron in Germany, and at PSI in Switzerland. Current research projects focus on the spin structure of the nucleon, on the nucleon mass budget, on the nucleon properties in the nuclear medium, on the Generalized Polarizabilities of the proton, the study of the excitation mechanism of the nucleon, and the proton radius puzzle.

Temple University is leading a program at the Brookhaven National Laboratory on gluon polarization measurements and a program studying the production of W bosons to deepen our understanding of the QCD sea.

Particle astrophysics, including dark matter searches like the DarkSide-50 liquid argon time projection chamber which is taking data at the underground laboratory LNGS in Italy, searches for dark-matter like particles with the DarkLight experiment, and x-ray polarimetry with gas-based tracking detectors to explore strong-gravity objects in space.

Theoretical Nuclear Physics Research

We address conceptual and phenomenological questions in the field of hadron structure. Topics include the spin structure of the nucleon, the universality and factorization of parton densities, and 3-D imaging of hadrons. The work is closely related to current and future experiments at high-energy particle accelerators.

Large scale simulations of Lattice QCD to study the strong interactions that bind quarks and gluons together to form the nucleons, the fundamental constituents of the visible matter. Open questions related to hadron structure are being addressed with numerical simulations performed on the biggest supercomputers.