



The Graduate Program and Research in Physics at
Wake Forest University, Winston-Salem (NC), USA

Program Director: Fred Salsbury

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Our department conducts research in computational and experimental biophysics, computational and experimental condensed matter physics and material science, and gravitational and particle physics.

Quantum Information Sciences

Multiple faculty members are performing research in quantum materials (**Winter** and **Carroll**), quantum optics (**Kandada**) and quantum computing (**Carroll**), or supporting such research (**Bonin**, **Jureschu**, **Thonhauser**). The physics graduate department is planning on starting formal graduate programs in this area for both PhD and MS students.

Computational Condensed Matter

Natalie Holzwarth's group concentrates on the development and use of computational tools to model the fundamental and technological properties of materials. Realistic simulation and modeling tools are essential for understanding the basic properties of materials and for designing materials for technology. The research addresses the need for the development of algorithms and codes for modeling complex materials; recently focused on modeling solid electrolyte materials for solid state battery technology.

Timo Thonhauser's group conducts research in theoretical and computational condensed-matter physics and materials science with a focus on the development of ab-initio electronic-structure methods and their application to bio-, nano-, and energy-related materials. These theoretical studies go hand-in-hand with experimental research and provide the necessary framework to understand the behavior and characteristics of materials.

Steve Winter's group concentrate on theoretical condensed matter physics in the area of quantum materials. These are systems where macroscopic quantum effects manifest in the material properties, with prominent examples including quantum magnets, superconductors, and topological insulators. We use a variety of theoretical approaches to try to model experiments on real materials, as well as classify and predict new quantum phases.

Experimental Condensed Matter

David Carroll's group explores the fundamental roles that dimension, topology, and symmetry play in the emergent properties of low dimensional condensed matter systems and so called "quantum materials." Additionally, recently, quantum computing research has focused on the development of massively parallel and neuromorphic architectures in Q-registers based on topologically stabilized Qbits.

Oana Jurchescu's laboratory focuses on the study of charge transport in organic and halide perovskite electronic materials. They study single crystals of small molecule organic semiconductors to elucidate their intrinsic properties, establish the potential and limit of their use, and provide feedback for material and device design. A significant component of their effort is aimed at understanding the fundamental aspects of charge transport in these materials and how processing impacts the quality of various interfaces in devices.

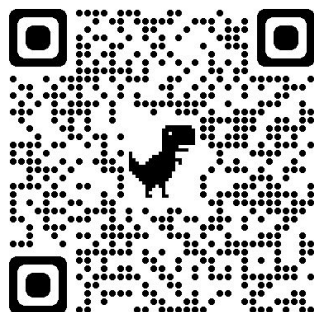
Ajay Ram Srimath Kandada's group investigates the chemical and physical factors that govern these dynamics in a wide class of materials through advanced optical spectroscopic techniques. Their experimental toolbox is composed of sources of ultrashort optical pulses and quantum-entangled photons in the visible and near-infrared spectral regions and spectroscopic systems to measure optical coherences in materials. The group's primary interest lies in the coherent dynamics and control of excitons in two-dimensional materials.

Gravitational and Particle Physics

Eric Carlson's research covers a variety of topics including both particle phenomenology and astrophysics. These topics include pseudoscalar couplings, the existence of a naturally small cosmological constant, and neutrino physics. Carlson believes astroparticle physics to be one of the most promising areas in particle phenomenology in the next decade or two.

Greg Cook's research interests are in the areas of computational astrophysics and gravitational physics. Currently, his research is centered on studying the coalescence of compact binary systems. Cook and his collaborators are currently developing the theoretical and computational tools needed to simulate the collision of a pair of black holes to study the ultimate coalescence of a compact binary system.

Check out our research in more detail with this QR code!





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Computational Biophysics

Machine learning: there is a strong interest in applications of machine learning in computational biophysics at WFU.

Sam Cho's interdisciplinary research group interests encompass biophysics and computer science. They are interested in the theoretical and computational studies and methods development of biomolecular coarse grained and atomistic molecular dynamics (MD) simulations in collaboration with experimental groups.

Fred Salsbury's research aims to help in the fight against disease by applying tools from computational physics to molecular-scale problems. Current projects focus on: 1) MD simulations with GPUs 2) drug discovery for chemotherapeutic development 3) development and application of new statistical methods 4) application of machine learning to macromolecular dynamics and drug development. 5) studies of dynamic allostery computationally

PhD student support as of AY 2023-24 includes: \$29,000 annual stipend, WFU Health Insurance, 100% tuition and mandatory fee waiver.

MS Student support includes a partial (74% as of AY 2023-24) tuition waiver. They may receive stipend support as an RA, depending on advisor.
Application deadline: 01/08/23

Check out our graduate program information, FAQs and application links with this QR Code!



Experimental Biophysics

Daniel Kim-Shapiro leads a laboratory that uses a variety of biophysical and biological techniques to understand blood flow. The lab studies how the important signaling molecule nitric oxide is compromised in various disease states, stored blood, and various cardiovascular disorders and ways to restore nitric oxide in these conditions. The work focuses on basic mechanistic science but also involves translation to the clinic including several clinical trials.

Martin Guthold's lab's research interests are in the general areas of biophysics, molecular biology, nanotechnology, microscopy techniques, – especially atomic force microscopy (AFM) and fluorescence microscopy, and next generation sequencing. Current projects include, among others, studies of mechanical and structural properties of fibrin fibers and blood clots and physical properties of cancer cells and normal cells

Keith Bonin's highly collaborative research has been focused on optics and biophysics with other professors within the Physics Department and the Wake Forest School of Medicine (WFSOM). Currently research includes, among others: studying mechanical properties of cells in 2D, optogenetics studies of the mesolimbic system in the brain, and studies on the motion of double-strand breaks in DNA in cancer cell nuclei.

Jed Macosko's group's long-term goal is the identification of precise mechanical-chemical couplings in molecular machines and the characterization of the overall pathways of their physical motion. They use a varieties of microscopies such as atomic force microscopy (AFM), single molecule fluorescence microscopy and video-enhanced differential interference contrast light microscopy (VE-DIC).

Affiliated Faculty

Affiliate physics faculty members, **Daniel Bourland** and **Michael T. Munley** from Radiation Oncology carry out research in the physics of medicine at Wake Forest School of Medicine. They mentor both Physics PhD students and Medical Physics PhD students.

Affiliate physics faculty members, **Lauren Lowman** and **Erin Henslee** from the department of Engineering carry out research in environmental engineering and cellular electrophysiology, respectively and can mentor Physics PhD students.