



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.

### New Faculty Alert!

Starting in Fall 2025, we will have two new faculty members: **Alejandro Cárdenas-Avendaño's** research concentrates on gravitational physics, high-energy phenomena associated with compact objects, and the dynamics of nonlinear system. **Emilie Huffman's** group simulates systems of many strongly interacting particles that can only be understood non-perturbatively.

More information can be found in their respective sections in gravitational physics and computational condensed matter Physics..

### Quantum Information Sciences

Multiple faculty members are performing research in quantum materials (**Hoffman, Winter** and **Carroll**), quantum optics (**Kandada**) and quantum computing (**Carroll**), or supporting such research (**Jureschu, Thonhauser**).

### Computational Condensed Matter Physics

**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.

**Emilie Huffman's** group simulates systems of many strongly interacting particles that can only be understood non-perturbatively. These systems consist of fermions (and sometimes quantum spins) on spatial lattices (or some other discretization) that are relevant to quantum materials, particle field theories, or nuclear theories. The group studies these systems with both classical hardware via quantum monte carlo methods, as well as recently developed quantum hardware platforms.

### Experimental Condensed Matter Physics

**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 Physics

**Alejandro Cárdenas-Avendaño's** research concentrates on gravitational physics, high-energy phenomena associated with compact objects, and the dynamics of nonlinear system. He uses both analytic and computational methods to investigate black holes and neutron stars, analyzing their electromagnetic and gravitational signatures to challenge the boundaries of general relativity. Present projects involve creating high-resolution imaging methods for black holes and studying the intricate dynamics of extreme mass-ratio inspirals for future gravitational wave detection with LISA

**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.



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## Computational Biophysics

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

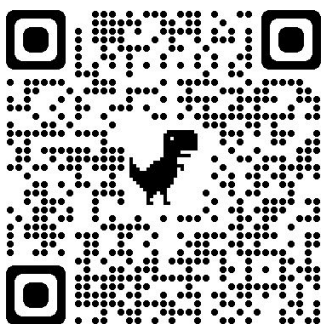
**Sam Cho's** interdisciplinary research group interests encompass biophysics and computer science. They are interested in the theoretical and computational studies and methods development of biomolecular coarse grained and atomistic molecular dynamics (MD) simulations in collaboration with experimental 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 2024-25 includes: \$29,725 annual stipend, WFU Health Insurance, 100% tuition and mandatory fee scholarships.

MS Student support includes a partial (75% as of AY 2024-25) tuition scholarship. They may receive stipend support as an RA or TA; not guaranteed.  
Application deadlines: 01/08/25

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

**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.

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

