The Graduate Program and Research in Physics at
Wake Forest University, Winston-Salem (NC), USA
Program Director: Fred Salsbury
email: salsbufr@wfu.edu

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

Computational Biophysics

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: MD simulations with GPUs 2) drug discovery for chemotherapeutic devlopment 3) development and application of new statistical methods 4) application of machine learning to macromolecular dynamics and drug development.

Gravitational and Particle Physics

Paul Anderson and his students apply quantum field theory to the study of black holes and cosmology. The presence of a strong gravitational field results in some interesting and unusual phenomena. A semiclassical approximation to quantum gravity is often used to compute such effects..Anderson is currently interested in the validity of this approximation.

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.

Experimental Biophysics

Daniel Kim-Shapiro leads a laboratory that uses a variety of biophysical and biological techniques to understand blood flow. using a variety of spectroscopies and computational methods, The lab studies how the important signaling molecule nitric oxide is compromised in various disease states, stored bood, and various cardiovascular disorders.

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).

George Holzwarth collaborates closely with Keith Bonin and Jed Macosko and Independently, uses variational Bayes probability methods to analyze the cause of start-stop movement of endogenous particles, such as peroxisomes, in live cells.

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

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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.

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