Graduate Studies in Physics

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We hope this publication helps you find what you need to know about our graduate program in physics and what you can expect to find at Washington University and in St. Louis. If you want more information or to arrange a visit, please contact us at:

gradinfo@physics.wustl.edu

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Research Groups

**Astrophysics & Space Sciences**
6 Extraterrestrial Materials
6 Astroparticles, Cosmology, & Gravitation
7 High Energy Astrophysics
7 Dark Matter
7 Gamma-Ray Astronomy
8 X-Ray Astronomy
8 Cosmic-Ray Astrophysics
9 Theoretical Astrophysics
9 McDonnell Center for the Space Sciences

**Condensed Matter & Materials Physics**
12 Two-Dimensional Materials
13 Quantum Information Science
13 Nucleation & Structure of Liquids & Glasses
14 Condensed Matter Theory
14 Institute for Materials Science & Engineering

**Nuclear & Particle Physics**
15 Theoretical Nuclear & Particle Physics
16 Nuclear Theory
16 Experimental Nuclear Physics

**Biological & Biomedical Physics**
10 Neurophysics
10 Theoretical Physics of Ecology & Evolution
11 Systems Cell Biology
11 Biological Physics of Cells

**Faculty**
17 Faculty

For information about student life
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For general information about St. Louis
stlouis-mo.gov

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physics.wustl.edu
GRADUATE ADMISSIONS

ADMISSION REQUIREMENTS

For admission to our graduate program, a Bachelors degree is required with no minimum undergraduate GPA specified. The three standard GRE examinations are required. The Physics (subject) exam is recommended. Students from non-English speaking countries are required to demonstrate proficiency in English via the TOEFL. The minimum acceptable score is 550 (equivalently 213 or 79).

Admission deadline: December 15

GRADUATE APPLICATION FEE

$45

ADDRESS ADMISSION INQUIRIES TO

Graduate Admissions
Washington University
Department of Physics
Campus Box 1105
One Brookings Drive
St. Louis, MO 63130-4899
USA

gradinfo@physics.wustl.edu

DEGREE REQUIREMENTS

DOCTORATE

Complete 36 units of academic courses, maintaining an average grade of B (GPA 3.0). Once the academic credit is completed, a student may take additional lecture courses up to a total of 72 units. Courses that count towards academic credit are any regular 400- or 500-level lecture courses in the physics department, approved courses outside the physics department, reading courses, and mentored research. Once the academic credit is completed, the remaining units up to a total of 72 can include more lecture courses, but are typically research. Students are required to pass the Ph.D. qualification procedure before formally joining a research group, and this normally occurs before the start of the third year. There is also degree-required teaching. Submission of an original research dissertation and an oral examination in defense of the dissertation are required.

A comprehensive Graduate Student Handbook, which discusses requirements and resources in detail is available online at physics.wustl.edu/graduate/about-the-program/handbook. For more information, contact the Graduate Student Secretary by calling 314-935-6250 or emailing gradinfo@physics.wustl.edu.

MASTER’S

36 semester hours of course credits, of which at least 30 semester hours must be in classroom or seminar courses at the 400 level or higher. Classroom and seminar courses include reading courses and mentored research. The latter can be used for a maximum of 6 units of credit. The student must maintain an overall grade average of B (GPA 3.0) or better. Among the student’s courses there must be at least 12 semester-hours of the “core” courses required for Ph.D. qualification.
FINANCIAL AID

Students who are admitted to graduate study for the Ph.D. in Physics at Washington University generally receive a complete financial support package including a tuition scholarship that pays full tuition, together with a stipend. Such financial support is guaranteed by the department for the first five years for students who are making satisfactory progress towards the Ph.D. degree. Graduate study in Physics generally does not require additional student loans, working part-time, or any other outside means of support.

In addition, students who have been admitted to the graduate program have the opportunity to engage in research in the summer prior to their first academic year and/or during subsequent summers. In addition to the convenience of not having to seek other employment during the summer months, employment in summer research has several advantages, such as finding areas of physics that are of special personal interest, making significant progress towards completion of the Ph.D., and having the opportunity to perform research that results in scientific publications. Students who have been admitted to the graduate program in physics should inquire about research opportunities by contacting the head of the particular research group in which they are interested.

For more information about financial support and fellowships, visit physics.wustl.edu/graduate/about-the-program/financial-support

To apply, go to www.applyweb.com/wustl/index.ftl or physics.wustl.edu/graduate/how-to-apply
The Department of Physics at Washington University in St. Louis aims to prepare its graduate students for a broad range of careers, from academia and teaching to high-tech and industry. During their first two years, students are financially supported while they develop a solid and broad base of physics knowledge through core graduate curriculum courses, along with upper-level courses in their areas of specific interest. In their third year, graduate students are frequently supported while they pursue their thesis research with their thesis supervisor. Learning and research take place in both formal and informal settings with a wide range of colleagues, including faculty members, postdoctoral fellows, research scientists, and graduate student peers.
Physicists at Washington University use experimental techniques of high-energy physics, observational techniques of astrophysics, and the laboratory study of extraterrestrial materials to address a variety of astrophysical problems. These include the origin of cosmic rays, energetic processes in galactic and extra-galactic objects, the synthesis of heavy elements in nature, the formation of dust around stars, and the history of the lunar surface and of meteorites.

EXPERIMENTAL ASTROPHYSICS AND SPACE SCIENCES

EXTRATERRESTRIAL MATERIALS

The Laboratory for Space Sciences (Professor Ryan Ogiore; Research Professors Sachiko Amari, Christine Floss, and Alex Meshik; and Senior Research Scientists Kevin Croat, and Olga Pravdivtseva) studies extraterrestrial materials, such as meteorites and interplanetary dust particles. This interdisciplinary research seeks to understand the formation of the solar system through chemists who measure isotope effects in meteorites, astronomers who observe interstellar dust, and theoretical physicists who model supernova explosions.

The Laboratory is a world leader in a special branch of astrophysics involving microanalytical studies of presolar grains from meteorites. Presolar grains are literally stardust, formed in the expanding atmospheres of Red Giant stars and in the ejecta from supernovae, and were incorporated in the cloud of interstellar gas and dust from which the solar system formed.

ASTROPARTICLE PHYSICS, COSMOLOGY, AND GRAVITATION

A broad spectrum of research problems in these fields are tackled through experiments and theoretical investigations in the group led by Professor Ramanath Cowsik. The goal is to understand the dynamics of large scale systems like galaxies, high energy phenomena like cosmic rays and those revealed through radio, x-ray and gamma ray astronomies, and probe the very nature of gravitation using highly sensitive instruments designed and fabricated in the laboratory. What is dark matter, how is it distributed across the Milky Way, how does it affect the dynamical motions of stars and interstellar gas and how can we actually detect the dark matter particles? How are cosmic rays accelerated to highly relativistic energies, what signals do they generate that may be detected on earth, are supernovae and supernova remnants the sources of cosmic rays? Einstein’s Equivalence Principle implies the universality of free fall; is this perfectly valid or is there a minuscule violation? Can we find such violations with sensitive instruments? These are some of the questions that are being investigated.
HIGH ENERGY ASTROPHYSICS

The Laboratory for High-Energy Astrophysics (LEXAS) is led by Professors James Buckley, Martin Israel, and Henric Krawczynski and Research Professors W. Robert Binns and Brian Rauch. Faculty and students in this group design and build instruments that are flown on spacecraft and high-altitude balloons or are used at ground-based observatories to study X-rays, gamma rays, cosmic-ray nuclei and electrons, and neutrinos. Students gain experience designing, building, and working with state-of-the-art electronic detector systems and using high-performance computing platforms and novel algorithms for scientific analysis of large data sets. The group also conducts theoretical studies of astrophysical and particle processes used in the interpretation of the experimental results.

DARK MATTER

Buckley’s research group is part of the LUX-ZEPLIN (LZ) dark matter collaboration which uses direct detection experiment, one of three experiments selected by the U.S. Department of Energy as part of the next-generation (G2) dark matter portfolio. The LZ collaboration consists of 128 scientists and engineers from the US, UK, Portugal and Russia. The LZ detector will consist of 7 tons of liquid Xenon to detect faint interactions between dark matter particles and ordinary matter. With involvement in both indirect detection experiments (VERITAS and CTA), direct detection (LZ) as well as dark matter theory (Cowsik and Ferrer), Washington University has a vital research group that has made important contributions to Dark Matter studies ranging from the first predictions of weakly interacting Dark Matter (Cowsik) to important early calculations of dark matter signals in gamma rays from the Galactic Center and Dwarf Galaxies (Buckley and Ferrer).

GAMMA-RAY ASTRONOMY

Gamma-ray astronomy gives direct information about the most energetic objects in the universe. Buckley, in collaboration with scientists from the Harvard Smithsonian Center for Astrophysics and other institutions in the US, UK, and Ireland, observes the gamma-ray sky at energies near a trillion electron volts with VERITAS, an array of Cherenkov telescopes on Mount Hopkins in Arizona. VERITAS is presently the most sensitive gamma-ray telescope worldwide in the Very High Energy (VHE) regime. Buckley uses VERITAS to search for gamma rays from dark matter annihilations. Buckley is also part of the international CTA consortium, currently constructing a new generation of ground-based gamma-ray experiments using square-kilometer arrays of atmospheric Cherenkov telescopes. Other research areas include studies of the gamma-ray emission from highly relativistic outflows being generated close to black holes and studies of particle acceleration by the relativistically expanding remnants of exploded stars.

Buckley also works on the development of novel photodetectors based on InGaN/AlGaN heterostructures grown in the laboratory by molecular-beam epitaxy. This work is currently being extended to the development of low radioactive background detectors for cryogenic dark matter experiments.
Krawczynski is the Principal Investigator of the X-Calibur experiment, a balloon-borne telescope measuring the polarization of hard X-rays from mass accreting black holes, neutron stars, and pulsars. The mission flew for the first time in September 2016 from Fort Sumner, NM, and is scheduled for a longer 30-50 day flight from the Antarctic. The experiment is expected to deliver new insights about how black holes grow. The measurements of the polarization of X-rays from X-ray pulsars can verify strong-field Quantum Electrodynamics predictions. The group has been developing ray tracing simulations to study the observable X-ray polarization signatures.

Krawczynski’s group is using the Chandra X-ray satellite to observe gravitationally lensed quasars. The data can be used to measure the spin of the central black hole, and to constrain the stellar and dark matter mass fractions of the lensing galaxies.

Cosmic-ray Astrophysics

Professors Binns, Israel and Rauch study the origin of cosmic rays and astrophysical neutrinos with instruments on spacecraft and high-altitude balloons. Their research is carried out in collaboration with scientists at institutions including Caltech, NASA/Goddard Space Flight Center, and University of Hawaii. Students gain experience designing, building, and working with state-of-the-art electronic detector systems and using computer systems for controlling instrumentation and for analyzing large quantities of data aimed at understanding the origin of cosmic rays.
Professor Katz is developing theories of Fast Radio Bursts, recently discovered enigmatic phenomena. As short as a millisecond, they are the fastest phenomenon in astronomy other than pulsar pulses. Yet they are powerful enough to be seen at "cosmological" distances of a billion parsecs (about three billion light years). Leading theories are that they are super-pulses from very fast, young and strongly magnetized pulsars, or that they are the result of narrowly beamed radiation from accretion onto black holes. He is also working on a phenomenon much closer to home: the hypothesis that the dips of the luminosity of the famous Boyajian’s star, discovered in the Kepler satellite’s search for exoplanets, are the result of occultation by dust rings in the outer Solar System.

Graduate students Maneesh Jeyakumar and Dawson Huth are seen working on the torsion balance at Tyson Research Center, Washington University. The inset below shows the cross shaped bob of the balance, which is suspended by an almost invisible 1.6 m long tungsten fiber inside the ultra high vacuum chamber, and viewed by an autocollimator of nano-radian resolution. This apparatus is built to test Einstein’s Principle of Equivalence.
APPLICATIONS TO BIOLOGY AND MEDICINE

Experimental research groups work at the interface between physics and biology or medicine. These programs may involve active collaboration with research and clinical faculty at the renowned Washington University School of Medicine.

NEUROPHYSICS

The brain is the most complex system we know. It is the result of an evolutionary process and consists of billions of interconnected neurons. Connectivity between neurons is neither random nor regular. Most neurons produce sequences of pulses, by which signals between the neurons are exchanged. The signal exchange is delayed. Neurons perform nonlinear transformations on the incoming pulse trains. Noise enters at every step.

The signal flow in the brain is not just feedforward. Rather, feedback dominates most pathways. Professor Wessel's group studies signal processing with neural feedback loops using the vertebrate isthmotectal loop as a model system. The isthmotectal loop is present in most vertebrates, has been anatomically characterized in bird, frog, and turtle, and is experimentally accessible in these species both in vivo and in vitro. Dr. Wessel's group and his collaborators use electrophysiological, anatomical, and computational methods to study the mechanisms and functional roles of the isthmotectal loops in visual processing. The combined in vivo, in vitro, computational, and comparative investigation of isthmotectal feedback promises to uncover general principles of active signal processing with neural feedback loops.

THEORETICAL PHYSICS OF ECOLOGY AND EVOLUTION

The health of our planet, and our own, is shaped by complex microbial communities. Recent advances in sequencing technology gave us unprecedented experimental access to these ecosystems. What we found is a strange new context where many familiar terms are starting to fail us, including “fitness”, "species", and perhaps even “organism”.

Competition between communities with different members, or genetic recombination between individuals with different genes?

What if our macroscopic intuition about ecology and evolution is simply wrong at the scale of microbial life? Professor Tikhonov’s research group aims to address the exciting theoretical challenges raised by microbiome research, combining statistical physics, bioinformatics, and experimental collaborations at WashU Medical Campus and beyond. Other interests of the group include genetic regulatory networks, developmental biology and information theory.
**SYSTEMS CELL BIOLOGY**

Professor Mukherji’s group studies eukaryotic cellular organization. Arguably the grandest goal in cellular biophysics is the uncovering of design principles that govern all aspects of cellular function. Efforts in systems and synthetic cell biology have focused mainly on the design principles of gene expression and signaling systems. A quantitative understanding of eukaryotic cellular organization in space, however, would afford biophysicists and bioengineers with a powerful opportunity to predict how the physical architecture of the cell constrains and regulates fundamental life processes. To unleash this potential, it is imperative to understand one of the defining features of the eukaryotic cell: its organization into spatial compartments known as organelles. Coordinating organelle abundance and activity with developmental and environmental cues is one of the chief ways the cell can match its biochemical capabilities with its physiological demands. How does the cell orchestrate flows of matter and energy to produce exquisitely defined organelles at the nanometer and femtoliter scales of a cell? Can we engineer the decision-making processes in the cell to control organelle copy number, size, and composition in vivo and can this allow us to rationally alter cellular metabolism and signaling toward desired goals? Professor Mukherji’s group aims to use a combination of theory and experiment to uncover the design principles that control: how the cell regulates organelle biogenesis and how, in turn, organelles communicate with the rest of the cell to regulate cellular physiology.

**BIOLOGICAL PHYSICS OF CELLS**

Professor Carlsson’s work, in biophysical modeling, treats the molecular-scale processes that allow cells to move, change shape, and divide. These processes are driven by branched polymer networks, or parallel bundles, of the protein actin. The dynamics of these actin structures are modeled by a combination of Brownian dynamics, stochastic growth simulation, and analytic theory. We are currently focused on how polymerization of actin drives the process of endocytosis, in which cells absorb molecules and materials from outside the cell. Actin nucleates from a spontaneously formed target pattern of proteins in the cell membrane to form a three-dimensional patch. We seek to understand how this patch exerts the membrane-bending forces required to drive endocytosis, and the nonlinear-feedback mechanisms that drive the protein dynamics.
EXPERIMENTAL CONDENSED MATTER & MATERIALS PHYSICS

Experimental work in progress includes a wide variety of projects in condensed matter physics, chemical physics, low dimensional physics, quantum physics, materials physics, biophysics, and medical physics. Many projects in materials science are in collaboration with faculty in the departments of Chemistry, Biology, and Earth & Planetary Sciences, as well as in the schools of Engineering & Applied Science and Medicine.

TWO-DIMENSIONAL MATERIALS

The explosive growth of research into graphene - a single layer of carbon atoms - since the mid-2000’s has directly led to the discoveries of numerous additional atomic crystals, the advent of study into Dirac materials having quasi-relativistic electronic structures, and the discovery of materials with topological character. Such topics and more are the focus of Professor Erik Henriksen’s laboratory, which utilizes ultra-low temperatures (less than 10 millikelvin) in combination with extremely strong magnetic fields (up to 14 Tesla) to explore the fundamental physics of the electronic system in devices built around these materials, with an eye toward uncovering novel electronic structures and properties. The emergent properties of correlated electrons in high quality low-dimensional systems are of particular interest. Many such phenomena center on peculiar manifestations of the quantum Hall effect that arise in relativistic settings, yet occur in atom-thin crystalline materials. State-of-the-art micro- and nano-fabrication facilities housed in the cross-disciplinary Institute for Materials Science and Engineering are employed to create the devices that are at the heart of these studies, and encompass thin film growth and deposition for metals and oxides, plasma-based etching, nanometer-scale lithographic techniques, and the creation of quasi-3D materials composed of stacked 2D crystals. Once realized, these unique devices are explored via measurement of their electronic transport properties, through exploring thermodynamic quantities such as the compressibility of the low-dimensional electron system, and via infrared optical transmission experiments.
CONDENSED MATTER SYSTEMS FOR QUANTUM INFORMATION SCIENCE

Condensed matter systems can be engineered to exhibit specific quantum properties that are necessary for the basic building blocks of a quantum computer. Using ultra-low-loss superconducting films and dielectrics, Professor Kater Murch’s group fabricates circuits that exhibit the same quantum properties as natural atoms but with an increased level of control and manipulability. Using these systems, Murch’s group is exploring fundamental questions in quantum measurement and the evolution of open quantum systems.

Several superconducting circuits, each exhibiting the properties of a single atom, can be coupled together to form a synthetic quantum material. Murch’s group is exploring how such systems, together with tools from quantum optics, can be used to create novel states of matter and to simulate the quantum evolution of other material systems.

NUCLEATION AND STRUCTURE OF LIQUIDS AND GLASSES

Professor Kelton is working to develop a better understanding of the principles governing phase formation and stability in condensed phases and the relations between phase transitions, physical properties and atomic structures of complex phases. Studies are focused on nucleation and growth processes in condensed phases, the relations between local atomic structure and the nucleation barrier, the coupling of phase transitions of different order, and the dynamical and structural processes in the liquid that hold clues to glass formation and the glass transition. A new kinetic theory for nucleation, developed in this group, has led to an improved understanding of nucleation processes where long-range diffusion is important, such as in solid-state precipitation. An experiment on the International Space Station made in collaboration with researchers from the European Space Agency is underway to check this model for describing crystal nucleation in a quiescent microgravity environment. Kelton is also working with scientists at Corning Inc. to develop a deeper understanding of crystallization in silicate glasses.

Kelton uses a wide range of experimental techniques to study the order in silicate glasses, and in metallic glasses and related transition metal alloy liquids. Like more common silicate glasses, metallic glasses are amorphous, containing no long-range translational order but significant short- and medium-range order. Kelton and his group have demonstrated that this order is typically very similar to

Electrostatic levitation is used in the WU-BESL to study the properties of liquid metals—without ever touching them.

Professor Kater Murch discusses his experimental setup
The condensed matter theory group consists of Professors Zohar Nussinov, Alexander Seidel, and Li Yang. They are attempting to understand how the collective properties of condensed matter systems, such as that of the so-called Quantum Hall systems, superconductivity, and various magnetic systems, emerge from the physics at the microscopic scale. Collaboration is carried out with the experimental groups in the department (in particular, with Professors Kenneth Kelton and Ralf Wessel).

One of the main thrusts is the study of “topological quantum order,” which appears in some of these systems. In particular, Nussinov and Seidel study quantum magnets and non-Abelian quantum Hall states, whose use has been suggested for topological quantum computing. Additional effort is spent by their groups on trying to understand defect dynamics and the behavior of glasses.

Another thrust is to study atomic structures and electronic structures of solids. Yang is working on computational simulations for capturing many-electron interactions and predicting their effects on electronic and optical properties for energy and device applications. Yang and Nussinov study networks of clusters in metallic glasses and liquids to understand complex dynamical properties.

CONденсED MATTER THEORY

that found in an icosahedral quasicrystal. Working in collaboration with researchers at NASA Marshall Space Flight Center and the Advanced Photon Source, his group developed a new technique for studying the structures of reactive metal alloys at temperatures up to 3000 K. In 2003, this led to the first proof of a 50-year-old hypothesis linking the liquid structure to the nucleation barrier. In 2008, Kelton’s group constructed an electrostatic levitation facility at Washington University, optimized for structural and thermophysical property studies of equilibrium and non-equilibrium liquids. Experimental studies made using this facility have provided new information about dynamics, crossover phenomena and possible liquid/liquid phase transitions, and their relation to structural changes in the liquid. Working in collaboration with Professors Nussinov and Li, they have discovered and explained a new universal scaling behavior of the viscosity of metallic liquids. Kelton recently led a collaboration with researchers from Iowa State University, the University of Tennessee and Oak Ridge National Laboratory to design and build the first electrostatic levitation facility for use at the Spallation Neutron Source, the most intense pulsed neutron source on Earth. With this facility, elastic neutron scattering measurements have produced some of the first studies of chemical ordering in supercooled liquids. Inelastic scattering studies have enabled studies of the microscopic processes that lead to liquid dynamical behavior and reveal the nature of the universal scaling of the viscosity.

RESEARCH CENTER

Institute for Materials Science and Engineering (IMSE)

The Institute for Materials Science and Engineering officially opened on July 1, 2013. It serves as a central hub for materials research at Washington University. The IMSE is a PhD granting institute that sits primarily in the Schools of Arts & Sciences and Engineering and Applied Science. It maintains a world-class sample preparation and characterization equipment center that is located in the basement of nearby Rudolph Hall. IMSE membership consists of over 30 faculty, and many graduate and undergraduate students from ten participating departments, two in the School of Medicine.

See http://imse.wustl.edu for additional information.
Professor Mark Alford's research is centered in nuclear astrophysics, and draws on ideas from widely disparate areas such as particle physics, nuclear physics, astronomy, and condensed-matter physics. Alford works on the properties of ultra-dense matter, which is formed in neutron stars where gravitational forces squeeze matter until the atoms collapse. What is left is a liquid of neutrons and protons. At the center of a neutron star these may in turn be crushed until they fall apart into quarks. Professor Alford is interested in the phenomenon of “color superconductivity,” where quarks pair up and form a state analogous to that formed by electrons in superconducting metals. He is also working on what happens in neutron stars when they collide. These rare but explosive events provide an opportunity to observe nuclear matter in a state of violent turmoil.

Professor Francesc Ferrer works in astroparticle physics and theoretical cosmology. He studies the composition and evolution of the universe and the implications for cosmology of models beyond the Standard Model of particle physics. He focuses on the detection of weakly interacting dark matter, and on its distribution around the super-massive black hole at the center of the Milky Way. He also studies the origin of cosmic magnetic fields, which could be linked to events in the early stages of the evolution of the universe, such as the epoch of baryogenesis, when the observed excess of matter over antimatter was generated.

Professor Michael Ogilvie works on a wide range of topics in quantum field theory and statistical mechanics, with an emphasis on the properties of quarks and gluons. His areas of expertise include quantum chromodynamics (QCD) at finite temperature and density, phase transitions, lattice gauge theory, quark confinement and chiral symmetry breaking.

Phase diagram of a model of quarks in the chemical potential-temperature plane. The critical line marks the boundary between nuclear matter and quark matter. The shaded region is where oscillations occur in the densities of different colors of quarks.
Illustration of the probability to add an s-wave nucleon to the $^{40}$Ca nucleus as a function of the distance to its center and as a function of energy. If only the Pauli principle would act this plot would be zero as that contribution has already been subtracted.

A consistent picture of physics beyond the Standard Model to explain all experimental hints (neutrino oscillation, dark matter, baryon asymmetry) and theoretical issues (e.g. electroweak symmetry breaking, flavor puzzle, grand unification) could lead to observable effects in both high and low-energy experiments.

**NUCLEAR THEORY**

Professor Willem Dickhoff’s group studies the properties of nucleons in nuclei and neutron stars, using state-of-the-art calculational techniques such as the method of self-consistent Green’s functions. Special attention is devoted to superfluid properties of neutrons critical for our understanding of the cooling of neutron stars. The group uses data from Jefferson Lab in Virginia to test their predictions for the behavior of nuclei, and has implemented a framework to predict and interpret the results from experiments at centers like the facility for rare isotope beams (FRIB) at Michigan State University. Professor Dickhoff’s group has close ties with the experimental nuclear physics program of Professors Sobotka and Charity.

**EXPERIMENTAL NUCLEAR PHYSICS**

Experimental work in nuclear physics is concentrated in two groups, one led by Professor Lee Sobotka and Research Professor Robert Charity and the other by Professor Demetrios Sarantites and Research Senior Scientist Walter Reviol. These programs are in the Department of Chemistry. The work of these groups involve heavy-ion reaction mechanisms from near barrier to relativistic energies, the continuum structure of light nuclei with exotic n/p ratios (some of which have astrophysical relevance), the structure of the heaviest nuclei, in-medium nucleon-nucleon correlations, and the nuclear equation of state.

Experiments addressing these topics are conducted at the National Superconducting Cyclotron Laboratory at Michigan State University, the ATLAS facility at the Argonne National Laboratory, the Cyclotron Institute at Texas A&M, the LANSCE facility at LANL and several international facilities. The Charity/Sobotka experimental effort is also engaged in the only university-based CMOS chip development program for low-to-moderate-energy nuclear physics. Professor Jonathan Katz has led the design of a detector system to distinguish between higher and lower energy neutrons emitted in long bursts for which conventional methods such as time of flight and individual neutron detection are inapplicable.
PROFESSORS

Alford, Mark G., PhD, Harvard, 1990. Chair of Department of Physics. Quantum field theory and particle physics; color superconductivity.

Buckley, James H., PhD, Chicago, 1994. High-energy astrophysics, gamma-ray astronomy; direct detection of dark matter.

Carlsson, Anders E., PhD, Harvard, 1981. Theoretical biophysics of cells; mechanobiology.


Dickhoff, Willem H., PhD, Free University of Amsterdam, 1981. Theoretical physics; many-particle theory, nuclear physics.

Israel, Martin H., PhD, Caltech, 1968. High-energy astrophysics, cosmic-ray and neutrino astronomy.


Krawczynski, Henric, PhD, Hamburg, 1997. High-energy astrophysics; gamma-ray astronomy, x-ray astronomy.

Ogilvie, Michael C., PhD, Brown, 1980. Quantum field theory and particle physics; theoretical physics; computational physics.

Sarantites, Demetrios, PhD, MIT, 1963. Nuclear physics. (Departments of Chemistry & Physics)

Sobotka, Lee G., PhD, California, Berkeley, 1982. Nuclear physics. (Department of Chemistry)


ASSOCIATE PROFESSORS

Ferrer, Francesc, PhD, Universitat Autònoma de Barcelona, 2001. Particle cosmology; the nature of dark matter and dark energy.


Yang, Li, PhD, Georgia Institute of Technology, 2006. Condensed matter and materials theory.

ASSISTANT PROFESSORS


Tikhonov, Mikhail, PhD, Princeton, 2014. Microbiome, microbial ecology and evolution.

RESEARCH PROFESSORS

Amari, Sachiko, PhD, Kobe University, 1986. Presolar grains, meteorites, noble gas and secondary ion mass spectrometry.


Charity, Robert, PhD, Australian National University, 1984. Nuclear physics. (Department of Chemistry)

Floss, Christine, PhD, Washington (St. Louis), 1991. Space physics; cosmochemistry.

Meshik, Alex P., PhD, Vernadsky Institute, Moscow, 1988. Space physics; rare-gas mass spectrometry.

RESEARCH ASSISTANT PROFESSORS

Bugaev, Viatcheslav, PhD, Altai Univ. (Russia), 2011. High-energy astrophysics, neutrino astronomy.

Kislat, Fabian, PhD, Humboldt (Berlin), 2011. X-ray and gamma-ray astronomy, tests of fundamental physical laws by high-energy astronomy.

Rauch, Brian, PhD, Washington (St. Louis), 2008. Cosmic ray composition and astroparticle observations.

SENIOR LECTURERS

Hynes, Mairin, PhD, Washington (St. Louis), 2010. Physics education.

LECTURERS


Errando, Manel, PhD, Universitat Autònoma de Barcelona, 2009. High energy astrophysics.