

School of Natural Sciences and Mathematics

Department of Physics

Objectives

The goal of the Graduate Program in Physics is to develop individual creativity and expertise in the fields of physics. In pursuit of this objective, study in the program is strongly focused on research. Students are encouraged to begin participating in ongoing research activities from the beginning of their graduate studies. The research experience culminates with the doctoral dissertation, the essential element of the PhD program that prepares students for careers in academia, government laboratories, or industry.

A Master of Science degree is offered to those seeking to acquire or maintain technical mastery of both fundamentals and current applications.

NOTE> Please be advised, the admissions section below feeds in from a separate page. Any changes made to the admissions section below will not be retained. Please contact catalog@utdallas.edu with any questions.

Admission Requirements

The University's general admission requirements are discussed on the [Graduate Admission](#) page.

The Graduate Physics Program seeks students who have a BS degree in Physics or closely related subjects from a university or college, and who have superior skills in quantitative and deductive analysis. Official scores from the GRE General Test (verbal and quantitative) and the GRE Subject Test in Physics are required. Decisions on admission are made on an individual basis. However, as a guide, a combined score on the verbal and quantitative parts of the GRE General Test of 308, with at least 155 on the quantitative part, is advisable based on past experience with student success in the program.

For graduate work it is assumed that the student has an undergraduate background that includes the following courses at the level indicated by texts referred to: mechanics at the level of Symon, Mechanics; electromagnetism at the level of Reitz and Milford, Foundations of Electromagnetic Theory; thermodynamics at the level of Kittel, Thermal Physics; quantum mechanics at the level of Griffiths, Introduction to Quantum Mechanics (chapters 1-4), some upper-division course(s) in modern physics, and atomic physics. Students who lack this foundation may be required to take one or more undergraduate courses to complete their preparation for graduate work.

Financial Support

A limited number of teaching assistantships (TAs) are awarded to those students displaying the most promise in teaching or research. Specific decisions regarding TA awards are made on an individual basis. Students who wish to be considered for financial support are encouraged to submit completed applications by February 1st for admission in the fall semester. Admission for the spring term is possible, but opportunities for financial support in such cases are extremely limited and not guaranteed. Teaching assistantship awardees are required to complete 12 graduate physics courses approved by the graduate advisor during the first 24 months in residence. Continuation of support is evaluated yearly and requires achievement of a minimum GPA of 3.0, and a satisfactory record in teaching or research assignments.

Financial support is preferentially provided to students in the PhD track.

Specializations

The central principle in the structure of the graduate program is that a student's progress and ultimate success is best served by early and varied research experiences coupled with individually tailored course sequences.

Current areas of research specialization in the physics program are: Atmospheric and Space Physics; Astrophysics/Cosmology/Relativity; Condensed Matter Physics/Materials Science; and High Energy Physics. Further details on the current research topics in these areas are provided below.

Astrophysics, Cosmology and Relativity

This research group studies fundamental problems in theoretical astrophysics, physical cosmology, and relativity. These research efforts typically involve analytical, numerical, and cosmological-data related projects. Current areas of research include: the acceleration of the expansion of the universe (cosmological constant, dark energy); dark matter; fitting cosmological models to observational data; gravitational lensing (lenses) and its applications to cosmology; cosmic microwave background; exact solutions to Einstein's equations; large-scale structure; space-time junction conditions and wormholes; cosmological models of wider generality than the classical homogeneous models and their possible observational signatures. Group members are also interested in spin precession and gravitational-wave emission by binary black holes and the interactions between black holes and stars in their host galaxies. Group members are also engaged in research in computational astrophysics, in particular modeling systems on the scale of galaxy clusters and the large scale cosmic web. More specific information is available on individual faculty webpages.

Atmospheric and Space Physics

Research in Atmospheric and Space Physics encompasses both theory and experiment, with

emphasis on, ionospheric physics, magnetospheric physics, large environmental data interpretation, planetary atmospheres, atmospheric electricity and its effects on weather and climate, and space instrumentation. Much of the research occurs in the William B. Hanson Center for Space Sciences, which includes laboratory facilities for instrument design, fabrication, and testing. Faculty and students participate in ongoing satellite missions sponsored by NASA and DoD, and smaller exploratory cube-sat missions. Students participate in analysis of large data sets from previous missions, and from ground-based optical and radar instruments at locations at high and low latitudes. Particular areas of interest include large and small scale dynamics and electrodynamics, numerical modeling of the thermosphere and ionosphere, characteristics of the plasma environment of the magnetosphere, plasma instabilities and irregularities, data interrogation using machine learning and development and testing of innovative space flight instrumentation. Computer facilities include a network of dedicated workstations and access to supercomputers. For further details see www.utdallas.edu/research/spacesciences.

High Energy Physics and Elementary Particles

The UT Dallas High Energy Physics Group collaborates on the ATLAS experiment at the CERN Large Hadron Collider (LHC). The LHC operates at the energy frontier of elementary particle physics. In 2012, the ATLAS was one of two experiments that reported the discovery of the Higgs boson. Even as ATLAS is measuring the properties of the Higgs, the search continues for physics beyond the Standard Model such as supersymmetric partners to quarks, leptons and bosons, and exotic objects such as microblack holes, gravitons, magnetic monopoles, dark matter, and even "dark photons", the gauge bosons of a hypothesized interaction of dark matter particles. The UTD group plays a leading role in dark photon searches.

The UTD group works on the pixelated detector at the center of ATLAS that records the tracks of charged particles emerging from LHC collisions. Group members actively participated in the commissioning of the Pixel Detector. Currently, the group is working on a detector R&D project for the ITk, the ATLAS inner tracker upgrade that will replace the ATLAS tracking detectors for the start of High Luminosity-LHC operations in the early 2020's.

Solid State/Condensed Matter Physics/Materials Science

Condensed matter physics is at the interface of many disciplines and involves a collaborative approach with colleagues in chemistry, materials science and engineering, and electrical engineering. Our research facilities are distributed over physics research labs, the NanoTech Institute (nanotech.utdallas.edu) and Electrical Engineering Cleanroom.

Research in condensed matter physics involves both experimental and theoretical efforts with emphasis on the fundamental physics and applications of novel phases and phenomena in strongly correlated electron systems such as superconductors, semiconductors, semiconductor heterostructures, 2D materials, quantum wires, quantum dots, cold atoms, topologic materials, photovoltaic, organic and polymeric materials. Faculty and graduate research assistants investigate the electronic, magnetic and optical properties in such materials, as well as applications in

electronics, spintronics, photonics, quantum computing, and renewable energies.

On the experimental side, research facilities include a full line of low temperature labs (including dilution refrigerator, PPMS, MPMS, VTI, cryogenic probe station, dip station) to cover the temperatures from 400K down to 10mK and a magnetic field up to 12T for electron and spin transport, magnetization studies. There are also several spectroscopy labs for ultrafast, nuclear magnetic resonance (NMR), Raman, THz, and electron spin resonance (ESR) studies. In addition, we have labs for single crystal growth, thin film growth, nanomaterial growth, and cleanroom facility along with several surface characterization facilities in UTD.

The research interests in condensed matter theory are dedicated to physical properties of various novel and advanced materials and their potential practical applications. Research topics include ultra-cold atomic gases, quantum computation, topological states of quantum matter, interaction effects in many-body systems such as topological insulators and superconductors, graphene and other low-dimensional materials, optoelectronic properties of nanostructured and hybrid semiconductor systems, with particular interests on the physics of light-matter interaction, charge and energy transfer.

The interaction of nanoscale materials, such as carbon nanotubes, with biological entities are being investigated for prospective biomedical and electronic applications. For example, chemically functionalized carbon nanotubes are being studied as building blocks in transistor and sensor applications.

Degree Requirements

The University's general degree requirements are discussed on the [Graduate Policies and Procedures](#) page.

All candidates for graduate degrees in physics must satisfy general University degree requirements. Well-prepared students may demonstrate by examination adequate knowledge of the core and basic course material. In addition to the general University graduation requirements, graduation in physics requires achieving a grade of B or better in each core course in the MS and PhD programs.

Master of Science in Physics

30 semester credit hours minimum

Department Faculty

FACG> nsm-physics-ms

Distinguished Chair in Natural Sciences and Mathematics: Roderick A. Heelis

Green Distinguished Chair in Academic Leadership: B. Hobson Wildenthal

Professors: Phillip C. Anderson, Robert Glosser, Matthew J. Goeckner, Mustapha Ishak-Boushaki, Joseph M. Izen, Mark Lee, Xinchou Lou, Roger Malina, Robert M. Wallace, Anvar A. Zakhidov, Chuanwei Zhang

Professors Emeritus: Austin J. Cunningham, Walter Heikkila, John H. Hoffman, Wolfgang A. Rindler, Myron B. Salamon, Brian A. Tinsley

Associate Professors: Lunjin Chen, Yuri Gartstein, Lindsay J. King, David J. Lary, Anton V. Malko, Fabiano Rodrigues, Jason D. Slinker

Assistant Professors: Michael Kesden, Michael Kolodrubetz, Lloyd Lumata, Bing Lv, Kaloyan Penev, Xiaoyan Shi, Russell Stoneback, Fan Zhang

Senior Lecturers: Paul MacAlevey, Kuei Sun

UT Dallas Affiliated Faculty: Yves J. Chabal, Kyeongjae (KJ) Cho, John P. Ferraris, Matthew J. Goeckner, Heather Hayenga, Christopher L. Hinkle, Julia W. P. Hsu, Wenchuang (Walter) Hu, Stephen D. Levene, Lawrence J. Overzet, A. Dean Sherry, Mary L. Urquhart, Duck Joo (D. J.) Yang

Objectives

A minimum total of 30 graduate semester credit hours is required, including the core courses listed below.

Core Courses: 12 semester credit hours

[PHYS 5301](#) Mathematical Methods of Physics I

[PHYS 5311](#) Classical Mechanics

[PHYS 5320](#) Electromagnetism I

[PHYS 6300](#) Quantum Mechanics I

Elective courses: 18 semester credit hours

In addition to the core courses, 18 semester credit hours of additional graduate level physics or related field courses must be successfully completed by MS candidates in physics, with prior approval from the graduate advisor. Up to 6 semester credit hours of elective credit may be satisfied through approved industrial internships, supervised research, or the satisfactory completion of an MS thesis. Prior approval for these options must be obtained from the graduate advisor.

Doctor of Philosophy in Physics

75 semester credit hours minimum beyond the baccalaureate degree

Department Faculty

FACG> nsm-physics-phd

Distinguished Chair in Natural Sciences and Mathematics: Roderick A. Heelis

Green Distinguished Chair in Academic Leadership: B. Hobson Wildenthal

Professors: Phillip C. Anderson, Robert Glosser, Matthew J. Goeckner, Mustapha Ishak-Boushaki, Joseph M. Izen, Mark Lee, Xinchou Lou, Roger Malina, Robert M. Wallace, Anvar A. Zakhidov, Chuanwei Zhang

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Core Courses

A minimum of 21 semester credit hours in the graduate core sequence are required for the PhD degree, plus 3 additional courses (with at least one outside the student's specialty area) specified by the Graduate Advisor and the student's research advisor. The required core courses must include:

[PHYS 5301](#) Mathematical Methods of Physics I

[PHYS 5302](#) Mathematical Methods of Physics II

[PHYS 5311](#) Classical Mechanics

[PHYS 5313](#) Statistical Physics

[PHYS 5320](#) Electromagnetism I

[PHYS 5322](#) Electromagnetism II

[PHYS 6300](#) Quantum Mechanics I

Students in space sciences must also take:

[PHYS 6383](#) Plasma Science

Additional courses may be required to satisfy the particular degree requirements and/or to ensure sufficient grounding in physical principles. The graduate advisor and the student's supervisory committee must approve course selections. A minimum of one year residency after admission to the doctoral program is required.

Students are required to take and pass a qualifying examination during their first year in the PhD program. The qualifying examination consisting of an examination in each of four physics subjects based on undergraduate level material is given in early January of the first year of graduate study. Failure in any subject requires retaking the failed exam(s) in August. Students passing all four exams by August will automatically become PhD candidates. Students failing only one subject exam will be evaluated and may be allowed to stay one semester and repeat the exam the following January. Students failing more than one exam will be dismissed from the PhD program, but will be allowed to complete a master's degree.

Students admitted for the spring semester will take the first set of exams in August of that year.

After a student has completed the required coursework with a minimum grade of B in each core course and a minimum GPA of 3.0 for all courses, passed the qualifying examination, and decided upon his/her field of specialization, the student is required to identify a dissertation topic and form a Supervising Committee to guide the student's dissertation work. The student must submit a proposal that outlines the present state of knowledge of the field and presents the research program the student expects to accomplish for the dissertation. This proposal must be approved by the Supervising Committee and the department head. A seminar on the dissertation proposal must be presented, followed by an oral examination conducted by the faculty on the proposed area of research and related topics. The Supervising Committee shall determine by means of the exam and any ancillary information whether the student is adequately prepared and has the ability to conduct independent research. The approved dissertation proposal is then filed with the Dean of Graduate Studies. An approved dissertation proposal is normally expected no later than the end of the student's third year.

Before the final dissertation defense, a PhD student should have demonstrated his/her original and significant contribution to his/her research field. This requirement may be most easily met by having at least one paper either accepted or under review by a peer-reviewed journal. The PhD student, in the opinion of the dissertation committee, should make substantial contribution to the paper that should compose a major part of his/her dissertation. Alternative proof of this contribution must be approved by the dissertation committee and the graduate curriculum committee.

