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.

Admission Requirements

The University's general admission requirements are discussed on the Graduate Admission page (catalog.utdallas.edu/2016/graduate/admission). 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, contemporary cosmology, and relativity. These research efforts typically involve analytical, numerical, and cosmological-data related projects. The group is instrumental in organizing the biennial Texas Symposia on Relativistic Astrophysics, beginning in Dallas in 1963 and recurring regularly all over the world since then. Current areas of research include: gravitational lensing (lenses) and its applications to cosmology; the acceleration of the expansion of the universe (cosmological constant, dark energy); fitting cosmological models to observational data (e.g. CMB, lensing, supernovae); dark matter; the structure of the big bang; the role of inflation; computer algebra systems applied to general relativity and cosmology; space-time junction conditions and wormholes; cosmological models of wider generality than the classical homogeneous models and their possible observational signatures. More specific information is available at: www.utdallas.edu/~mishak/relativitycosmology.html.

Atmospheric and Space Physics

Research in Atmospheric and Space Physics encompasses both theory and experiment, with emphasis on aeronomy, ionospheric physics, 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 suborbital sounding rockets. Most students participate in analysis of large data sets from previous missions, and from ground-based optical and radar instruments at locations ranging from Greenland to South America. Particular areas of interest include large and small scale dynamics and electrodynamics, numerical modeling of the thermosphere and ionosphere, characteristics of the near earth plasma environment, the effects of solar variability on atmospheric electricity, cloud microphysics and tropospheric dynamics, plasma instabilities and irregularities, 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) and the BaBar experiment, at the PEP-II asymmetric b factory located at the Stanford Linear Accelerator Center (SLAC). Atlas will search for the Higgs boson, believed to be responsible for electroweak symmetry breaking, for new physics beyond the standard model such as supersymmetric partners to known...
particles, and for new hadrons. Atlas data-taking will begin in 2009. BaBar measures CP violation in the decays of bottom mesons and is exploring whether the origin of this CP violation lies within the Standard Model. BaBar data is fertile ground for precision and rare decays of bottom and charm particles, and tau lepton. The group explores both charmonia and a class of unexpected particles with charm-anticharm quark content with properties that are quite different from conventional charmonium. BaBar has completed data-taking and is analyzing its data. The group's research is funded by the U.S. Department of Energy. The UT Dallas High Energy Physics group specializes in high performance computing, simulation production, and data analysis while contributing to the commissioning and operation of experiments. Additional information can be found at: www.utdallas.edu/~joe/hepweb/utdhep.html

Solid State/Condensed Matter Physics/Materials Science

Materials Science is at the interface of many disciplines and involves a collaborative approach with colleagues in chemistry, and electrical engineering. Our research facilities are distributed over the physics laboratories, the NanoTech Institute (nanotech.utdallas.edu) and Electrical Engineering Clean Room.
Research in Materials Science involves both experiment and theory with emphasis on the physical aspects of solid state materials, optical properties of solids, Raman scattering, physical properties of thin films, and carbon nanotubes. Various nanoscale and synthetic materials are being studied for their optical, electronic, magnetic and transport properties, as well as applications in photonics, spintronics and (opto)electronics. The materials of interest include nanostructures (quantum dots and wires, fullerenes and carbon nanotubes) and low-dimensional systems, photonic band gap crystals and "left-handed" electromagnetic meta-materials, organic and polymeric materials. Unconventional superconductivity and superconducting nanostructures are also under investigation.
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 (catalog.utdallas.edu/2016/graduate/policies/policy).
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

Distinguished Chair in Natural Sciences and Mathematics: Roderick A. Heelis
Green Distinguished Chair in Academic Leadership: B. Hobson Wildenthal
Professors: Phillip C. Anderson, Austin J. Cunningham, Robert Glosser, Matthew J.
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

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

**Green Distinguished Chair in Academic Leadership:** B. Hobson Wildenthal

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

**Professors Emeritus:** Walter Heikkila, Wolfgang A. Rindler, Myron B. Salamon, Brian A. Tinsley

**Associate Professors:** Yuri Gartstein, Lindsay J. King, David J. Lary, Anton V. Malko, Jason D. Slinker

**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
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 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 first semester 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.