

- Students seeking the PhD in philosophy are required to submit satisfactory scores on the Graduate Record Examination (GRE) or another appropriate standardized examination.
- Previous academic performance must demonstrate the potential for graduate work in philosophy.
- An applicant whose first language is not English must demonstrate proficiency in oral and written English prior to being admitted.
- The applicant must, at a minimum, meet the requirements for acceptance into the Toulouse School of Graduate Studies at UNT.

In addition to meeting all of the requirements above, students applying for admission to the cooperative doctoral program in philosophy must submit three letters of recommendation, a writing sample representative of their best academic work in the field, and a “statement of purpose” describing both their reasons for pursuing doctoral work in philosophy and their specific areas of academic interest (e.g., sub-disciplinary areas of interest within the field).

Information on requirements for the PhD with a major in philosophy is available from the department and online at [www.phil.unt.edu/programs/graduate/phd](http://www.phil.unt.edu/programs/graduate/phd).

## The Center for Environmental Philosophy

**Eugene C. Hargrove, Director**

The Center for Environmental Philosophy encourages and supports workshops, conferences and other special projects, including postdoctoral research in the field of environmental ethics. Activities currently include the publication of *Environmental Ethics: An Interdisciplinary Journal Dedicated to the Philosophical Aspects of Environmental Problems*, which is now in its fourth decade of publication; Environmental Ethics Books, a reprint series of important books dealing with environmental ethics and philosophy; and annual workshops on college and university curricula development and on nature interpretation. National research conferences focusing on selected topics in environmental ethics are held on an irregular basis.

## Courses of Instruction

All Courses of Instruction are located in one section at the back of this catalog.

### Course and Subject Guide

The “Course and Subject Guide,” found in the Courses of Instruction section of this book, serves as a table of contents and provides quick access to subject areas and prefixes.

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# Department of Physics

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Physics Building, Room 110

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Web site: [www.phys.unt.edu](http://www.phys.unt.edu)

### Chris Littler, Chair

*Graduate Faculty:* Duggan, Grigolini, Hu, Kobe, Kowalski, Krokhn, Littler, Matteson, McDaniel, Mueller, Neogi, Ordenez, Perez, Philipose, Quintanilla, Roberts, Rout, Shemmer, Shiner, Weathers.

Students in the Department of Physics have the opportunity to obtain training with state-of-the-art equipment in new and modern research laboratories in areas of interest to the scientific and industrial communities, particularly those involved in microelectronics, semiconductors, applications of accelerators, lasers and modern computational methods. Opportunities are available to develop highly marketable skills in modern basic and applied physics as well as close interactions with regional industries.

## Research

The physics department is conducting research in solid state, semiconductor and polymer physics; atomic, molecular and applied nuclear physics; accelerator based materials physics and nuclear magnetic resonance; and theoretical physics in quantum, statistical and computational physics and non-linear dynamics, including applications to biomedical phenomena.

Housed in the Physics Building, the General Academic Building, the Science Research Building and Discovery Park, the laboratories associated with these programs include ultrahigh vacuum scanning tunneling microscopy, atomic force microscopy, near field optical microscopy, micro Raman, photoluminescence spectroscopy, static and dynamic laser light scattering, rheological characterization, UV-visible spectroscopy, and ultrafast optical spectroscopy facilities. These state-of-the-art facilities are used to investigate carbon nanotubes; carbon and diamond films; polymer gels and related biomaterials; self-assembly and phase behaviors of hydrogel nanoparticles; the crystallization, glass transition

and gelation of colloidal dispersions; smart gels for sensors and device applications; nitride optoelectronics; quantum dots; plasmonic nanomaterials; intersubband QW optical devices; III-V semiconductor heterostructures; layered organic-inorganic perovskites; and biophotonics.

A prime interest in theoretical physics lies in applying quantum theory to many-particle systems. Mathematical problems involving Green's functions, Feynman diagrams, canonical transformations and gauge theory are being investigated. These and other methods are being applied to solids, quantum fluids and nuclei. Plasma confinement schemes are also being investigated using computational techniques.

#### **The Ion Beam Modification and Analysis**

**Accelerator Laboratory** contains four accelerators, including a 200 kV high-current Cockcroft Walton machine, two 2.5 MV single-ended Van de Graaff and a 3 MV Tandem Electrostatic Pelletron-Type Accelerator. The program's objectives are (1) fundamental studies of ion atom collisions, including ionization, excitation and charge transfer processes, and (2) the use of ion beams for materials characterization and modification of electronic and other materials. The most notable of these characterization techniques is the development of an accelerator-based Secondary Ion Mass Spectrometer (SIMS) that can detect impurities in materials at the sub parts-per-billion level. This technique, called Trace Element Accelerator Mass Spectrometry (TEAMS), was developed in conjunction with the materials characterization group at Texas Instruments Inc. Other materials characterization techniques include nuclear reaction analysis, charged particle activation analysis, Rutherford backscattering spectrometry, ion channeling, elastic recoil detection, and particle-induced X-ray emission. These techniques can also be applied with a heavy-ion microprobe attached to the tandem accelerator. Modification of metal and semiconductor materials by ion implantation is also of interest.

Atomic and molecular spectroscopy investigations are being made to determine interaction parameters from line width and line profile data to better understand the collision phenomena and momentum transfer associated with gaseous mixtures. Experimental measurement and theoretical modeling of vibrationally excited molecular systems are being conducted with the goal of understanding molecular potentials. Precision spectroscopic measurements of atomic transition energies are being conducted to test the accuracy of QED theory.

The program in statistical physics has a variety of specializations, including both classical and quantum non-equilibrium statistical mechanics with an emphasis on stochastic differential equations. There also are investigations into deterministic

randomness (chaos) and its relation to traditional stochastic processes. These techniques along with the numerical methods are applied to all areas of physics. In addition to the study of chaos, the techniques for non-linear dynamics are applied to the understanding of neural networks (research done in collaboration with members of the biological sciences department) and other complex physiological systems.

**The Center for Nonlinear Science (CNS)** is a research organization whose research focus is phenomena-driven rather than discipline-driven and, therefore, spans traditional disciplines such as physics, mathematics, biology and economics. The emphasis of CNS is on the development of new analytic and computational techniques to assist in the understanding of complex (nonlinear) phenomena that have not yielded their secrets to traditional methods of investigation.

Federal support of research projects in the department includes the National Science Foundation, the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Office, the Department of Energy, the Defense Advanced Research Projects Agency and the Army Night Vision Laboratory. Other research support has been granted by the Robert A. Welch Foundation, the Texas Advanced Technology Research Program, Texas Instruments Inc. and other industries.

## **Admission Requirements**

Application to the master's or doctoral programs in physics is made in two separate parts:

1. The prospective student must complete all of the general application requirements for the UNT Toulouse School of Graduate Studies. These requirements are described in this catalog and on the Toulouse School of Graduate Studies web site. To satisfy the requirements for a standardized admission test, the prospective student must take the general Graduate Record Examination (GRE); of principal interest are the results from the quantitative and analytical portions of the examination.
2. The prospective student must also complete the Department of Physics Graduate Application and submit it along with a current curriculum vitae and three letters of reference to the attention of the graduate advisor, UNT Department of Physics. The application and reference forms are available from the UNT Department of Physics web site. The letters of recommendation must be from individuals familiar with the applicant's academic and/or professional abilities. One letter may be from a current or past employer (if such experience exists), and at least one letter must be from the last academic institution attended.

In addition to the above, the program may consider the applicant's related work experience, research and publication record, presentations at professional meetings, leadership roles, teaching excellence, awards, potential to enhance the intellectual diversity of the department and program, potential to enhance the diversity of the university, and other factors that might provide evidence of potential success in completion of a graduate degree in the Department of Physics.

## Degree Programs

The Department of Physics offers graduate programs leading to the following degrees:

- Master of Arts, and
- Master of Science, both with a major in physics; and
- Doctor of Philosophy with a major in physics.

Concentrations at the doctoral level are available in atomic physics, theoretical physics and solid state physics.

## Master's Degree Options

Master of Arts (with thesis) or Master of Science (with research problems in lieu of thesis, or a course work option).

### Option 1, Master of Arts

The graduate credit requirement for the Master of Arts degree is 30 semester hours chosen in the following manner.

1. PHYS 5500, 5510, 5710 and 5720.
2. PHYS 5950 (6-hour thesis). The thesis must be submitted in the manuscript form prescribed by the American Institute of Physics.
3. 12 semester hours chosen from physics or related fields, with permission of academic advisor and major professor.

### Option 2, Master of Science

The graduate credit requirement for the Master of Science degree is 33 semester hours chosen in the following manner.

1. PHYS 5500, 5510, 5710, 5720, 6000 and 3 additional hours chosen from the basic curriculum of the physics PhD program.
2. PHYS 5920 and 5930 (Research Problems in Lieu of Thesis). Research problems in lieu of thesis are independent though not necessarily original studies that may be experimental, computational, tutorial, bibliographic, pedagogic or a combination of these. As part of the requirements for each problems course, the student must present a formal written report of the work done in the course, which must

be approved by the advisory committee. Reports for PHYS 5920 and 5930 must be submitted in the manuscript form prescribed by the American Institute of Physics (see *AIP Style Manual*, current edition).

3. 9 hours chosen from physics or related fields. Physics courses must include PHYS 5450.

### Option 3, Master of Science

The graduate credit requirement for the Master of Science degree is 36 semester hours chosen in the following manner.

1. PHYS 5500, 5510, 5710, 5720, 6000, 6001, 6030 and 6110.
2. PHYS 5450.
3. 9 additional hours, which may include 2 hours of PHYS 5940 and 6 hours of PHYS 5900.

### Seminar in Current Literature or Colloquium

All physics graduate students must attend the department of physics' colloquium each week during each long term/semester of full-time graduate study. Students may opt to earn credit for this requirement by enrolling in PHYS 5941.

### Examinations

An entrance interview concerning fundamental physics is required of all students. The results are used for advisory, placement and remedial purposes.

An oral presentation of the master's thesis (PHYS 5950) is required. The thesis is accepted by the student's advisory committee after an oral examination is successfully completed and the thesis is filed in the graduate dean's office. Problems in lieu of thesis (PHYS 5920 and 5930) must be accepted by the student's advisory committee; oral presentation is optional.

## Doctor of Philosophy

The Doctor of Philosophy degree represents the attainment of a high level of scholarship and achievement in independent research. To be granted a PhD with a major in physics, a graduate student admitted to the physics PhD program must achieve the following: (1) admission to candidacy for the PhD, and (2) approval for the granting of the PhD.

### Admission to Candidacy for the PhD

Admission to candidacy for the PhD with a major in physics involves a two-part qualification process. In the first part, the student must demonstrate proficiency in the core areas of physics; in the second, the student must complete required advanced course work, and demonstrate preparedness for conducting independent research toward the dissertation.

### 1. **Demonstration of proficiency in the core areas of physics:**

The student must complete the following six core courses or their equivalents: PHYS 5500, 5510, 5710, 5720, 6030 and 6110. Students who take these courses at UNT and earn a grade of A in at least three of these courses and a grade of B in the rest will automatically satisfy this part of the qualification process. A student who enrolls at UNT with a master's degree in physics from another institution may meet this requirement by completing PHYS 5510, 5710, 6030 and 6110, and attaining a grade of A in at least two of the courses and a minimum grade of B in the remainder. Alternatively, any student may satisfy this part of the qualification process by earning a minimum grade of B in the six core courses or their equivalent and by passing a comprehensive examination over the core areas of physics, to be scheduled and administered by the departmental examination committee. A student should pass this part of the qualification process after no more than three years of full-time graduate study if entering the program with only a bachelor's degree in physics, and after no more than one year of full-time study if entering the program with a master's degree in physics.

### 2. **Preparation of independent research:**

There are several aspects to this part of the qualification process. First, the student must select a major professor and a doctoral advisory committee. A major professor provides close guidance and supervision of the student's doctoral studies. The doctoral advisory committee is selected by the student in consultation with the major professor and must include the major professor. Second, the student must file a degree plan, which must be approved by the doctoral advisory committee and the graduate advisor. These two things should be done before or very shortly after satisfying the first part of the qualifying process. Third, the student must complete organized course work required by the degree plan and earn a minimum grade of B in each course. Fourth, after the student and major professor have decided upon a dissertation research project for the student, the student must present a proposal for the research to the doctoral advisory committee. This proposal must be in the form of both a written report and an oral presentation to the doctoral advisory committee. Prior to the oral presentation, the student must provide each member of his or her doctoral advisory committee with a copy of the report. The report and the oral presentation to the doctoral advisory committee must include both a description of the research already done and a proposal of research for completing the dissertation. The doctoral advisory committee will administer an oral examination at the end of the oral presentation

over the proposal and related topics. The doctoral advisory committee must approve of the admission to candidacy for the PhD degree before the student applies for candidacy at the Toulouse School of Graduate Studies. Course work recommendations associated with specific concentrations are available. Please inquire with the graduate advisor. The following courses are recommended for all students: PHYS 5450, 5700, 6000, 6155 and 6500.

### **Approval of Granting the PhD**

Approval of granting the PhD degree in physics requires demonstration of professional research aptitude. Professional research aptitude must be demonstrated by conducting research and reporting the research in at least one peer-reviewed professional journal article of which the student is the first author, in a dissertation and in an oral presentation to the doctoral advisory committee known as the final defense. The appropriateness of the journal publication(s) must be evaluated by the committee. At least 30 days prior to the scheduled final defense, the student must provide each member of his or her doctoral advisory committee with a copy of his or her completed dissertation and a copy of the requisite journal article(s), which must be either already published or accepted for publication—in the latter case, copies of the letter(s) of acceptance for publication should be included. The doctoral advisory committee must approve the granting of the PhD degree before the student may submit the dissertation to the graduate dean for final approval.

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