Department of Physics

http://www.utdallas.edu/dept/physics/

Faculty

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Affiliated Faculty: Cyrus D. Cantrell (Engineering), John P. Ferraris (Chemistry), Wenchuang Hu (Engineering), Duck-Joo Yang (Chemistry), Mary Urquhart (Science/Mathematics Education)

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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 Ph.D. program that prepares the student 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.

A Master of Science degree in Applied Physics is offered for students wishing to emphasize applications encountered in most industrial and high technology environments.

Admission Requirements

The University's general admission requirements are discussed here.

The Physics Program seeks students who have a B.S. degree in Physics or closely related subjects from an accredited university or college, and who have superior skills in quantitative and deductive analysis. 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 of 1100, or 700 on the quantitative part, is advisable based on our 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), and 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.

Degree Requirements

The University’s general degree requirements are discussed here.

The candidate for either the M.S., MS in Applied Physics, or Ph.D. must satisfy general University degree requirements.

Well prepared students may demonstrate by examination adequate knowledge of the core and basic course material.

Student Support

A limited number of assistantships are awarded to those students displaying the most promise in teaching or research. Specific decisions are made on an individual basis. Awardees are required to complete 8 graduate physics courses (not including research courses) during the first 24 months in residence. Continuation of support requires achievement of a minimum GPA of 3.3, and a satisfactory record in teaching or research assignments.

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Research

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; Atomic and Molecular Physics; Quantum Electronics and Applications; Optics; Astrophysics/Cosmology/Relativity; Solid State/Condensed Matter Physics/Materials Science; High Energy Physics and Elementary Particles; Chemical Physics, and Computational Materials Science.

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Astrophysics, Cosmology and Relativity

The Theoretical Cosmology and Relativity Group studies fundamental problems in astrophysics, contemporary cosmology, and relativity. These 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 information is available at: http://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 W. 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. They also 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 http://www.utd500.utdallas.edu.

Atomic And Molecular Physics

Experimental research in atomic and molecular physics is directed toward a more complete understanding of such processes as the dynamics of excitation and energy transfer, the thermal economy and transport properties that occur in a variety of plasma and discharge configurations.

Sophisticated diagnostic instrumentation used in these studies include ultraviolet, visible and infrared spectrometers and detectors, tunable pulsed and C. W. lasers, a shock tube facility and mass spectrometers. Several minicomputer systems are used for data acquisition and analysis.

Chemical Physics

Research in chemical physics centers on electrical and magnetic properties of conducting organic molecular crystals and polymers. A variety of laser-based diagnostic techniques for flame and combustion systems are under development. Examples include the detection of light atoms in flames, soot sizing and droplet/vapor evaporation processes.

Intramolecular vibrational energy transfer and chemical reaction dynamics are studied via quantal and classical dynamics in computer simulations.

High Energy Physics And Elementary Particles

The UTD High Energy Physics Group collaborates on the Atlas experiment at 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,

and for new physics beyond the standard model such as supersymmetric partners to known particles. Atlas

data-taking will begin in 2007. 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 will collect data through 2008. The group's research is funded by the U.S.

Department of Energy. The BaBar group specializes in high performance computing, simulation production, and

data analysis while contributing to the commissioning and operation of experiments.

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Deleted: The group's main activity is the BaBar experiment, at the PEP-II asymmetric b factory located at the Stanford Linear Accelerator Center (SLAC). BaBar has published measurements of 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. BaBar's goal is to explore CP violation in the decays of bottom mesons and to study bottom and charm meson decay. Research with BaBar is funded by the U.S. Department of Energy. The BaBar group specializes in high performance computing, simulation production, and data analysis while contributing to the operation of the experiment. Graduate students utilize the HEP group's own Linux processing farm. With 128 CPU's, it is the most powerful computing facility on campus, but is continually expanding to scale with the growing BaBar data set. UTD is networked to SLAC via Internet2.¶
Optics¶
Research in Optics in the UTD Physics Program concentrates in quantum optics, nonlinear optics and selected applications in physics and chemistry. Areas of particular interest include quantum coherence theory and the quantum statistical properties of light; the effects of coherent nonlinear-optical processes on the propagation of electromagnetic waves. ¶

Quantum Electronics

The research effort in Quantum Electronics is devoted mainly to the development of new types of lasers from the visible to the gamma-ray spectrum and to multiphoton spectroscopy of atoms and molecules. High-resolution multiphoton spectroscopy and high-power charge-transfer lasers originated at the university. Major research equipment includes two intense electron-beam devices that are used to excite potential laser plasmas at power levels of 4 and 100 gigawatts, respectively, and a state-of-the-art Nd: YAG laser system. In experiments on atomic and molecular spectroscopy, both pulsed and continuous narrowband tunable dye lasers are being used for basic studies of atomic structure and molecular interatomic potentials.

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, NanoTech Institute and Electrical Engineering CleanRoom.Research in Materials Science involves both experiment and theory with emphasis on the physical aspects of Materials Science. A synopsis of our activities is given below: Measurements of optical properties of solids with emphasis on modulated reflectance and Raman scattering of semi-conductors are routinely carried out.

Various nanoscale and synthetic materials are being studied for their optical, electronic and transport properties, as well as applications in photonics 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.

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.

Master of Science in Applied Physics

A minimum of 32 graduate credit hours are required. In order to receive the MSAP degree, students must successfully complete at least 16 semester credit hours of core courses. In addition to the core courses 16 additional credit hours may be chosen from the Physics elective courses listed below or from electrical engineering, computer science, biology, geosciences, chemistry and management courses. The complete list of these courses may be obtained from the MSAP Graduate Advisor, or from the Physics Department’s website.

1. MSAP Core Courses (16 credit hours minimum)
Required:
PHYS 5401 Mathematical Methods of Physics I, or
PHYS 5406 Mathematical Methods of Applied Physics

A minimum of 12 additional credit hours must be taken from the core list below. Elective courses totaling 16 additional credit hours may be chosen from the Physics elective courses listed below:

PHYS 5305 Monte Carlo Simulation Method and its Applications

PHYS 5411 Classical Mechanics
PHYS 5317 Atoms, Molecules and Solids
PHYS 5318 Atoms, Molecules and Solids II
PHYS 5321 Experimental Operation and Data Collection Using Personal Computers
PHYS 5372 Solid State Devices
PHYS 5402 Mathematical Methods of Physics II
PHYS 5416 Applied Numerical Methods
PHYS 5425 Applied Electromagnetism I
PHYS 5426 Applied Electromagnetism II

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2. Physics Elective Courses (up to 16 credit hours)

PHYS 5283 Plasma Technology Laboratory
PHYS 5304 Proposal and Report Preparation
PHYS 5323 Virtual Instrumentation with Biomedical Clinical and Healthcare Applications
PHYS 5324 Computer Interfacing and Data Acquisition
PHYS 5369 Special Topics in Applied Physics
PHYS 5372 Solid State Devices
PHYS 5367 Photonic Devices
PHYS 5375 Electronic Devices Based on Organic Solids
PHYS 5382 Space Science Instrumentation
PHYS 5383 Plasma Technology
PHYS 5385 Natural and Anthropogenic Effects On The Atmosphere
PHYS 6283 Plasma Science Laboratory
PHYS 5351 Basic Aspects and Practical Applications of Spectroscopy.
PHYS 6353 Atomic and Molecular Processes
PHYS 6374 Optical Properties of Solids
PHYS 6383 Plasma Science

Up to 6 hours of an industrial internship or supervised research may be substituted for up to two of the elective courses. The following research courses will satisfy this requirement:

PHYS 7V10 Internal Research
PHYS 7V20 Industrial Research

Master of Science

A minimum total of 32 graduate hours is required.

1. Core courses (12 hours)

PHYS 5401 Mathematical Methods of Physics I

PHYS 5421 Electromagnetism I
PHYS 6400 Quantum Mechanics I

2. Elective courses (20 hours)

20 hours of graduate level physics courses to be selected by the student with the approval of the Graduate Adviser. Six hours of research including an M. S. thesis may be substituted for two of the elective courses.

Doctor of Philosophy

A candidate for the Ph.D. must take the following courses: PHYS 5411, 5413, 5422, 5401, 5402, 5421, 6400, and PHYS 6401. Students whose research will be carried out in Space Science should substitute PHYS 6383 for PHYS 6401. A candidate must also take a minimum of 3 elective courses, 2 from within his/her area of specialization and 1 selected from outside the student's specialty area. 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. In the first two semesters in residence students in the Ph.D. track should also register for Phys5100. A minimum of one year residency after admission to the doctoral program is required.

Near the end of the first year in residence all Ph.D. track student must take a written qualifier examination. Continuation of teaching assistantships and GSS awards are contingent upon satisfactory performance on the qualifier.

When a student has completed the required course work with the minimum GPA of 3.3 and has decided upon his/her field of specialization, a committee is formed to guide the student's dissertation work. Once a dissertation topic has been identified, 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 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. A manuscript embodying a substantial portion of the dissertation research accomplished by the student must be submitted to a suitable professional refereed journal prior to the public seminar and dissertation defense. A public seminar, successful defense of the dissertation, and its acceptance by the Supervising Committee conclude the requirements for the Ph.D. In lieu of the traditional dissertation, and at the discretion of the supervising professor, a manuscript dissertation following the guidelines published by the Graduate Dean's Office may be substituted.

Course listing for Doctor of Philosophy

Core Courses (28 credit hours required, 27 for Space Science.)

PHYS 5411 Classical Mechanics
PHYS 5413 Statistical Physics
PHYS 5422 Electromagnetism II
PHYS 5401 Mathematical Methods of Physics I
PHYS 5402 Mathematical Methods of Physics II
PHYS 5421 Electromagnetism I
PHYS 6400 Quantum Mechanics I
PHYS 6401 Quantum Mechanics II
PHYS 6383 Plasma Science (Space Science students only; in lieu of PHYS 6401)

General Elective Courses

PHYS 5100 Current Topics in Physics
PHYS 5V49 Special Topics in Physics
PHYS 5304 Proposal and Report Preparation
PHYS 5305 Monte Carlo Simulation Method and its Applications
PHYS 5416 Applied Numerical Methods
PHYS 5321 Experimental Operation and Data Collection Using Personal Computers
PHYS 5324 Computer Interfacing and Data Acquisition
PHYS 6303 Applications of Group Theory in Physics
PHYS 6309 Special Topics in Mathematical Methods of Physics
PHYS 6311 Relativistic Quantum Field Theory I
PHYS 6312 Relativistic Quantum Field Theory II
PHYS 8V20 Research in High Energy Astrophysics and Cosmology

Astrophysics/Cosmology

PHYS 5402 Mathematical Methods of Physics II
PHYS 5391 Relativity I
PHYS 5392 Relativity II
PHYS 5395 Cosmology
PHYS 6399 Special Topics in Relativity
PHYS 8V20 Research in High Energy Astrophysics and Cosmology
PHYS 8V90 Research in Relativity

Atomic and Molecular Physics

PHYS 5351 Basic Aspects and Practical Applications of Spectroscopy.
PHYS 6353 Atomic and Molecular Processes I

PHYS 6V59 Special Topics in Atomic Physics
PHYS 8V50 Research in Atomic and Molecular Physics

High Energy Physics

PHYS 6314 High Energy Physics
PHYS 5402 Mathematical Methods of Physics II
PHYS 6311 Relativistic Quantum Field Theory I
PHYS 5391 Relativity I
PHYS 5416 Applied Numerical Methods
PHYS 5305 Monte Carlo Simulation Method and its Applications
PHYS 8V10 Research in High Energy Physics

Solid State/Condensed Matter Physics/Materials Science

PHYS 5371 Solid State Physics
PHYS 5372 Solid State Devices
PHYS 6371 Advanced Solid State Physics
PHYS 6374 Optical Properties of Solids
PHYS 5351 Basic Aspects and Practical Applications of Spectroscopy
PHYS 5367 Photonic Devices
PHYS 5402 Mathematical Methods of Physics II
PHYS 5324 Computer Interfacing and Data Acquisition
PHYS 5305 Monte Carlo Simulation Method and its Applications
PHYS 8V70 Research in Materials Science

Space Science

PHYS 5283 Plasma Technology Lab
PHYS 5381 Space Science
PHYS 5382 Space Science Instrumentation
PHYS 5383 Plasma Technology
PHYS 5385 Natural And Anthropogenic Effects On The Atmosphere
PHYS 6283 Plasma Science Lab
PHYS 6383 Plasma Science
PHYS 6388 Ionospheric Electrodynamics
PHYS 5416 Applied Numerical Methods
PHYS 5305 Monte Carlo Simulation Method and its Applications
PHYS 8V80 Research in Atmospheric And Space Physics

Quantum Electronics

PHYS 6339 Special Topics in Quantum Electronics
PHYS 8V30 Research in Quantum Electronics

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PHYS 5361 Fourier Optics
PHYS 6366 Optics of Photonic Band Gap Nanostructures
PHYS 6369 Special Topics in Optics
PHYS 8V60 Research in Optics ¶

Thesis and Dissertation Courses

PHYS 8398 Thesis
PHYS 8399 Dissertation