The Department of Physics: 1987-88

I. Description of Department

Physics is the science of the nature of matter, interactions between material objects, and interactions between matter and energy. Physics is commonly regarded to be the foundation of natural sciences and engineering.

The Department of Physics at SMU has historically served two principal functions: (1) service teaching of undergraduates whose major course of study is in another department, and (2) teaching a small, high-quality, undergraduate, physics-major program. The average number of bachelor degrees awarded in physics is about three per year, averaged over the history of the university. This number is comparable with the number of professional B.S. - degree graduates in chemistry and biology at SMU. In the Fall Semester, 1987 about 370 non-major students are being taught in service courses. Presently, the B.A., B.S., and M.S. degrees are offered in physics. A double-degree program is jointly offered with the electrical engineering department such that a student can simultaneously obtain a B.S. in physics from Dedman College and a B.S. in E.E. from the School of Engineering and Applied Science.

Physics graduates typically enter technical careers. Nationally, about 50% enter graduate school and about 50% are immediately employed. Of the 50% that enter graduate school, about 29% study physics and 21% study other subjects.

The Department of Physics consists of 8 faculty and 3 staff. The Science Division Shop, consisting of 1 staff member, is also budgeted through the Department of Physics.

II. Outstanding Features of Physics Program

Two features of the SMU physics program of which we are most proud are our traditional ability to prepare undergraduates for graduate study in physics and the success of those students in their continuing work. Our best undergraduate physics majors have been admitted to the top-ranked group of graduate schools (Princeton, Stanford, Harvard, California Institute of Technology, Yale, etc.); as far as we know, all have been well-prepared and successful. In the only survey of which we are aware, SMU ranked 21'st nationally in the percentage of its undergraduate physics majors who went on to obtain a Ph.D. in physics. Our most notable alumnus is Dr. James W. Cronin (B.S., 1951), presently Professor of Physics at the University of Chicago, who was awarded the Nobel Price in Physics in 1980. We attribute this perennial high rate of success to our having excellent students, our relatively-small classes, the personal interest in individual students shown by the faculty, and high academic expectations by SMU physics professors.

Our most important present asset is the young faculty we have added since 1983 (1 in '83, 1 in '85, and 2 in '86). Each of these professors received his Ph.D. from a school ranked in the top 10% of Ph.D.-granting physics departments in the United States. Each has postdoctoral research experience (2-11 years) before coming to SMU. These four professors, three experimentalist and one theorist, have common scholarly interests so that they form an effective research group in the general topical area of laser-matter interactions. Their research interests include fundamental interactions in atoms, photophysics of solid surfaces, quantum optics, and nonlinear dynamical systems that exhibit chaos. Such studies have relevance to both basic and applied physics. Furthermore, the scholarly interests of this group complements research in photothermal/photoacoustic spectroscopy and imaging that has been active in the Physics Department and internationally recognized for almost a decade. The various projects in the Physics Department have applications in optical communication and computation, laser design, materials characterization, nondestructive evaluation, and computer physics.

III. Goals and Needs

Our immediate goal is to increase the number of undergraduate physics majors. A major step in achieving that goal was the curriculum modification of 1986-87, which included three principal features: (1) reducing the size of service-teaching classes (General Physics) to a maximum of 25 students per section, (2) redesigning the physics-major curriculum, and (3) increasing the personal interaction with physics majors by actively involving them in the scholarly research of the faculty.

In the near future, we hope to reactivate a graduate program in physics, offering both M.S. and Ph.D. degrees. As a first step toward this goal, we are participating with the Department of Chemistry and the School of Engineering and Applied Sciences to offer a graduate program in Materials Science. A strong physics-major program and/or graduate program is vital in attracting and retaining the best faculty. Phisicists have excellent job opportunities in the industrial and government sectors; the opportunities to interact with good students and to do research of one's own choosing are the principal attractions in faculty recruitment.

High school students who indicate physics as a probable career as a group have the highest average mathematics score and the second highest average verbal score on the scholastic aptitude test (SAT). This means that the expected academic quality of prospective physics majors is very high. Unfortunately for SMU at present, it also means that recruitment of such students is very difficult since they are in high demand at all good universities. Scholarships for physics majors at SMU is therefore one of our highest-priority needs at this time.

In order to have a physics program commensurate in quality and vitality with the best small undergraduate colleges or universities with whom SMU is usually compared, we must have a minimum of about 12 full-time faculty in the Department of Physics and the good students -- certainly undergraduate, but also graduate -- to go with them.

RESEARCH INTERESTS

Jeff Chalk

My research interests are in applications of quantum mechanics. My research time while at SMU has been given mainly to the quantum theory of scattering with nuclear physics as the principal focus, but my interests have gradually shifted toward solid state physics. My most recent research has consisted of a study of the propagation of wave packets, and I want this to provide the basis for a transition to solid-state theory. My experience fits fairly well the research area of scanning tunneling microscopy, so I intend to familiarize myself with recent progress in that discipline. Since I am essentially a beginner in this new field, the problem of making the transition is not small. In order to help make this transition possible, I plan to phase out my recent commitment to developing lecture demonstrations in physics.

10/17/87

RESEARCH INTERESTS

George Crawford

ACID RAIN, The pH of almost every rain in the Dallas area has been measured over the past three years. A summary paper on the results of the three years work has been submitted to the Air Pollution Control Association for presentation and publication as part of the APCA annual meeting to be held in Dallas, June 19-24, 1988. The paper combines pH measurements, air pollutant data and air mass movements, using a model I have created. In June, 1987, I created and hosted an international conference on acid rain on the SMU campus. There will be another such conference under my direction during the APCA annual meeting, 6/19-24, 1988. I have created and maintain an acid rain network for the Texas Environmental Coalition. The network of data takers extends all across Texas. I continue to operate the SMU SOLAR DEMONSTRATION House and have given many tours and presentations. I am currently revising the cool air part of the equipment, modifying the Lithium Bromide Absorption Chiller as a part of the continuing research. The second phase of research involving my passive solar house in the Upper Red River Valley, New Mexico is well under way. The work will be continued through next summer.

10/17/87

RESEARCH INTERESTS

John Englund

I am currently working on three different projects, each of which involves the theory of nonlinear optical instabilities. One of them is a detailed statistical study of the production of short optical pulses from the Raman effect. This is a problem in quantum optics. In addition, I have been studying the dynamical behavior of a generic model of a laser-irradiated molecule. Among various properties examined are the appearance of chaos and optical bistability. The third area involves the theory of gas-laser instability in connection with frequency pushing.

10/17/87

RESEARCH ACTIVITIES

Kenneth C. Harvey

At present, I am starting an experimental program to confine low-energy atoms in traps consisting of magnetic fields. I have begun calculations of the stability and trapping times of magnetic traps for neutral atoms. A scheme to produce ultra-cold atoms is being investigated and a paper on it is in preparation. A computer-based data acquisition system based on the IBM PS/2 Model 30 has been assembled and is now working. A tunable laser with the resolution and power to cool and interrogate the trapped atoms is being built. The bulk of the kinetic energy must be removed from the atoms for them to initially fall into the trap. I have developed a scheme to inject the atoms into the trap with improved efficiency compared to other current efforts. A paper on this technique is in preparation. Finally, a magnet to produce a confining magnetic field for the trap is being designed and built. Very recently I have been working on a proposal to Teledyne Geotech for a laser-based seismometer. The device would increase the present level of sensitivity for seismometers. A modest level of external funds appears available for this project. In the most recent past, I have developed an optically-pumped, metastable hydrogen beam for use in the parity experiment being done at the University of Michigan. The properties of a radio-frequency plasma for a vacuum ultraviolet lamp and hydrogen dissociation beam source were calculated. Parts of the atomic beam, such as lamps, detectors and sources, were designed and constructed. It remains to finish some analysis and to publish the results. To facilitate this, an AT&T 3B2/310 computer system has been put together. The system is networked with a number of other systems for communications. A word processing package using troff and an HP LaserJet Laser printer has been installed and is now working. One paper on UV transmitting windows has been completed and another on optical-pumping efficiency is near completion. I am also working with new computer techniques in physics. I have developed a new software environment for computer-aided data acquisition and signal analysis in the laboratory. I have begun to investigate the possibility of bringing NSFNet to SMU. The principle node in Texas for NSFNet is at Rice University. A gateway to this network would bring to SMU improved communications with other universities and the national supercomputer centers.

RESEARCH INTERESTS

Georges Jamieson

I am interested in the study of collisions of atoms and molecules in the gas phase. Currently I am most interested in the transfer of energy from an excited molecule to another molecule or atom during a collision. This collisional excited energy transfer can be studied in detail through the use of laser excitation and subsequent measurement of the polarization of laser-induced fluorrescence light. During the past few years I have also become interested in the interaction of strong laser beams with solid surfaces. The techniques developed during this research are being used in the energy transfer work in order to produce supersonic molecular beams of excited atoms of refractory materials.

10/17/87

RESEARCH INTERESTS

A. T. Rosenberger

My research interests lie in the field of optical physics, specifically in the area of quantum optics, nonlinear optics, and related topics. Present investigations involve optical bistability, the properties of high-finesse optical resonators, and instabilities occuring in the interaction between light and atoms or molecules. An example of this last is a completely passive optically bistable system consisting of a molecular gas cell within an optical resonator, which can be used in transmission to impress a modulation on a resonant laser beam. This instability and its evolution with incident laser intensity are characteristic of a transition from a state of order to a state of deterministic chaos. Nonlinear dynamics, the study of instabilities and transitions to chaos, is a wide-ranging field of interdisciplinary applicability and importance. Another example being studied is the occurrence of chaos in multiple-pulse superradiance. Optical systems are especially attractive for basic experimental studies of chaos, because of the high data rates possible; these chaotic effects could also prove to be important in applications of optical physics to communication and computation.

10/17/87

RESEARCH INTERESTS

C. W. Tittle

My principal research interest is neutron physics, including neutron detection, neutron absorption, and neutron transport in matter. The primary application is to nuclear well logging, in which neutrons are used to measure certain properties of earth formations *in situ*. My most recent research has involved developing a method to interpret a particular neutron logging system by use of the neutron macro-parameters, slowing down length and thermal diffusion length. The method turned out to be quantitative and will have important application in the oil industry. The first paper on this subject is about to be published in Nuclear Geophysics, probably in the next issue which is due at any time. A second paper is nearly ready for submission. My broader research interest is in applied nuclear physics, including gamma ray spectroscopy and radioactive tracers.

10/16/87

RESEARCH ACTIVITY

Grover C. Wetsel

Application of the photothermal-optical-beam-deflection-imaging apparatus to materials characterization and nondestructive evaluation is continuing; present investigations include imaging of grain structure in semiconductors (with Dr. Thomas Moore of Texas Instruments) and superconducting/normal areas in high T_c superconductors. An experimental search for chaos in coupled, continuum electromechanical systems is in progress. Development of a scanning tunneling microscope has been completed; the first working model is currently being tested in air. High vacuum operation should be accomplished by the end of the year. A laser-heterodyne interferometer is being assembled for construction of an atomic force microscope. Whereas the tunneling microscope is restricted to the study of conductors and semiconductors, the force microscope can be used to image insulators and magnetic materials on an atomic scale.

10/17/87