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In This Issue:

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The View from the Chair

Since August 1, 2007, I have had the privilege and pleasure of serving as the department chair of physics at TTU. I am excited about the great potential evident all around me, and I would like to share a few thoughts about where we are as a department and the direction I would like us to take in the future.

This semester, Spring 2008, we have introduced two special sections of introductory physics for our majors, Physics I and II. We have also instituted a fresh approach to teaching introductory labs, with the focus more on inquiry than on following a predetermined recipe. Teaching assistants who are responsible for these labs are also required to take a graduate course in which these modern pedagogical methods are covered. We are currently searching for a Director of Instructional Laboratories, a newly generated staff position that requires an advanced degree. There are several other changes ahead of us in the undergraduate program, including the upgrading of all levels of undergraduate labs (Physics III, sound/music, optics, and advanced), better sequencing of courses for majors, the introduction of a capstone project, and so on. As we introduce changes to our curricula, we will evaluate the student learning outcomes, and I should be able to report on these in the next issue of *physics@ttu*.

Our Engineering Physics undergraduate program was revisited in October 2007 by the accreditation agency (ABET), which followed up on the previous review that took place in 2005. With the agreement and the support of the College of Engineering and the College of Arts and Sciences, I have undertaken the mission to not only "fix" this program but to build a modern and competitive curriculum that will be at the leading edge of critical issues in science and engineering. This program will address the most relevant problems of our time, for instance, energy, materials, environment, and communication. We now have a task force designing this unique major, about which they will make a complete proposal in May 2008. I welcome participation and input from our alumni concerning this critical and ambitious project.

Our astronomy courses have been attracting increased enrollment. Both the solar and stellar astronomy classes are filled to the brim this semester, and the Gott Skyview Observatory near Shallowater is increasingly utilized by these students to observe the night skies. We are renovating this facility to provide a larger telescope, an enlarged structure around the dome, ADA-compliant access to the main telescope, a classroom, and the observatory's first bathroom. I welcome support from our alumni for these significant improvements.

The research productivity in our department is on the rise. The number of faculty with publications shows an increasing trend: 10 in 2001, 12 in 2002, 11 in 2003, 12 in 2004, 15 in 2005, and 17 in 2006. And the number of refereed publications by our faculty went up to more than 60 in 2006 from 36 in 2001. The annual external funding levels have hovered around $2M for the last six years, fluctuating somewhat in response to faculty departures and additions. Our faculty is striving hard to garner new research dollars, and we are committed to exploring all possibilities to increase the kind of externally funded research that will promote intellectual depth in both our undergraduate and graduate programs.

Last semester, I streamlined the way faculty members contribute to the running of the department. Now, four groups carry the main load: Undergraduate Affairs, Graduate Affairs, Faculty Affairs, and Infrastructure/Facilities. These working groups are convened by Professors Thacker, Lichti, Estreicher, and Huang, respectively, and each group comprises approximately five faculty members. Professor Thacker is also Associate Chair. We are very fortunate in our committed, hard-working, and creative faculty.

We have been additionally blessed with generous scholarship endowments from our Tech family. These scholarships enable many students to fulfill their dreams towards a professional career in science and technology. We rely heavily on our alumni and friends for their continued support.

This newsletter issue features four short articles about current research topics pursued by some of our faculty. On page 5, Professor Cheng gives an interesting perspective on the crossroads between physics and Alzheimer's disease, while on pages 9-10, Professor Lichti discusses the interesting phenomenon that he and his collaborators have uncovered concerning magnetic polarons. Professor Wilhelm's research has recently resulted in an article in *Nature*, and on pages 11-13 he gives us a glimpse of galactic halos. Finally, John Davis from TTU's Office of Communications and Marketing wrote a news piece for Tech's web page—one click away from the main page—titled *Hunting for the God Particle*. With his permission, this summary of the high-energy physics group's main effort appears on pages 14-16.

I envision this newsletter, *physics@ttu,* as a primary means of communication for our faculty, staff, students, alumni, and friends. Such a vehicle can build stronger institutional memory as it highlights both our successes and failures. These pages will serve as our mutual window between those who are most diligently working to move our department into a bright future and those who would like to help. Let me invite all who care about our department to contribute in any way they feel able, whether financially or by sharing your ideas in this forum. On the road ahead of us, we need all our dedicated alumni and friends.

Sincerely yours,

Nural Akchurin

Nural Akchurin
Professor and Chair
(nural.akchurin@ttu.edu)

Computing Alzheimer's Disease

Kelvin Cheng

The word "protein" originates from "πρώτα", a Greek word meaning "of primary importance." Like other biological molecules such as lipid, polynucleotide (DNA or RNA), and polysaccharide, proteins participate in all the major cellular processes in our bodies. Proteins are linear polymeric molecules made up of sequences of covalently linked amino acid units. They act as enzymes that catalyze the biochemical reactions, as pumps or channels that regulate the ion concentrations, and as biopolymer networks that provide the mechanical movements and scaffolds of our cells. Some proteins are involved in the signaling pathways, immune responses, and energy metabolisms of our body. To work properly, all of the above processes require the participating proteins to maintain specific and highly dynamic conformations.

Most of the proteins are synthesized from DNA via a two-step process of transcription and translation. However, certain proteins are formed directly from some other larger proteins by an enzymatic cleavage mechanism involving a set of proteins known as proteases. Under normal circumstances, this cleavage process is regulated, and it represents

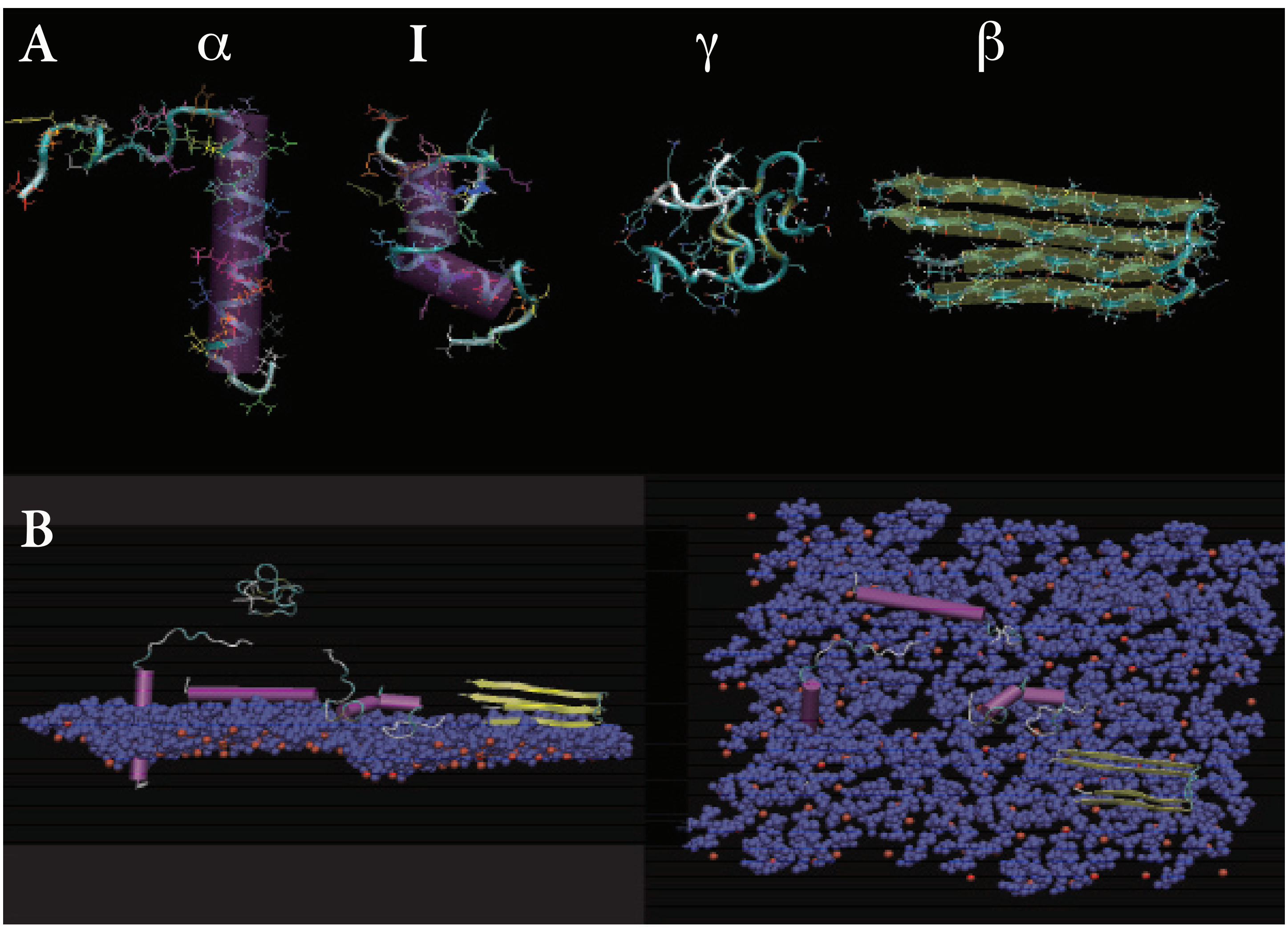


Figure 1: Various atomistic structures of Beta-amyloid (A) and their orientations in a cholesterol (red) /phosphatidylcholine (blue) bilayer membrane surface containing cholesterol nano-domains (B) are shown. For clarity, only the polar atoms of the monolayer are shown.

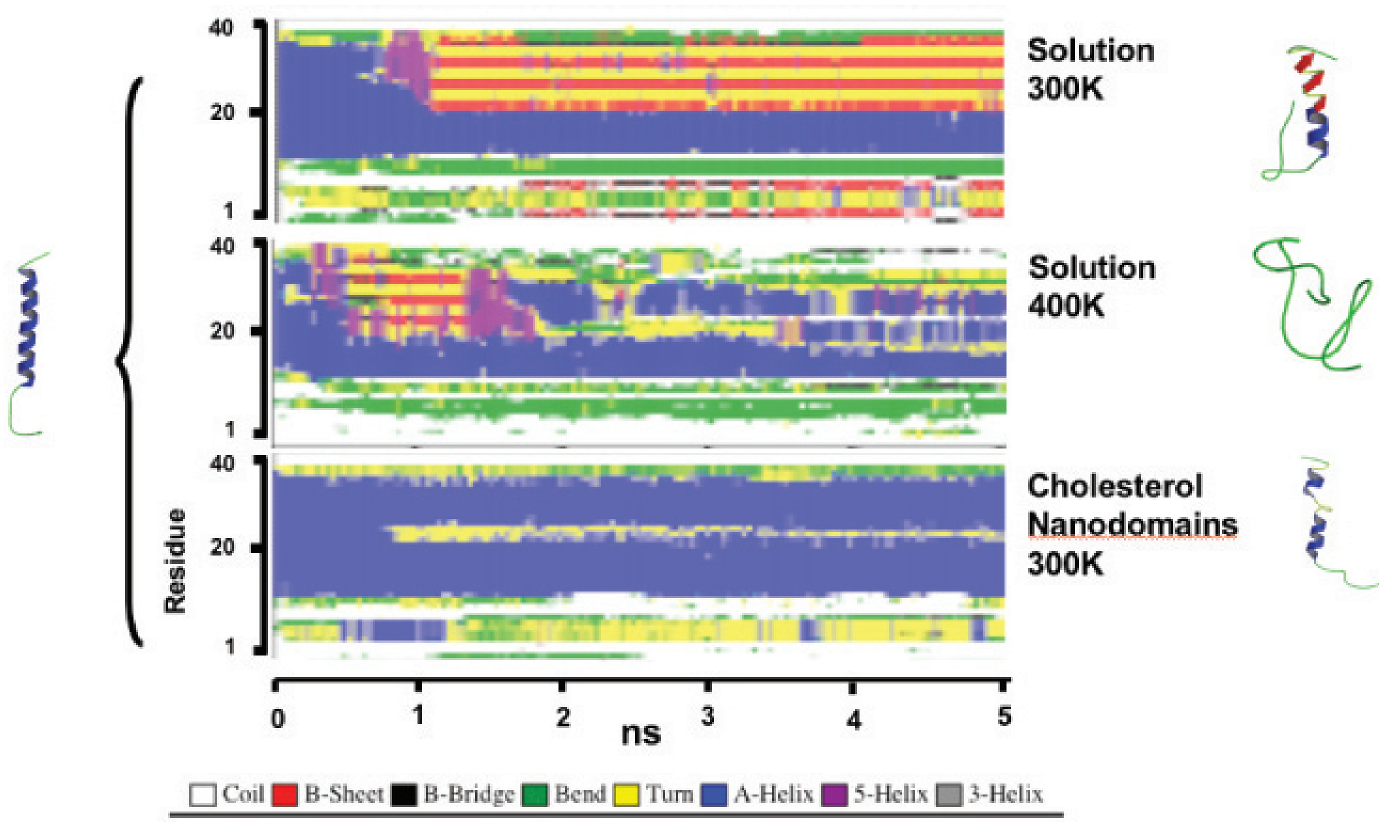


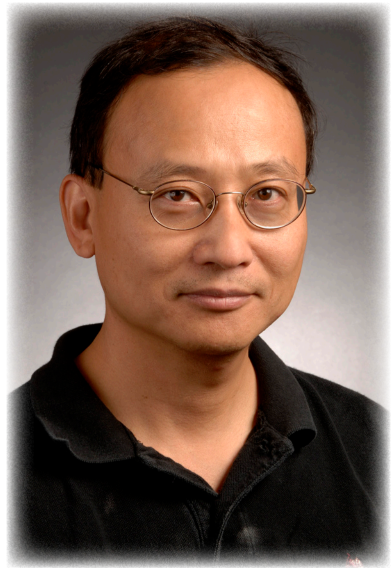
Figure 2: Time-evolution of the secondary structures of beta-amyloid in three molecular environments: solution (T = 300 K), solution (T= 400 K) and the surface of lipid membrane containing cholesterol nano-domains (T = 300 K).

an essential contribution to normal physiological pathways and defense mechanisms inside our bodies. However, some protein cleavage products may misfold and self-aggregate upon their release. Failure to get rid of these aggregated products has been known to be the leading cause of the "protein-aggregation" diseases, *e.g.*, Bovine spongiform encephalopathy (mad-cow disease), Huntington's, Parkinson's, and Alzheimer's. The detailed mechanisms of how and why certain proteins undergo misfolding and aggregation are still unknown.

Among various "protein-aggregation" diseases, Alzheimer's disease has been of particular scientific interest for decades. It is estimated that one in ten persons over age 65 and about half of those 85 or older have this progressive and incurable disease. Currently, it has affected more than five million Americans, and that number could more than triple by mid-century as our population ages. Most scientists believe that the misfolding and self-aggregation in the brain of a particular protein, beta-amyloid, are the major molecular events that trigger the early onset of Alzheimer's disease. Beta-amyloid is a short protein that consists of only 39 to 43 amino acid residues. According to the current Amyloid Cascade hypothesis, beta-amyloid is released from the controlled cleavages of a large beta-amyloid precursor protein in the neurons of the brain by two proteases, beta and gamma secretases. It is believed that beta-amyloid is a normal metabolic product in the neurons. However, some freely released beta-amyloid chains may misfold and aggregate to form highly toxic oligomers, which attack the surface of neurons in the brain. Subsequent self-assembly of the toxic oligomers, or pre-fibrils, results in an irreversible accumulation of amyloid fibrils on neurons, the hallmark of end-stage Alzheimer's disease found in the brains of patients.

To design effective therapy for this disease, an understanding at the atomistic level of the misfolding and aggregation events of beta-amyloid is urgently needed. At present, the detailed structures of the misfolded monomer and oligomers of beta-amyloid are still not clear. Knowledge of these structures will provide important clues for developing new therapeutic intervention, known as anti-aggregation therapy, that will target beta-amyloid early aggregation for the treatment of Alzheimer's disease. At present, most research efforts are focused on the misfolding and aggregation events of beta-amyloid in the solution phase. Very little, if any, is known about similar events on the surface of neurons, the primary target of beta-amyloid in the disease progression of Alzheimer's disease.

From a computational standpoint, the reason for this lack of detailed information about the misfolding and aggregation events of beta-amyloid and their structures on the neuronal membrane surface is the difficulty of creating a realistic neuronal membrane surface mimic. Previous computational studies on beta-amyloid/membrane interactions focused on simple one-component and continuum lipid membrane systems that failed to capture the molecular organizations of certain key membrane components (lipids) and atomistic interactions between the lipids and beta-amyloid molecules.



Professor Kelvin Cheng (kelvin.cheng@ttu.edu), a biophysicist, has been with our department since 1989. One of his recent interests is protein folding and its ramifications for our health. He explains his work on a computational approach to explore the early misfolding and aggregation events of Alzheimer's beta-amyloid proteins on the neuron surface. Professor Cheng is teaching graduate-level Molecular Biophysics this spring.

Recently, we have successfully designed and constructed a multi-component neuronal membrane mimic with nano-scale architecture. This model membrane consists of a bilayer made of cholesterol and phosphatidylcholine, the major lipids found in neurons. In addition, cholesterol nano-domains of defined lateral organization have also been simulated. Recent studies have indicated that these nano-domains are dynamically stable structures in lipid membranes. Also, they can regulate the activities of certain membrane surface acting proteins and the amyloid cascade process leading to Alzheimer's disease. However, the mechanism by which these nano-domains affect the misfolding and aggregation of beta-amyloid on the lipid membrane surface remains unknown and constitutes the major focus of our work.

To explore the folding and aggregation events of beta-amyloid on the neuronal membrane mimic with nano-domains, we plan to utilize a computational approach involving both coarse-grained and all-atom molecular dynamics (MD) simulations. This new hybrid MD method will allow us to sample a large configuration space, achieve simulation times in milliseconds, and reveal atomistic details of conformations -- all necessary to unraveling the complexities of protein folding and aggregation events on membrane surfaces.

Figure 1 summarizes the design framework of our computational study. Here, we first constructed the monomeric beta-amyloid in the α-state. We then constructed two water/protein/membrane molecular clusters, one with the protein partially inserted in the lipid membrane and the other with the protein lying on the lipid membrane surface (Figure 1B). The lipid membrane surface shown here consists of 40% cholesterol, a biologically relevant lipid composition found in the neurons, with stable highly ordered cholesterol nano-domains. Finally, we constructed a third cluster consisting of water/protein only and in the absence of the lipid membrane that serves as a control. Some initial results of the intermediate state, or partially folded beta-amyloid (I-state) and completely unfolded protein (γ-state) in solution, are shown in Figure 1A. The aggregated beta-sheet stack structure (β-state) of beta-amyloid in solution published by another research group is also shown for comparison.

Figure 2 shows our 5-ns simulation data of beta-amyloid in three different environments: with the solution at T = 300 K and 400 K, and on the membrane surface with cholesterol nano-domains at T = 300 K. It is clear that the misfolding pathway of the protein in the 3D isotropic solution phase is distinctly different from that on the 2D membrane surface with cholesterol nano-domain structures. The appearance of beta sheet (red) and turn (yellow) structures is a signature of the misfolding regions of the protein that may lead to the development of a beta-sheet stack, the currently hypothesized structure of the toxic oligomer of beta-amyloid (Figure 1A).

Our plan is to compare the structures of our aggregated state of beta-amyloid on the membrane surface and in solution with the published toxic oligomer structures in solution, and to examine the stability of the protein that is partially inserted in membrane. The latter mimics the structure of the protein immediately after its release from the cleavages of the large beta-amyloid precursor protein. We anticipate that our information-rich MD simulation data will provide unique opportunities for data mining, *i.e.*, the search for the unique conformations of the protein that will help us to design drugs that target the misfolding and self-aggregation structures of beta-amyloid. Two Ph.D. students and

Dr. Mark Vaughn from the TTU Chemical Engineering Department are also involved in this project. The Welch Research Foundation, NSF, and HPCC of TTU provide support.

ON THE WEB

For a 200-ns simulation of all-atom simulations of PC/cholesterol nano-domains:

www.phys.ttu.edu/~kcheng/hpcc/CR_Z1.mpg

The polar atoms of PC are in blue, the cholesterol polar head group is in yellow, the hydrophobic chains are in light blue, and water molecules are in red/white dots.

For a 5-ns all-atom simulation of the unfolding of Alzheimer's beta amyloid protein on lipid nano-domains:

www.phys.ttu.edu/~kcheng/hpcc/alphaSL_SU.mpg

The protein is in white. The lipid polar atoms (cholesterol in pink and PC in blue) are also shown.

Society of Physics Students

Stephen Torrence, the president of SPS, says the society provides an opportunity for physics and engineering physics students to meet, collaborate, and generally share their passion for the field. He invites all interested students to participate in the society's activities. He can be contacted at stephen.torrence@ttu.edu.

SPS officers Eric Andersen (left), Anthony Chappa, Stephen Torrence and George Laity (front) are seen at the 2007 banquet.

SPS organized two activities in 2007: Ballistics Day, hosted by Professor Glab, and the Star Party Picnic at the Gott Skyview Observatory, which was co-hosted by the South Plains Astronomy Club. Both were well attended.

Planned future activities include a lecture on medical physics by Dr. Murali Nair from the Joe Arrington Cancer Center and a visit to his facilities at Covenant Hospital. Additionally, a visit is planned to the Nano Tech Center this spring.

SPS traditionally organizes the annual Spring Scholarship Banquet. This year's award ceremony is scheduled for Thursday April 10th at 3:30 PM in the Science Building and will be followed by a banquet at the Merket Alumni Center. We would love alumni to attend this event. Those interested should contact the department office. Each banquet features invigorating disquisitions. For instance, Professor Borst shared his critical analyses of student learning data at the 2007 Spring Scholarship Banquet (right).

Magnetic Polarons

Roger Lichti

As my primary research over the past fifteen years or so, I have investigated the physical and chemical behavior of the hydrogen atom as an interstitial impurity in semiconductor materials by using implanted positive muons to form a very light, short-lived 'isotope' of hydrogen known as muonium. This work has been very successful and has provided much of the experimental basis for our current understanding of isolated hydrogen impurities in these materials as the precursor to technologically important defect chemistry in which hydrogen reacts with other defects to help stabilize electrical and optical properties critical to devices like semiconductor lasers.

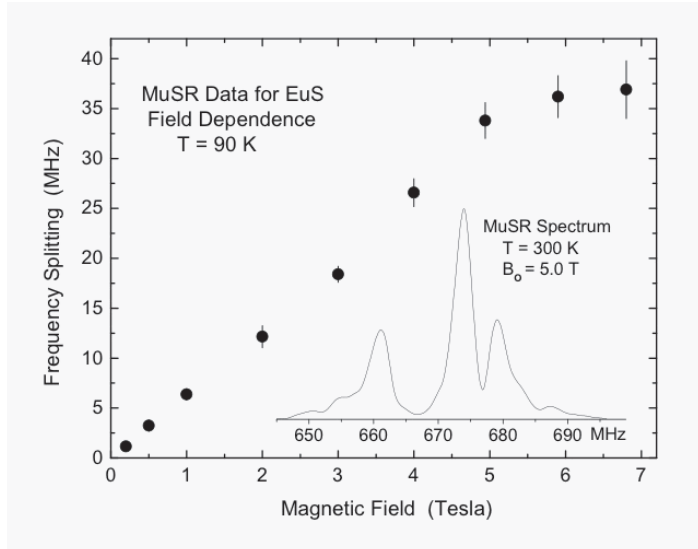
Very recently, I have joined with colleagues from the Kuchatov Institute in Moscow and the University of British Columbia in Vancouver to use muons to study the details of magnetism on the microscopic scale in ferromagnetic (FM) semiconductors, which are candidate materials for 'spintronics' devices. Here the muon serves as a sensitive probe of local magnetic fields and their fluctuations. The data we obtain on the atomic scale distribution of internal magnetic fields will help decide between competing theories of FM interactions in diluted magnetic semiconductors (DMS), such as GaAs doped with Mn, which shows a maximum T_c of about 160 K. Mn-doped GaAs is *p*-type and the holes mediate the FM coupling between Mn^{2+} ions, but details are not yet understood. Other materials, such as the II-IV-V_2 chalcopyrites, are being developed in an effort to reach room temperature ferromagnetism in a functional semiconductor so as to make spin-based devices commercially viable. We observe ordered magnetism up to 350K in Mn-doped $CdGeAs_2$.

A second method of introducing spin into a functional device is to inject spin-polarized electrons into the active region of a transistor, using magnetic layers in traditional silicon based ICs, for example. Interface barriers make magnetic metals very poor injectors, but concentrated ferromagnetic semiconductors such as EuS can work, although its T_c = 16.5 K. However, the concentrated FM semiconductors show a number of precursor effects well above T_c that can be explained by development of magnetic polarons. These are small regions of FM order in which a quasi-localized electron couples with the magnetic ions inside its somewhat extended wave function. Free magnetic polarons only exist just above T_c, but an electron weakly bound to a positively charged impurity can form a bound magnetic polaron at much higher temperatures. Destruction of these polarons by an electric field should release spin-polarized electrons and may bypass the requirement of long-range FM order for a useful spintonics device.

We recently discovered a muon spin precession spectrum in EuS that has many of the features anticipated for a magnetic polaron. The implanted muon serves both as the impurity which captures an electron to initiate formation of this bound magnetic polaron and as a probe of its characteristics. We have obtained dependences on both temperature and applied magnetic field that allow us to determine both the size and magnetic moment of the muon-induced magnetic polaron in EuS. We have found similar spectra in five other semiconductors with an FM ground state: EuO, EuSe, and three members of a second class of FM semiconductors.

The experimental methods we use are known as MuSR, which stands for muon spin rotation, relaxation, or resonance, depending on the exact technique. These are variants of magnetic resonance that make use of the effects of parity violation in both the production of muons from pion decay and in the decay of muons themselves. Our experiments use three international MuSR User Facilities: TRIUMF in Vancouver, the ISIS Facility of the Rutherford Appleton Laboratory near Oxford in the UK, and the Paul Scherrer Institute (PSI) in Switzerland. These labs produce beams of 100% spin polarized 4.1 MeV muons, which are implanted into our samples. When a muon decays, a positron is emitted preferentially along the instantaneous direction of the muon's spin, allowing us to determine the time evolution of muon spin on average from histograms composed of roughly 10 million muon decay events per data point. The muon lifetime of 2.2 μs and its Larmor precession frequency of 135.5 MHz/Tesla determine the basic time scale for the sensitivity of MuSR techniques.

The insert in the accompanying figure shows the spectrum that is assigned to a magnetic polaron in EuS. Data were obtained at TRIUMF using a MuSR spectrometer with high frequency resolution in fields up to 7.0 Tesla. The central line is from muons that have not captured an electron, while the two outer lines are from the magnetic polaron, specifically from muon spin-flip transitions with the electron spin either "up" or "down." As the temperature is lowered, the splitting increases and its field dependence eventually saturates, as shown at 90 K. These dependences and other features easily distinguish this spectrum from that of any standard neutral muonium species.



Our model for this spectrum is currently rather simplified, assuming a spherical *s*-state electronic wave function that extends over a region containing *N* magnetic Eu^{2+} ions. Without the magnetic ions, one would see a splitting equal to the electron-muon hyperfine constant, which in the simplest model of a donor impurity yields both the binding energy and radius of the electron's wave function. We modified this picture to replace the electron magnetic moment with the total polaron magnetic moment, creating the hyperfine field sensed by the muon. The observed saturation at 90 K yields a saturated hyperfine constant of roughly 37 MHz. Combined with the low-field slope, we get a net polaron moment of between 35 and 40 μ_B and a net polaron spin of 18 - 20. These values yield a polaron radius of nearly 0.7 nm, which in turn should enclose roughly 15 magnetic ions. More detailed fits that include amplitudes of the spectral lines and the inferred electron spin polarization will refine these numbers, and a more realistic model of the couplings between an electron and the magnetic ions will be required to complete our characterization of the magnetic polaron in EuS. These data constitute the first spectroscopic evidence and direct characterization of a magnetic polaron. A publication announcing these results is currently in the final stages of preparation.

Professor Roger Lichti (roger.lichti@ttu.edu) specializes in condensed matter physics. He has been on the TTU faculty since his arrival in 1979 as an assistant professor. In this article, he shares with us his recent discovery of magnetic polarons. Professor Lichti is the convener of the Graduate Affairs Group and will also serve as the graduate advisor beginning June 1, 2008.

The initial MuSR spectroscopy of a magnetic polaron -- along with a number of other early results demonstrating well ordered internal magnetic fields below the ordering temperature and development of magnetic features above T_c for both the concentrated and diluted ferromagnetic semiconductors -- shows great promise for MuSR techniques to yield unique new information on the materials being developed for possible spintronics applications. This growing collaboration will soon begin using a very unique low-energy muon spectrometer at PSI to investigate internal magnetic fields in thin layers of magnetic semiconductors as a function of depth in geometries much more relevant to potential devices. We have obtained well characterized samples from some of the world's leading materials development groups working in this field and expect eight to ten weeks of MuSR Facility time to be allocated to this overall project during 2008.

ON THE WEB

www.isis.rl.ac.uk/muons

musr.org

lmu.web.psi.ch

www.phys.ttu.edu

A Tale of Two Halos

Ron Wilhelm

Astronomical research in the Department of Physics at Texas Tech has been experiencing a renaissance for the past six years. This past year, we marked the culmination of several years of intense stellar research with a discovery publication in *Nature* (Carollo *et al*, Volume 450, 13 December 2007), entitled *Two Stellar Components in the Halo of the Milky Way*. This paper shows for the first time that the halo of our Milky Way galaxy is composed of two distinct populations of stars.

The Milky Way galaxy, like most other spiral galaxies, has three main components of stars: a central bulge, a disk with spiral arms, and an outer halo of very ancient stars. The insert below shows an image of the Sombrero Galaxy, which is seen nearly edge-on to the disk.

The halo of the Milky Way is of great interest to astronomers because it contains the first population of stars that formed in the Galaxy. Most have ages of nearly 13 billion years. Because these were the first stars to form in the Galaxy, they are exceptionally good stars for probing the mechanisms at work during the formation and early evolution of the Milky Way. For decades, astronomers have studied small samples of halo stars, and the data from these studies suggested that our Galaxy may have formed as a single giant gas cloud that collapsed under gravity to form the bulge and disk that we see today. In this scenario, the halo stars were thought to form as the gas fell inward, toward the center of the Galaxy. As the gas fell in, the slight amount of rotation in the gas increased and caused the gas to flatten into a disk, just as pizza dough being tossed and spun in the air can be flattened into a thin crust. Unlike the gas (which can suffer collisions), the halo stars that formed could not fall into the disk of the Galaxy because they had no way to change their orbits (they are collision-less) and therefore remained distributed throughout the halo.

With large telescopes to capture spectra of stars, it is possi-

ble to directly examine the atomic elements that make up a given star. The first stars to form in the universe were composed of only hydrogen and helium. All the other elements were forged in the nuclear furnaces of stars and spread back out into the universe when the stars exploded at the end of their lifetimes. New stars that form from a mixture of this processed gas have a greater abundance of these newer elements. When astronomers examined the stars in the halo of the Galaxy, they discovered that these stars have very few processed elements, with some having fewer than one-thousandth the abundance of that of our own Sun. Furthermore, data on the motion of these stars showed that the halo barely rotated around the Galactic center, unlike the disk that rotates at several hundred kilometers per second. These two factors suggested that when the gas in the halo was beginning to collapse to form the Milky Way, the first stars formed from nearly pristine hydrogen and helium gas, and that this gas had not yet begun to spin rapidly around the Galaxy.

However, for the past 20 years this model of a single, monolithic collapse for the Galaxy has been brought into serious question. In this model, it is expected that an intermediate population of stars should be found in the halo that contain more processed elements and that orbit at speeds between that of the halo and the disk of the Galaxy. This intermediate population has never been found, suggesting that the Galaxy may have been built up over time from the in-fall and disruption of smaller satellite galaxies that orbit around the Galaxy. This model is known as a "bottom-up" model which posits large galaxies forming from the merger of many smaller galaxies. This model is also consistent with expectations from theoretical models that predict how galaxies formed in the early universe.

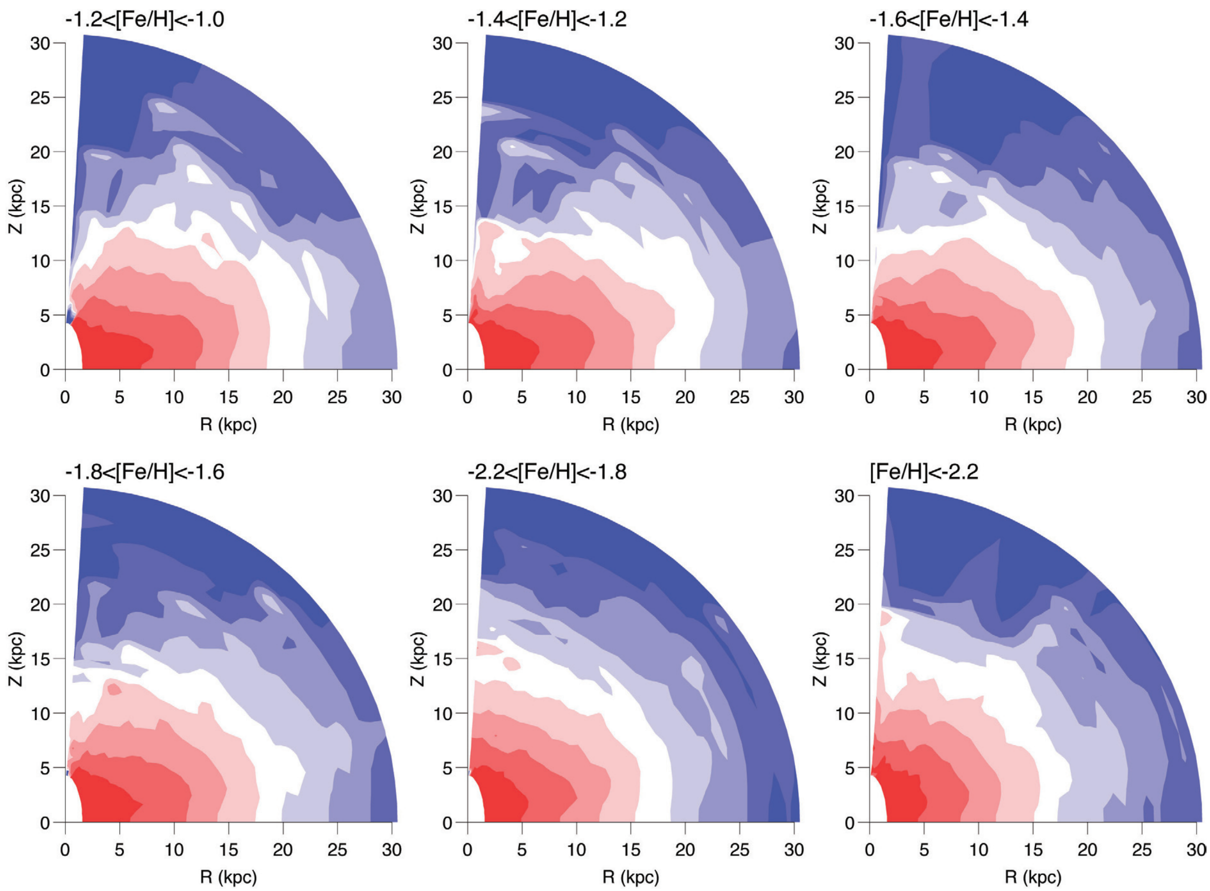


Figure 2: The distance above the disk of the Galaxy (Z) *versus* the distance from the center of the Galaxy. The contours are color coded to show the density of stars --red represents the highest density. The top row plots are for processed elemental abundances that were previously considered typical for the halo. The bottom plots represent stars that are very deficient in processed materials, with the bottom right plot showing the most deficient stars. Notice the halo shape changes from a flattened distribution to more spherical in the final plot.

The discovery of the two halos around the Milky Way is very important new evidence about how the Galaxy formed. This discovery was made through the analysis of over 20,000 stars from the Sloan Digital Sky Survey (SDSS). In the past eight years, the SDSS has accumulated spectra of over one million external galaxies and nearly 250,000 stars in our Galaxy. I have worked for the past four years in collaboration with astronomers from SDSS institutes to develop reliable software to analyze the enormous spectroscopic database at the SDSS. The fruits of this labor are now being realized in that we have determined velocity and processed elemental abundances and distances to tens of thousands of stars in the Galactic halo. Analyzing this enormous sample allowed us to determine for the first time that two distinct stellar populations exist in the halo, one dominating at nearer distances (the inner halo) and one dominating at greater distances (the outer halo).

Professor Ron Wilhelm (ron.wilhelm@ttu.edu) is an observational astronomer. He came to TTU in 2001 as an assistant professor and has recently been promoted to the associate professor rank. Professor Wilhelm is teaching Principles of Physics I for our majors' section this semester. His recent research was featured in the prestigious Nature *magazine's December 13, 2007 issue.*

The inner halo is slightly flattened, like a football and outlines the much flatter disk of the Galaxy. The amount of processed elements is greater than in the outer halo, and the inner halo rotates slightly in the same direction as the disk. The outer halo is more spherically distributed around the Galaxy, like a basketball, and extends to greater distances than the inner halo. It has significantly fewer processed materials than the inner halo and, surprisingly, has a significant rotation that is in the opposite direction of the disk. In the past, this outer halo has been difficult to detect because the orbits of the stars in the outer halo carry them into the inner halo, where they spend a large percentage of their time. Since most surveys of stars, including SDSS, probe the inner halo region, results are confounded by the mixture of inner and outer halo components. Only with the high precision analysis of this enormous number of SDSS stars and the inclusion of the velocity, abundance, and distance data is it possible to separate these two populations. The contour plot from the *Nature* article shows the change from a flattened halo to a more spherical halo when the SDSS data is binned in orbital velocity, abundance, and distance.

The outer halo is expected to have arisen from the disruption of the one or more satellite galaxies that were orbiting the Milky Way counter to the rotation of the Milky Way disk. It would not be possible for a population to orbit counter to disk rotation if the Galaxy were formed as part of a monolithic collapse. This outer halo confirms that the Milky Way has been built up, in part, from small galactic systems. The origin of the inner halo still remains uncertain and could either be part of the collapse of a large gas cloud or the remnants of many early mergers. In any case, this current result is a crucial piece of evidence that will help to solidify our understanding of the origin of the Milky Way and other galactic systems.

Astronomy research in the Department of Physics at Tech has now reached ground-breaking levels. The future will hold many new discoveries as TTU continues its collaboration with SDSS and with other future projects such as the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) being conducted at the McDonald Observatory.

ON THE WEB

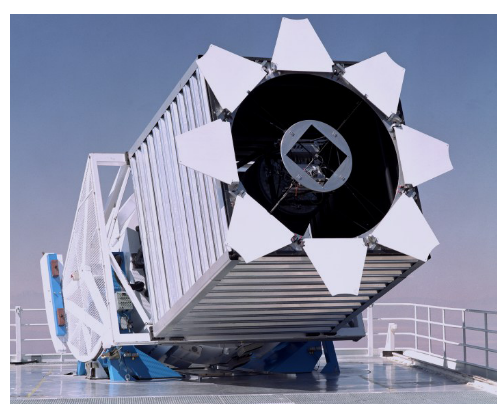
www.sdss.org

www.fnal.gov

www.as.utexas.edu/hetdex/

www.phys.ttu.edu

www.nature.com



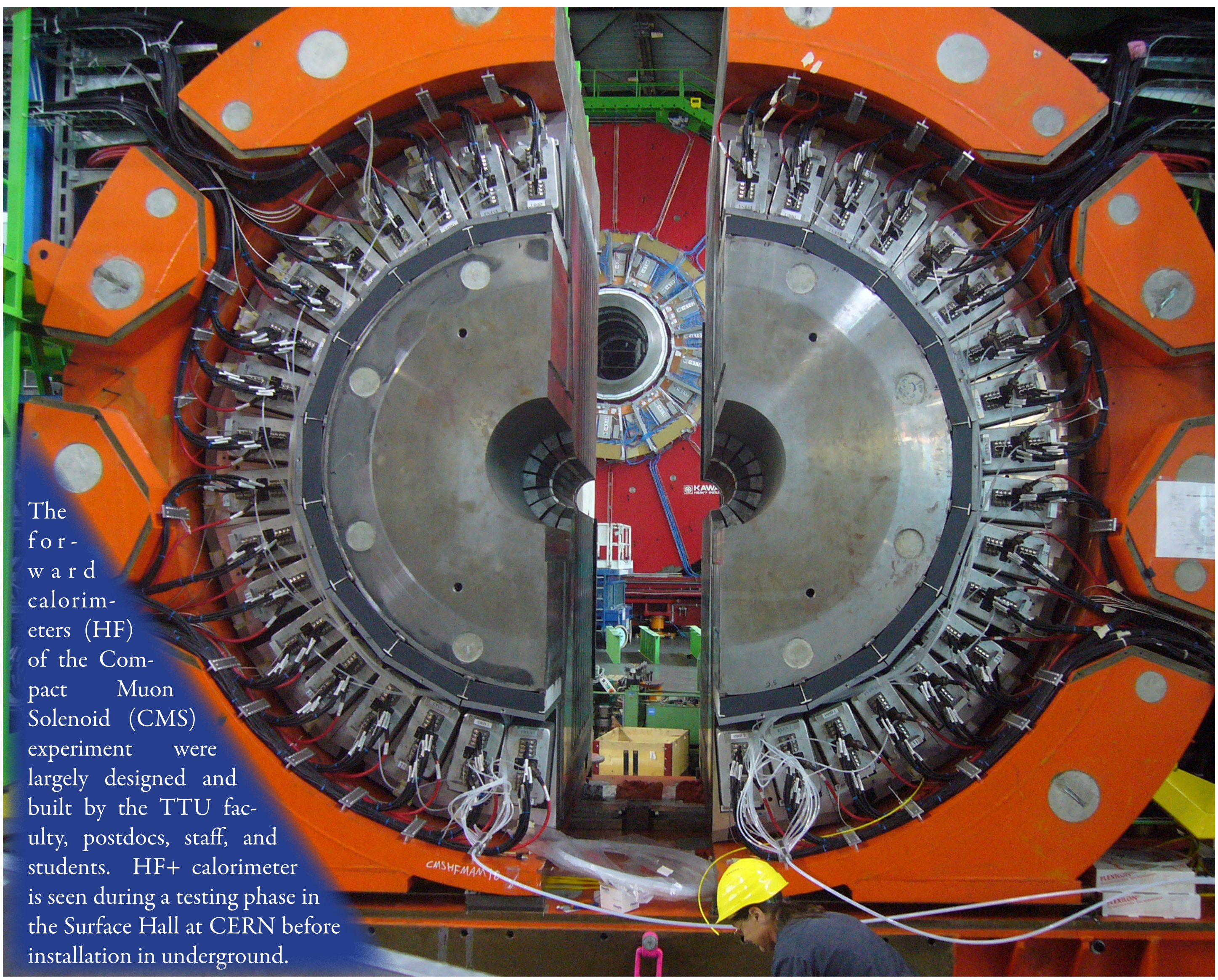
Hunt for the God Particle

John Davis

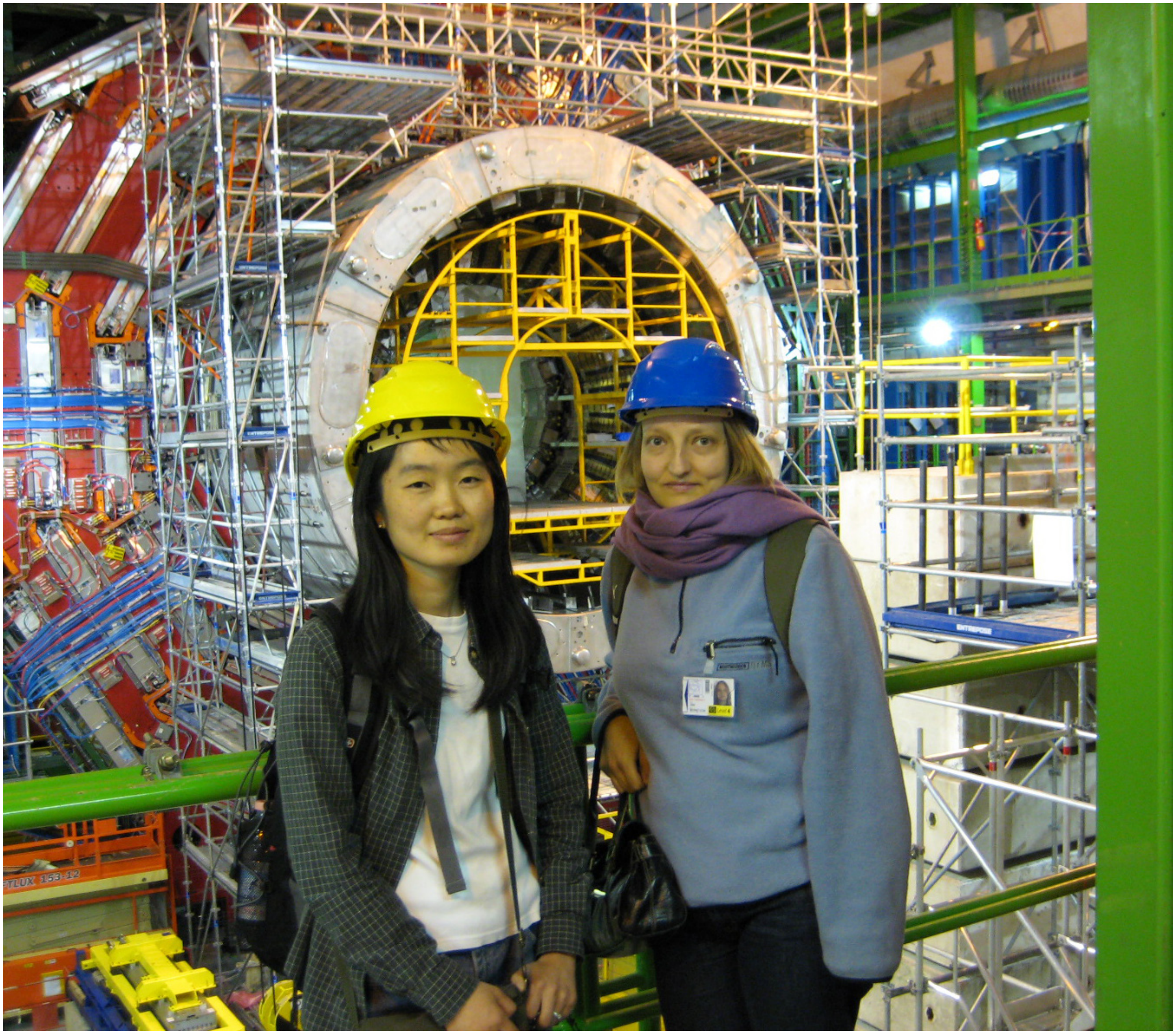
Outside Geneva, some 300 feet below the Swiss Alps and protected from the effect of cosmic rays, a phalanx of more than 2,000 international scientists prepare to fire up the world's largest particle collider to probe the bounds of mass and matter and answer some of the universe's most mind-blowing riddles.

The hunt is on for new particles and phenomena in physics, said Nural Akchurin, the chair of the Department of Physics and a project manager at the European Organization for Nuclear Research, known as CERN. High on the list is the Higgs boson. It's responsible for giving mass to subatomic particles, which make up atoms and so-on until you have a pencil, a rock or a Chrysler.

Simply put – but perhaps too simply – these scientists hope the $8 billion Large Hadron Collider and Compact Muon Solenoid will prove the existence of matter's smallest building blocks when the switch gets flipped in May 2008.



The forward calorimeters (HF) of the Compact Muon Solenoid (CMS) experiment were largely designed and built by the TTU faculty, postdocs, staff, and students. HF+ calorimeter is seen during a testing phase in the Surface Hall at CERN before installation in underground.



TTU Ph.D. candidate Youn Roh and postdoctoral fellow Dr. Lisa Berntzon of the High Energy Physics group are in front of the Compact Muon Solenoid (CMS) experiment at CERN (2007). The cylindrical structure in the background is a 4 Tesla superconducting magnet and the largest in the world.

Akchurin and three other Texas Tech professors are responsible for building the calorimeters – the catcher's mitts – they hope will contribute to these historic discoveries of phenomena that will usher in a new age of physics.

Barely cracking the spine of this "new physics" brand of particle science can overwhelm the average Joe. For instance, some theories suggest there actually 11 dimensions instead of four. Another says we live in a multiverse instead of a universe. Isaac Asimov or H.G. Wells contrived such ideas in fiction. But many physicists believe these theories are halfway proven already, Akchurin said. Their proof may come after the conclusion of the experiments at CERN.

Scientists hope to prove many theories with the experiments next summer. But perhaps the most important seeks to prove or disprove the existence of a particle called a Higgs boson – a theoretical particle in a barely perceptible dimension that some refer to as the "god" particle. And if it exists, does Higgs give the subatomic points their mass by holding the void of space together in strands of energy?

"In the most vanilla version of the Higgs theory," he said, "You need some mechanism through which you give mass to electrons and protons. Finding that mechanism could close the loop in assigning known masses. If you have Higgs, you can explain everything – or nearly most things."

If true, science could finally explain what makes something have mass – what makes a table a table and a chair a chair.

"This is much bigger than the atom bomb," Akchurin said. "If this project finds nothing but Higgs, that's huge. If this experiment finds nothing at all, I think that's equally as big a deal because we'll have to rethink all these other theories. Whatever comes out of this will be interesting."

Here's the plan: Scientists will accelerate opposing beams of protons to near the speed of light in the 17-mile, circular Large Hadron Collider.

As these protons are shot around the circular tunnel, the Compact Muon Solenoid will catch what happens when these protons crash into each other.

Somewhere in the melee of these particles' high-energy collisions, the researchers hope to create fractions of fractions of fractions of subatomic particles and see if the elusive Higgs decides to show its face. And Sung-Won Lee, an assistant professor of physics at Texas Tech University, will watch the calorimeters and hope to catch Higgs and other theoretical particles. As it stands, he said, Texas Tech's equipment is ready for final dress rehearsal and opening night.

"We are ready to go," Lee said. "Currently we are testing our calorimeter system again and again until the Large Hadron Collider starts operating in 2008. We don't want our detector to have any problems before it starts collecting real data. Our detector will serve as a unique tool that will help us answer some of the most profound questions about the universe."

Igor Volobouev, also a physics professor at Texas Tech, said he is the most recent member to join the university's presence at CERN. His most recent work there involves understanding the behavior of elementary particles from the spatial energy patterns created by the particles in the calorimeters of the experiment.

He felt certain that Higgs and other theoretical particles will make an appearance and confirm the Standard Model.

"This will be a triumph for the theory -- the Standard Model of particle interactions," Volobouev said. "At this point the theory is so well established that everybody in our field expects the Higgs particle to be there. Not finding it where it is expected would actually be much more surprising.

"Imagine that the planet Neptune is not seen anywhere near its predicted location -- that would generate some buzz."

Whatever should arise from the experiment's result, Akchurin said, mankind will have a greater understanding of the way the universe or multiverse works – at least the five percent we can see.

"Every time we have done particle experiments, we have learned something new," Akchurin said. "If God is fair, hopefully it will happen again."

(This article was written by John Davis of TTU's Office of Communications and Marketing and is reproduced here with his permission.)

ON THE WEB

www.fnal.gov
www.cern.ch
cms.cern.ch
www.interactions.org
www.uscms.org
www.uslhc.us
cmsinfo.cern.ch/outreach
highenergy.phys.ttu.edu

New Faculty

Dr. Luis Grave de Peralta joined our department in January 2007 as an assistant professor. He received his M.S. degree in physics in 1982 from Oriente University, Cuba, where he was a professor in the Department of Experimental and Theoretical Physics until 1989 and its chair for two years. He was subsequently employed by the National Seismology Center at the Cuban Academy of Sciences. He received his Ph.D. in electrical engineering in 2000 from Texas Tech University. Dr. Grave de Peralta taught Principles of Physics I (PHYS1408) in the Spring and Fall semesters of 2007. He is teaching Physics: Basic ideas and Methods (PHYS1304) in Spring 2008. His research fields of interest include ultrafast optics, quantum optics, plasmonics, and nanophotonics.

Dr. Sung-Won Lee, a native of Korea, joined the physics department as an assistant professor in January 2006 after a postdoctoral appointment with Texas A&M University. He received his Ph.D. in experimental high energy physics from the University of Glasgow, UK, in 2000. His research activities have spanned participation in the ZEUS experiment at DESY (Germany), the CDF experiment at Fermilab (USA), and the CMS experiment at CERN (Switzerland). Dr. Lee is a recipient of the British Chevening Fellowship and the first recipient of the DESY Bjorn Wiik Scholarship. He is married to Dr. Min-Joo Kim, a faculty member of TTU's Department of English. When not doing physics, he enjoys watching movies, especially 3rd world films, collecting gadgets, and of course spending quality time with his new baby.

Dr. Soyeun Park, an assistant professor newly appointed in the Department of Physics in Fall 2007 earned her Ph.D. in physics in 2003 at The University of Texas at Austin, then worked as a postdoctoral fellow in biomedical engineering at UT. Her research emphasizes cell biophysics, particularly the mechanotransduction modulating cellular mechanical properties, motility, and adhesions, which have a great impact on modern tissue engineering, cancer research, and neuroscience. In this research, she utilizes the atomic force microscopy and techniques combined with the modern material engineering based on self-assembly and soft nano-lithography. Dr. Park taught PHYS1403, algebra based introductory physics, in Fall 2007.

Dr. Igor Volobouev received his M.S. degree in physics from the Moscow Institute of Physics and Technology in 1993 and his Ph.D. from Southern Methodist University in 1997. Before joining our department as an assistant professor in January 2006, he worked at the Lawrence Berkeley National Laboratory, the University of Chicago, and the Stanford Linear Accelerator Center. Dr. Volobouev teaches a course in computational physics and studies high energy physics phenomena in large-scale particle accelerator experiments located at CERN and Fermilab.

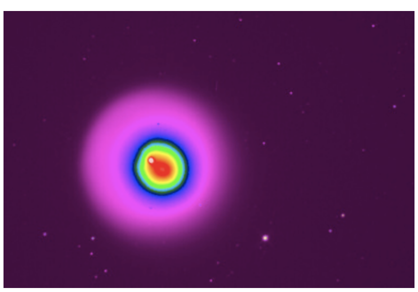
Accolades, News, etc.

- Dr. Stefan K. Estreicher, Horn Professor of Physics, visited Cambridge (UK) as the external examiner on a Ph.D. dissertation in January 2008. He will also serve as the external examiner for another Ph.D. dissertation in the UK in July, this time at King's College in London.

- The 2007 Research Enrichment Fund Grant Competition, sponsored by the Office of the Vice President for Research, awarded nearly $1M to various researchers on campus. Dr. Sung-Won Lee, Assistant Professor in Physics, received $35,000 for his proposal titled *Construction of A Remote Analysis System and Using it in Searches for New Physics at the Large Hadron Collider.*

- Dr. M. A. K. Lodhi, professor in the Department of Physics, and Abel Diaz, (Ph.D. 2006), have published a paper entitled *Effect of Thermospheric Neutral Density Upon Inner Trapped-belt Proton Flux* in *Space Weather*.

- Stephen Torrence, an undergraduate physics student at TTU, measured the expansion rate of the comet (Holmes/17P) in October 29, 2007 to be 2.64 km/s using the 16" Newtonian telescope at the Gott Observatory for his PHYS3304 class project. Modeling the comet as a sphere, this leads to a volume of ~60 times the volume of Jupiter.



- Dr. M. A. K. Lodhi was invited to serve as a member on the International Advisory Committee of the Regional Annual Fundamental Science Seminar in Skudai, Johor, Malaysia in 2007. Dr. Lodhi presented a paper entitled *Improvement of Power Output of AMTEC by Selecting the Appropriate Materials Under Various Conditions*.

- Dr. M. A. K. Lodhi, in collaboration with his former graduate student Justin Briggs (MS, 2006) published two papers, one in the *International Journal of Electrochemical Science*, entitled *The Grain Size Effect on Thermo-chemical Properties of AMTEC Electrodes,* and one in the *Journal of Power Sources* entitled *Temperature Effect on Lifetime of AMTEC Electrodes*.

- Dr. Ronald Wilhelm, assistant professor in Physics, is a co-author of an article in the December 13, 2007 issue of *Nature*, entitled *Two Stellar Components in the Halo of the Milky Way*. Dr. Wilhelm uses stellar data from the Sloan Digital Sky Survey (SDSS) to examine kinematic and chemical abundance patterns in the halo of the Galaxy.

- Dr. M. A. K. Lodhi, in collaboration with Norman Redington, a doctoral candidate in the Department of Physics, published *A Simple Five-Dimensional Wave Equation for a Dirac Particle* in the *Journal of Mathematical Physics*.

- Dr. Sung-Won Lee was invited to give a talk on *Recent Results of the CMS Hadron Calorimeters in the Combined Test Beams* at a parallel session of the 2007 IEEE Nuclear Science Symposium and Medical Imaging Conference in Hawaii, October 27 - November 3, 2007. Dr. Richard Wigmans, Bucy Professor of Physics, gave a presentation on the status of the DREAM project at the same symposium.

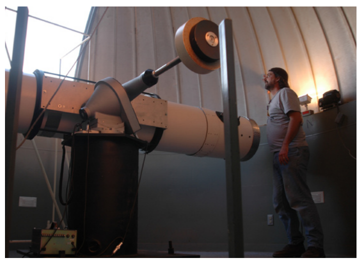
- Dr. Charles W. Myles, Professor of Physics, in collaboration with his doctoral student Koushik Biswas, published a paper in the *Journal of Physics: Condensed Matter* entitled *Density-functional investigation of* $Na_{16}A_8Ge_{136}$ *(A = Rb,Cs) clathrates*.

- Six graduate students presented papers at the Texas Section meeting of the American Physical Society in College Station, October 19-20, 2007. Jacob Ajimo (biophysics), Chiyoung Jeong (high energy), Emmanuel Nenghabi (condensed matter), Liming Qiu (biophysics), Lee Powell (astronomy) and Youn Roh (high energy) presented papers on their thesis research.

- Dr. Sung-Won Lee and Dr. Min-Joo Kim, Assistant Professor in TTU's English Department, became happy parents of a baby girl, Serin Lee, on September 28, 2007.

- Stephen M. Pizer, the Kenan Professor of Computer Science and Radiation Oncology and Head, UNC Medical Image Display & Analysis Group, University of North Carolina, visited our department and discussed emerging areas of research in computing, physics, medicine, and biology.

- We renewed the graduate admission and 150 credit-hour articulation agreements with the Angelo State University Department of Physics. Dr. Andrew Wallace, chair of department, was instrumental in this renewed initiative.
- TTU's Society of Physics Students, SPS, organized a barbecue and star gazing party at TTU's Gott Observatory in Shallowater. The South Plains Astronomy Club also participated.



- Dr. Nural Akchurin, Dr. Sung-Won Lee, and Dr. Efe Yazgan, Texas Tech high energy physicists, made a series of invited poster presentations in Daegu, Korea at the *XXIII International Symposium on Lepton and Photon Interactions at High Energy*, August 13-18, 2007.
- Dr. Stefan Estreicher co-chaired a major international conference, the 24th International Conference on Defects in Semiconductors (ICDS24), in Albuquerque, NM, July 22-27, 2007.
- Dr. Sung-Won Lee, Assistant Professor of Physics, and his colleagues have an article featured in *Fermilab Today* concerning their recent research entitled *Lepton and Quarks: Are They Related?*
- Texas Tech's High Energy Physics Group was cited in a January 14th, 2007 *New York Times Magazine* article featuring a particle detector largely designed and built by the TTU group as part of a global effort at CERN, the international accelerator laboratory in Geneva.
- Five graduate students from A&S departments were recipients of Science: It's a Girl Thing (SIGT) Provost Awards. Gigi Nevils (physics) was one of the recipients.
- Nine physics graduate students and one undergraduate student presented papers at the Texas Section of the American Physical Society in Arlington in October 2006. Chi-young Jeong (high energy), Youn Roh (high energy), Lee Powell (astronomy), Ken Carrell (astronomy), Koushik Biswas (condensed matter), Emmanuel Nenghabi (condensed matter), John Como (biophysics), Norman Redington (nuclear), and Anton Smirnov (biophysics), presented papers on their thesis research. Chris Cowden presented a paper on research he had conducted as an undergraduate with Dr. Akchurin on the anomalous magnetic moment of cosmic muons. Chris is now a graduate student at Cambridge University in the UK.
- Alden Astwood, an undergraduate in physics, was selected to the newly established chapter of Phi Beta Kappa.
- The TTU Nano Tech Center will undergo a major expansion in 2008. Three new faculty will be hired based on a State of Texas "Research Superiority" grant. The award was made to Mark Holtz, Professor of Physics, and Henryk Temkin, Professor and Maddox Chair of Electrical Engineering with joint appointment in physics. Holtz and Temkin co-direct the Nano Tech Center, which comprises an interdisciplinary group of researchers from the engineering and the arts and sciences departments. The award jump starts a $9M investment in nanophotonics, including $5M matching from AT&T in honor of former CEO and TTU alumnus Edward E. Whitacre. In addition to laboratory renovations and equipment purchase, the fund will help the Nano Tech Center attract three world-class researchers and endow two chaired professorships.
- Professor Mark Holtz and Assistant Professor Luis Grave de Peralta, along with colleagues in the College of Engineering, have received a contract from the U. S. Army to fund research in photonics. The research, carried out in the TTU Nano Tech Center, concerns the discovery, understanding, and application of phenomena specific to nano- and micro-fabricated optics. Dr. Grave de Peralta is pioneering planar waveguides, under this program, for encoding and decoding optical communications.
- Since 1995, Dr. Walter Borst has been playing a key role in obtaining funding for the South Plains Regional Science and Engineering Fair (about $10,000-12,000/year and about $150,000 so far). He has also arranged for awards from the American Physical Society.
- Dr. Walter Borst served as the secretary-treasurer (elected twice) of the Texas Section of the American Physical Society for 6 years (1999-2005). About 20 years ago, he served as the chair of the Texas Section of the APS. During that time, with funding from Shell Oil Research Company, he instituted monetary awards to students for best papers. These awards are still being made every year.
- Dr. Charles W. Myles, Professor of Physics, is the current secretary-treasurer of the Texas Section of the American Physical Society.

Graduates - Where are They Now?

Doctoral Degrees (2001-2007)

Daoying Song, *Phonons and Optical Properties of III-Nitride Semiconductors* (2007). Postdoc at the TTU Maddox Lab, Lubbock, TX.

Koushik Biswas, *Theoretical Investigation of Type-II Clathrate Materials* (2007). Postdoc at the National Renewable Energy Laboratory, Golden, CO.

Lu Tian, *Fabrication and Optical Characterization of Nanostructures on Semiconductor Materials* (2007). Engineer at Silican Genesis Corp., San Jose, CA.

Hisham N. Bani-Salameh, *Muonium Defect Centers in Aluminum Nitride and Silicon Carbide* (2007). Postdoc at the TTU Health Sciences Center, Lubbock, TX.

Abel B. Diaz, *Dynamic and Spatial Properties of Satellites in Isolated Galactic Systems* (2006). Research Scientist at National Security Technologies, Los Alamos, NM.

Md. Rejwan Ali, *Cholesterol-Induced Domain Formation in Multi-Component Lipid Membranes* (2006). Postdoc at the University of North Carolina, Chapel Hill, NC.

Richard Lombardini, *Vibrational Spectroscopy Calculations using a Weyl-Heisenberg Wavelet Basis and Classical Phase Space Truncation* (2006). Postdoc at Rice University, Houston, TX.

Damien J. West, *First-Principles Calculations of Vibrational Lifetimes in Silicon* (2006). Postdoc at the National Renewable Energy Laboratory, Golden, CO.

Iftikar Ahmad, *Study of Self-Heating in GaN/AIGaN, Heterostructure FET Using Visible and Ultra-violet Micro-Raman Spectroscopy* (2005). Postdoc at the Virginia Commonwealth University, Richmond, VA.

Brian Cannon, *Spectroscopic Characterization of Ordered Nanodomains in Self-Assembling and Fluid Lipid Bilayers* (2005). NIH Fellow at the University of Texas at Austin.

Kenneth E. Kambour, *A Theory of Lock-On and Electrical Breakdown* (2004). Postdoc at the Sandia National Laboratory, Albuquerque, NM.

Bashar I. Lahlouh, *Plasma-Enchanced Chemical Vapor Deposition of Low Dielectric Constant Materials* (2003). Assistant Professor at Applied Science University, Amman, Jordan.

Kimberly K. Bouldin, *Latent Fingerprint and Trace Explosives Detection by Photoluminescence and Time-Resolved Imaging* (2003). Chemist at Trace Analysis, Inc. Lubbock, TX.

Olga B Lobban, *Hadronic Vector Boson Decay and the Art of Calorimeter Calibration* (2003). Assistant Professor at Saint Mary's University, San Antonio, TX.

Xupeng Chen, *Investigation of a High-Power Virtual Cathode Oscillator* (2003). Assistant Professor at Huazhong University of Science and Technology, Wuhan, China.

Maen A. Gharaibeh, *Molecular Dynamic Simulations of Self-Interstitials in Silicon* (2002). Assistant Professor at Jordan University of Science and Technology, Irbid, Jordan.

Patrick J. Nichols, *Positron Molecular Scattering* (2002). Postdoc at the University of New Orleans, New Orleans, LA.

William J. Harris, *A Study of Cathode Erosion in High Power Arcjets* (2002). Director of Technical Development, Computer Transition Services, Lubbock, TX.

Richard Cardenas, *Calibration and Conformational Studies in Radiation Dosimetry Using Polymer Gel Dosimeters*, (2001). Associate Professor and Chair, Saint Mary's University, San Antonio, TX.

Masters Degrees (2001-2007)

Justin B. Briggs, *Amtec Power Output Optimization by Investigating the Grain Size Effect on its Electrode Materials* (2007).

Bhargava-Ram Kanchibotla, *Magnetic Properties of Iron (Fe) Nanostructures* (2005). Ph.D. candidate at Virginia Commonwealth University, Richmond, VA.

Sridhar Patibandla, *Ignition in Al1Fe2O3 Energetic Nano Composites* (2004). Ph.D. candidate at Virginia Commonwealth University, Richmond, VA.

Jason L. McAfee, *Structural and Vibrational Properties of N,N Pairs and {N,H} Complexes in Silicon* (2004). Ph.D. candidate at the TTU Department of Chemistry, Lubbock, TX.

Rayburn D. Thomas, *Study of Radiation Hardness in Optical Fibers* (2004). Program Manager at KTech Corp., Albuquerque, NM.

Sameer G Thakar, *Al/Fe_2O_3 Energetic Composites Based on Nanowire Arrays* (2004).

Damien J. West, *Copper Defects in Silicon* (2003).

Mikhail Shubov, *Accelerator Driven Nuclear Energy Systems*, (2000).

Applied Physics Masters Degrees

Nenad Stojanovic, *Thin Film Thermal Conductivity of Aluminum and Silicon Nitride* (2007). Ph.D. candidate at the TTU Department of Physics, Lubbock, TX.

Sashidhar Guttula, *Self-Assembly of Colloidal Lattice at Pickering Emulson Interfaces* (2007).

Benjamin D. Noll, *Atmospheric Density Fluctuations due to Solar Modulation and Orbital Debris Modeling* (2006).

Deeder Md. *Aurongzeb, Nanocrystal Formation at Interfaces in Ni/Al Multilayers* (2005). Engineer at GE-Lighting, Cleveland, OH.

Zahir K. Khawaja, *Photomodulated Reflectance Spectroscopy of Gallium Arsenide and Gallium Indium Arsenide* (2003).

Timothy A. Margheim, *Semiconductor Failure Analysis: A General Review and an Experiment in Photon Emission* (2007).

Richard A. Williams, *Plasma Etching and an Analysis of Vpp Signal Variations in the Final Oxide Layer Etch Recipe* (2007). Engineer at Intel, Rio Rancho, NM.

Emiliano Garcia, *Annular Lithography and Depth of Focus* (2007). Engineer at Intel, Chandler, AZ.

Brian G. McGonagill, *RIE Chamber Preparation Through Dry Clean / Season Modification* (2007).

Ryan Henderson, *Line Edge Roughness and Line Width Roughness* (2006). Engineer at Intel, Rio Rancho, NM.

Philip C. Pedigo, *Fundamental Study of Chemical Mechanical Planarization in a High Volume Manufacturing Environment* (2006). Engineer at Intel, Rio Rancho, NM.

Benjamin McCarty, *Wavefront Engineering Through Off-Axis Illumination* (2006). Engineer at Intel, Rio Rancho, NM.

Donald L. Stripe, *Full Wafer Layer by Layer Strip-Back for Failure Analysis: Development of a Reliable Process* (2006). Engineer at Intel, Hillsboro, OR.

Mihaela Maria Tanasescu, *Sample Preparation for Backside and Frontside Failure Analysis* (2006). Engineer at AMD, Austin, TX.

Syed Farad Hashmi, *Optimization of Positive Photo-Resist Etch Recipe* (2005). Engineer at Intel, Rio Rancho, NM.

Jose Noel C de Luna, *Infrared Emission Microscopy: Development of Full Wafer Capability at Fab11x and Analysis of 90nm MOSFET Emission Spectra* (2005). Engineer at Intel, Folsom, CA.

Stephen C. Slampa, *Defect Analysis and Advanced Techniques of Writing Sensitive and Robust SURFCAN Laser Scanning Defect Detection Recipes* (2005). Engineer at Intel, Rio Rancho, NM.

John D. Thompson, *Thickness Control of RRC Spin Coated Photolithographic Films* (2005). Engineer at Intel, Folsom, CA.

Jason C. White, *An Algorithmic Test Pattern for Embedded SRAM Testing* (2004). Engineer at Lockheed Martin, Dallas, TX.

Bradley D. Phipps, *Embedded Cache Memory Test* (2003).

Raghu Ramachandran, *Study of Sheet Resistance and Interlayer Adhesion in Electrodeposited Copper* (2003). Ph.D. candidate at Louisiana State University, Baton Rouge, LA.

Oscar B. Sanchez, *Phantom Yield Enhancement* (2003). Engineer at Texas Instruments, Dallas, TX.

Scott D. Williams, *The Effects of Prebake on the Hinge and Headspace of the Digital Micromirror Device* (2003). Engineer at Texas Instruments, Dallas, TX.

Paul Mauer, *Preliminary Results of Scanning Electron Microscope Automatic Defect Classification Implementation at Texas Instrument's Kilby Center* (2002). Engineer at Texas Instruments, Dallas, TX.

Lu Tian, *Automatic Lamp Lifetime Testing in RTP Chamber Using Labview* (2002).

Km. Nazmul Ahsan, *Sample Preparation for Transmission Emission Microscopy Using Tripod Polisher and Focused Ion Beam* (2002). Ph.D. candidate at the TTU Department of Electrical Engineering.

Iftikar Ahmad, *In-Situ Monitoring of Rapid Thermal Processing* (2002).

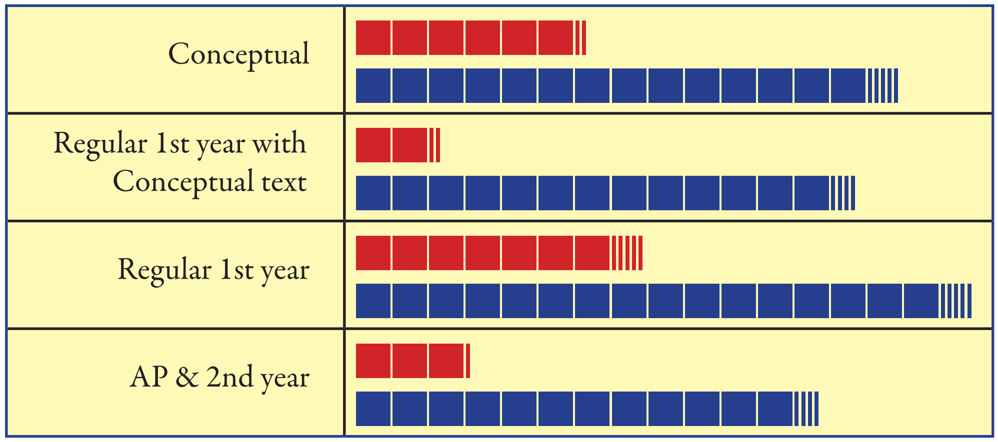
Jonathan W. VanBuskirk, *Monitoring, Control, and Quality Assurance Techniques for Ultra-Thin Gate Oxides* (2001). Engineer at Texas Instruments, Dallas, TX.

Kari Copeland, *Yield Enhancement at Texas Instrument's Kilby Center* (2001). Engineer at Texas Instruments, Dallas, TX.

Scholarships & Awards

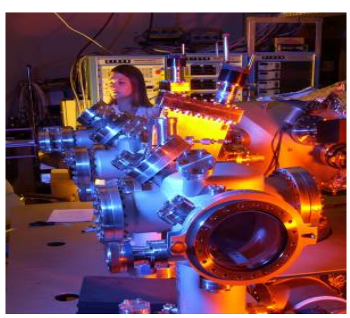
- Bucy Award to David Ryberg ($1,000)
- Gangopadhyay Award to Sarah Draper ($1,400)
- Gott Award to Kenneth Carrell ($500)
- Howe Award to Wei Wang ($750)
- Mann Award to William Courtney ($500)
- Schmidt Award to Jordan Phillips ($2,000), Charles Regan ($1,000), and Stephen Torrence ($2,000).
- Sterne Award to Sarah Draper ($200)
- Thomas Award to William Courtney ($500)
- Seibt Award to Youn Roh ($750)
- Outstanding Undergraduate Scholar Award to Alden Astwood
- Outstanding Master of Science Student Award to Jian Dai.
- Outstanding Master of Science with Internship (MSI) Student Award to Tim Margheim.
- Outstanding Doctor of Philosophy Award to Daoying Song.

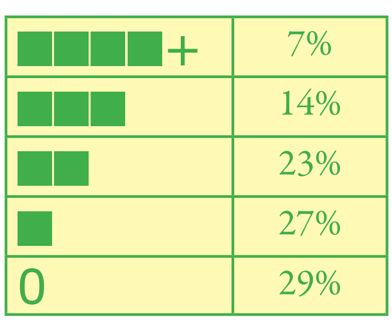
Let's Do the Numbers



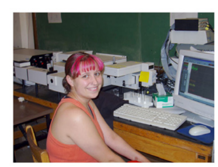
According to the American Institute of Physics (AIP), Statistical Research Center, 623,000 US high school students took physics in 1990. By 2005, the number had risen to over 1,000,000. This growth rate has been even greater in the state of Texas, and this trend is expected to continue. The table on the right shows the types of physics courses the students took in high school. Red represents 1990, while blue shows 2005. Each box represents 10,000 students, and a bar corresponds to 1,000. As TTU gears up to increase its enrollment to 40,000, our department will have to figure out how to best serve this growing population and their interest in physics.

Working with a professor on a project	37%
As a part of thesis project	28%
REU (Research Experience for Undergraduates)	26%
Non-departmental employment (*e.g.* summer job)	25%
While in a co-op or internship	13%
None	29%



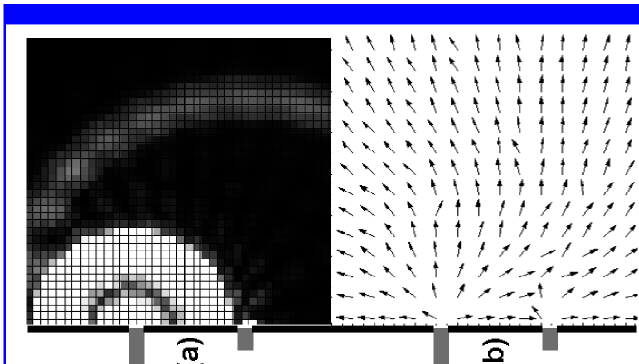


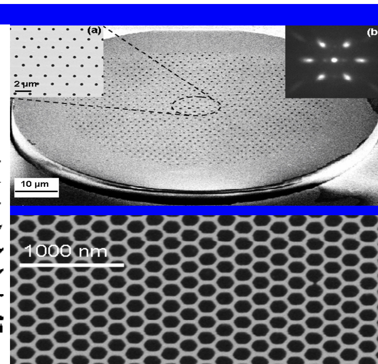
Research is an essential component in physics education at the undergraduate level, and according to the AIP, the research experience of physics undergraduates in the US is very diverse as indicated by the data on the left. The total percentage comes to more than 100% because seniors indicated more than one type of research experience during their years in college. In our department, undergraduate research mostly takes place in conjunction with a professor as part of a thesis or senior project (PHYS4000 or PHYS4306), a summer job in the department, or in centers or laboratories such as the Nano Tech Center, REU programs in the College of Engineering, Fermilab, CERN, *etc.* According to the AIP, nearly a third of US students lack any research experience, while 7% work on four or more projects during their undergraduate career (see table on the left). At TTU, we make every effort to ensure that our students go through some research experience outside of the class before they graduate. The images on page 24 provide a glimpse of some of the exciting research available to our students.

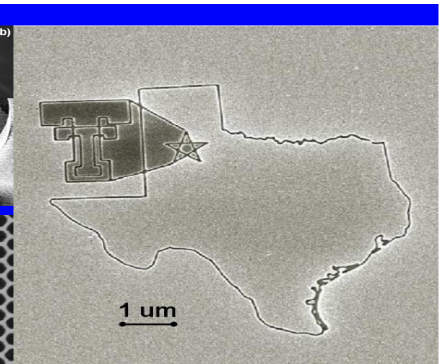


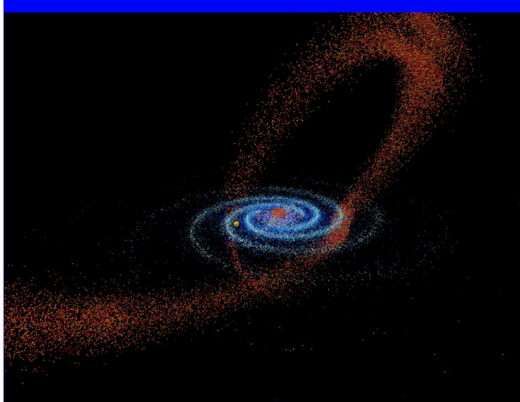
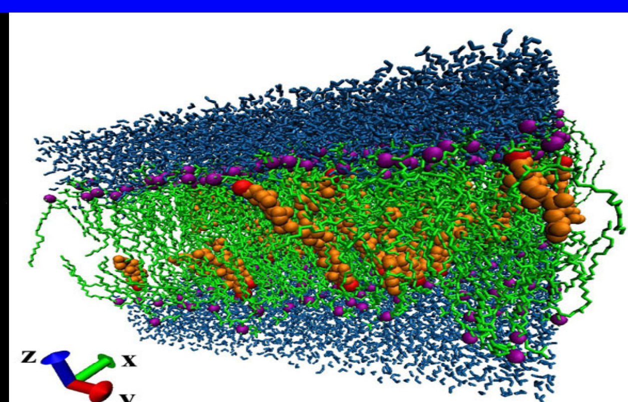
The number of TTU graduates in physics and engineering physics with bachelor's degrees since 1999 is tabulated on the right. The graduation rate has been mostly steady with an average of 7.1 graduates per year, physics and engineering physics majors combined. In the US, more than 5,000 physics bachelor's degrees were awarded in 2005. This represented a 40% gain compared to 1999, which had the lowest number in recent years. Because this trend is expected to continue, we need to be well prepared with a stronger and up-to-date curricula. We believe that a physics major is not only an excellent avenue for a career in science and academe but also for professions in law, medicine, engineering, business, and many others.

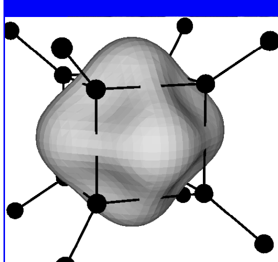
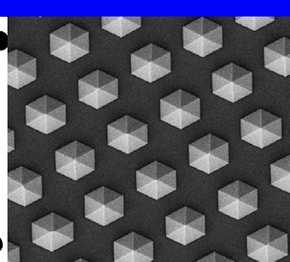
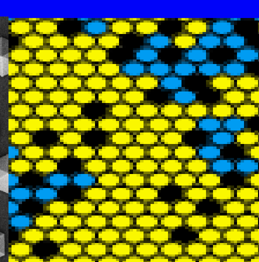
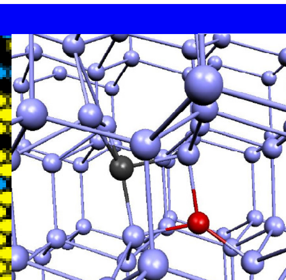
Year	Physics	Engineering Physics
1999	●●●●●	●●●
2000	●●●●	●●●●
2001	●●●●●	●●
2002	●●●●●●	
2003	●●	
2004	●●●●	●●●●
2005	●●●	●●●●
2006	●●●●●	●●●●●



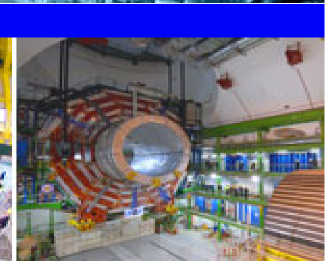




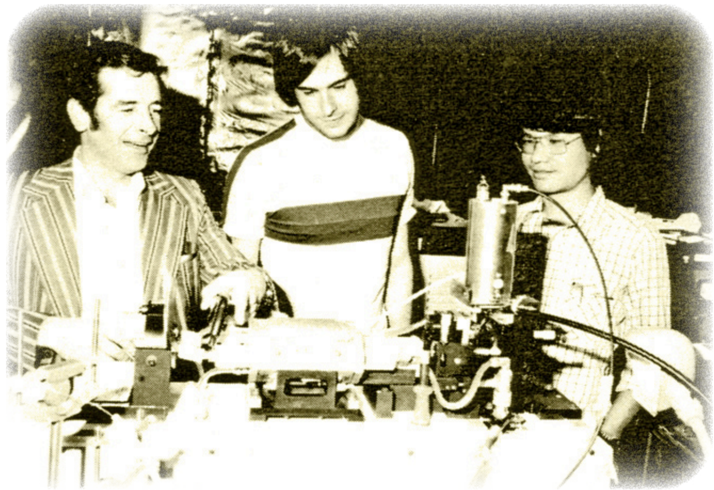


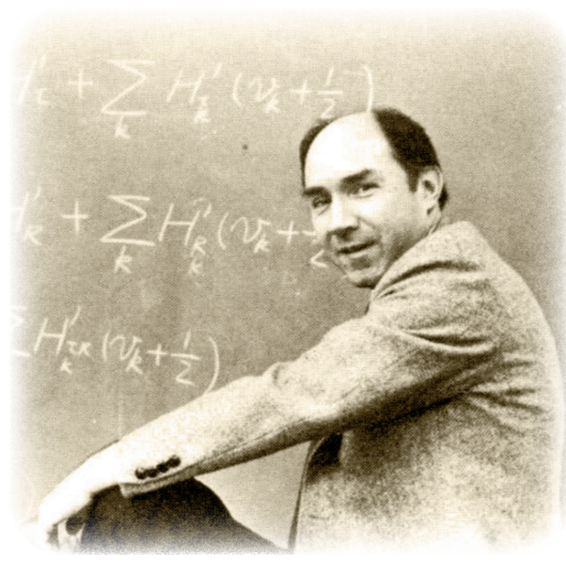
A Moment in Time

Preston F. Gott was an avid astronomer. He was on the TTU Physics faculty for 41 years. He was also instrumental in establishing the Preston F. Gott Skyview Observatory in Shallowater. Hundreds of students use the Observatory to observe the night skies every semester. Thank you Preston.

Professor Roger Lichti works with a student on an electron spin resonance spectrometer in the early 1980s. Roger contributed the article on magnetic polarons for this issue of the *physics@ttu*.



Professor Lynn Hatfield retired last year (2007) after 39 years at TTU. He is seen here with students operating a 500 MW ruby laser. Lynn is now enjoying his retirement and working on antique electron tube radios.



Professor Dick Quade is as hard at work today as he was when this photo was taken in the 1980s. Dick just published a paper on *The Torsional-rotational Microwave Spectra of CH_2DSH Revisited Including First Order Forbidden Transitions* in *J. Molec. Spec.* ***244*** *(2007)* 109-111. He still enjoys teaching PHYS1404, our algebra based introductory physics course.

Plea to Alumni

Sandra Hester

Sandra Hester and Joyce Norton are an indispensable part of our department. They perform many vital tasks, for instance, helping students with registration, preparing purchase orders and travel forms, following up on budget revisions, and booking class rooms. Their timely effort ensures that everything runs smoothly.

They are looking forward to hearing from all alumni and friends of the department. You can share your news for the next issue of *physics@ttu* by contacting them at sandra.hester@ttu.edu or joyce.norton@ttu.edu. They can also be reached at 806-742-3767 (voice) and 806-742-1182 (fax). If you're in the area, please consider visiting us.

Joyce Norton

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