Annual Issue

Fall 2007

DEPARTMENT OF PHYSICS

Ursa Baylor

Baylor University PHYSICS

The Annual Newsletter of the Department of Physics at Baylor University

Department Increases Majors; Offers Honors Intro Sequence

Thanks to the recruitment efforts of Dr. Jay Dittmann and others in the department, the number of majors has swelled to a new record this fall. In addition, the Department has begun phasing in an honors version of the General Physics 1420-1430 sequence. Honors General Physics I & II will both be offered in Spring 2008. Pictured above is the Fall '07 class of Dr. Linda Olafsen's Honors PHY 1420.

Inside this issue:

Special points of interest:

- *Special Research Focus:*
  Elementary Particle Physics
- *Images from Current Research Projects*
- *Departmental Scholarships*
- *Alumni encouraged to keep in touch*

And now a note from the Chair…

October 2007

Dear Friends,

Greetings from the Baylor Physics Department! Classes have resumed and professors have returned from summer research and teaching activities. This fall our department was pleased to welcome fifteen new undergraduate majors and nine new graduate students. Also welcomed back is Ed Schaub, this time as a (permanent) Lecturer. Ed has been teaching introductory courses, our sound and acoustics course, and our electronics laboratory course in the department for many years. Tibra Ali is a new Lecturer assigned to introductory courses and assisting with tutorials in our calculus-based courses.

Since I last wrote to you there have been new developments in several areas. We have completed the move of laptop computers into the graduate student area, and have installed a new printer for graduate student use. The new Undergraduate Study Area was completed in May—just in time for our summer REU students to enjoy. In addition to computers, printer, and workspace, the study area also has a rug, sofa, and comfortable chairs designed for in-depth physics conversations! Dr. Ariyasinghe's new lab was completed over the summer—finishing out all of the laboratory space in our third-floor research wing (but we have more assigned space on the first floor of the Baylor Sciences Building).

Last fall many of our faculty members contributed to the creation of a major strategic proposal and operational plan for the Department of Physics. Beginning with Baylor's Vision 2012 goal of reaching the top tier (usually top 50) of American universities, we considered what the Physics Department would need to be like in order for Baylor to accomplish this goal. By examining the physics department rankings of the top 50 universities according to the National Research Council and according to U.S. News & World Report, we found that top tier universities have physics departments that rank in the first or second tier (top 100). (The NRC ranks our department in the third tier.)

How do we reach the second tier? Statistics show that none of our peer institutions or other Big XII schools has reached the second tier without having at least 21 tenured or tenure-track faculty members. (We have 13.) Since the statistics clearly show that growth in physics is essential for Baylor's Vision 2012 success, we next considered which physics sub-disciplines it would be best to build up or develop. Our proposal recommended that we add to our existing strengths in the areas of condensed matter physics, elementary particle physics, and space/astrophysics. It also recommended two natural extensions in our offerings: physics education and astronomy.

The administration recently revealed which major strategic proposals had been approved. Although not all of the details are available, it appears that three interdisciplinary proposals and only one narrowly-focused departmental proposal will be funded. Because so many proposals were submitted (59), the department recognized that the chances were slim for our proposal to be funded this year. However, since we were encouraged to "dream big," we were surprised to learn that only narrowly-focused proposals that might easily be funded were approved. Broad-based departmental proposals like ours, which were backed-up by recommendations from outside consultants at top-tier universities, were rated in the lowest category. We continue to hope that the administration will recognize the necessity of developing broad strength in the sciences, particularly in physics, and we are encouraged by the approved search for a tenure-track faculty member this fall. If any of you are looking for an opportunity to help vault the Physics Department into the next tier, we would be delighted to talk with you!

We again thank you for your interest and support. Please continue to pray with us that we honor God in all of our work, and that we accomplish goals that are pleasing to Him. We hope to see many of you at our Alumni Colloquium (featuring Dr. Michael Henry) and Physics Homecoming Coffee on November 2nd.

With warmest best wishes,

Greg Benesh

Professor & Chairman

"Please continue to pray with us that we honor God in all of our work."

The Department by the numbers …

Number of Faculty: 19

Tenured or Tenure-track: 13

Lecturers: 6

Undergraduate Physics Majors: 33

Physics Graduate Students: 29

Postdoctoral Fellows: 5

Dr. Linda Olafsen meets with Representative Chet Edwards

2006 - 2007 Enrollments

Number of Students Enrolled in Physics Classes: 2165 **(up 7.9% from 2005-06)**

Summer 2006: 144 ♦ Fall 2006: 933 ♦ Spring 2007: 1088

Number of Students Enrolled in Undergraduate Laboratories: 2011 **(up 11.8% from 2005-06)**

Summer 2006: 144 ♦ Fall 2006: 860 ♦ Spring 2007: 1007

Number of Undergraduate Laboratories: 61

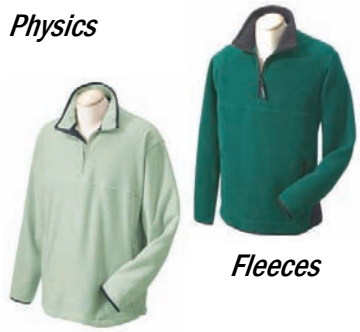
Summer 2006: 4 ♦ Fall 2006: 28 ♦ Spring 2007: 29

The new undergraduate study area.

Number of Funded Grants: 22

Scholarly Publications (including conference proceedings): 72

Conferences attended by Department Members: 38



Interesting factoid of the year:

US News & World Report's average ranking of universities from which our current tenured & tenure-track faculty received their Ph.D.'s: 24.8

Research Faculty Profiles

Wickramasinghe Ariyasinghe

Associate Professor

Research Interests:

Atomic and molecular physics

Auger electron spectroscopy

Electron scattering

Recent Publication:

Total Electron Scattering Cross Sections of alkanes at intermediate energies, W. M. Ariyasinghe, P. Wickramarachchi, and P. Palihawadana, Nucl. Inst. and Meth. Phys. Res. B 259 (2007).

Dr. W. Ariyasinghe engages in atomic physics experiments. The department has several electron beam facilities (20 eV to 10 keV energy) for studying interactions of low energy and intermediate energy electrons with atoms. Recently, he has been scattering electrons off of hydrocarbons and fluorocarbons, research of great important to astrophysics, atmospheric physics, chemical physics, plasma physics, bio-medical physics and semiconductor physics. His goal in this area of research is to provide an accurate pool of electron scattering cross sections for the users in above fields and industry.

The past research involves the use of Auger electrons produced by heavy ion bombardment (protons and He^+ ions) of small organic molecules to study the effect of chemical bonding on normal and satellite lines produced by the impinging ions. The study of heavy ion induced Auger spectroscopy continued to produce the K-shell and L-shell ionizations cross sections (an essential tool in understanding the interaction mechanism between energetic ions with atoms or molecules) of all second and third raw elements in the periodic table. In addition, Dr. Ariyasinghe conducted experiments to investigate the isotropic/ anisotropic nature of heavy ion induced Auger emission.

For several years, Dr. W. Ariyasinghe and collaborators have been involved with the slowing of He^+ ions in thin films of vapor-deposited elemental matter and in gases to study the degenerate electron gas model of Jens Lindhard (a student of Niels Bohr in Copenhagen) in three areas: (i) stopping power, (ii) calculation of mean ionization potentials, and (iii) energy straggling. The model is excellent for predicting qualitative features of various parameters, although certain quantitative limitations are clearly revealed.

Publications:

Total electron scattering cross sections of Kr ans Xe in the energy range 250 - 4500eV with C. Goains, Phys. Rev. A **70**, 1050294 (2005).

Electron scattering cross sections of He, Ne and Ar at intermediate electron energies with C. Goains, D. Powers, T. Wijerathna and P. Phalihawadana, Nucl. Inst and Meth. Phys. Res. B 225 (2004).

Total electron scattering cross sections of CH4 and NH3 molecules in the energy range 400 - 4000eV with T. Wijerathna and P. Palihawadana, Nucl.Inst and Meth. Phys. Res. B 217 (2004).

Total electron scattering cross sections of PH3 and SiH4 molecules in the energy range 90 – 3500eV with T. Wijerathne and D. Powers. Physical Reviw A **68**, 032708, (2003).

Total electron scattering cross sections of CF4 and C2F6 in the energy range 100 – 1500eV Journal of Rad. Phys. Chem.**68**, 79 (2003).

Total electron scattering cross sections of CF2 and CF4 in the energy range 100-1500eV Rad. Phys. Chem. **68**, 79 (2003).

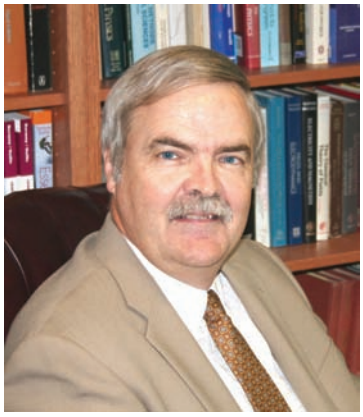
Total electron scattering cross seections of CH4, C2H2, C2H4 and C2H6 in the energy range 200-1400eV with D. Powers, Phys. Rev. A **66**, 052723, (2002).

Absolute K-shell ionization cross-section measurements of B produced by 0.4 - 2.0 MeV H+ and He+ ions and by .6 - 1.2 MeV H2+ ions with D. Powers, Phys. Rev. A **59**, 1291 (1999).

K-shell ionization of B,O, and F by 0.4-2.0 MeV He+ ions, with A. Ghebremedhin and D. Powers. Physical Review A **53**, 1537 (1996)

Angular distribution of total LMM Auger electron yields produced by energetic He+ ions in Ar, Cl, and S with P. Guo, A. Ghebremedin and D. Powers, Physical Review A **51**, 2117 (1995).

Research Faculty Profiles



Gregory Benesh

Professor

Chair, Physics

Research Interests:

Surface Electronic Structure

Surface Physics

Gravitational Collapse

Recent Publication:

Homothetic Self-similar Solutions of Three-Dimensional Brans-Dicke Gravity, Gen. Relativ. Gravit. **39**, 277-289 (2007).

Professor Gregory A. Benesh's research deals primarily with the study of metal surfaces with and without adsorbed layers of atoms. The redistribution of charge upon chemisorption determines the nature of the surface chemical bond. It also causes a change in the surface work function and affects the core-level binding energies of atoms near the adsorption site. Many metal surfaces, such as those of platinum, tungsten, and gold, display spontaneous phase transitions from the bulk atomic structure to a new structure once the surface is created. The role that electrons play in such transitions is under investigation. Metal surfaces also serve as catalysts for important chemical reactions. The rate at which interactions progress can often be enhanced by introducing different metal catalysts or by exposing a different crystal face of the same metal. Current research focuses on the face-dependent catalytic activity of various metal surfaces, and on the nature of inter-atomic forces on surface atoms.

One of the drawbacks of many surface calculations is the problem of interacting surface states across a thin slab; another is the neglect of bulk electron states which determine surface states and surface resonances. Professor Benesh and collaborators have developed a computational technique in which these problems are eliminated by embedding surface atomic layers onto an infinite bulk substrate. The SEGF method has proved to be extremely accurate for determining the energetics of surface states and resonances. Further refinements and extensions of the method are under development.

For quite some time, Dr. Benesh has been interested in what core-level shifts at surfaces tell us about charge transfer and bonding. An unexpected result is that adsorbed electropositive atoms, such as cesium, induce smaller surface core-level shifts than electronegative atoms, such as oxygen. Experimental results such as these have led some to conclude that electropositive atoms bond more covalently and less ionically than electronegative atoms.

Currently, Dr. Benesh is focusing attention on several surfaces of rhodium. The Rh(111) surface is particularly interesting since the surface and subsurface shifts are in opposite directions! Obviously, contributions other than from charge transfer play an important role, because no charge transfer is expected between neighboring rhodium atoms. In fact, it is believed that the environmental effect (caused by the reduced coordination of surface atoms) is at least as important as charge transfer. There is also a relaxation (final-state) contribution that is caused by the different screening properties of surface and bulk atoms. Dr. Benesh is currently calculating all three contributions to the surface and subsurface core-level shifts at the Rh(001), Rh(111), and Rh(110) surfaces.

Dr. Benesh has recently collaborated with Dr. Anzhong Wang in studying the gravitational collapse of massive stars. They have been investigating the critical nature of the collapse by finding self-similar solutions of the Einstein fluid equations. They are interested in calculating the critical exponents that describe the process.

Publications:

Asymptotes of Solutions of a Perfect Fluid Coupled with a Cosmological Constant in Four-Dimensional Spacetime with Toroidal Symmetry, With Anzhong Wang. Gen. Relativ. Gravit. **38**, 346 (2006).

Approximating Infinite-k Representations: Surface Relaxations and Work Functions of Al(001) and Be(0001). With Daniel Gebreselasie. Journal of Physics: Condensed Matter **9**, 8359-8368 (1997).

Surface Embedded Green Function Calculation of Total Energy and Force Application to Al(001) and Al(110). With Daniel Gebreselasie. Physical Review B **54**, 5940-5945 (1996).

The X-ray Photoemission Spectra of Nd(OH)3, Sm(OH)3, Eu(OH)3 and Gd(OH)3. With D.F. Mullica, C.K.C. Lok, and H.O. Perkins. Journal of Electron Spectroscopy and Related Phenomena **71**, 1-20 (1995).

Research Faculty Profiles

Gerald Bryan Cleaver

Associate Professor

Research Interests:

M-theory phenomenology

String Cosmology

Recent Publication:

The Ricci Curvature of Half-Flat Manifolds, with Tibra Ali, Journal of High Energy Physics 0705 (2007) 009.

Dr. Gerald Cleaver's research specialty is superstring theory, which unifies all forces in nature (gravity, electromagnetics, and the two nuclear forces). In superstring theory each elementary particle in nature originates as a distinct vibration of a single type of string (or loop) of energy, much as different musical notes are produced from a single violin string. Dr. Cleaver's current research topics in string theory include the construction of phenomenologically realistic superstring models, string/M-theory cosmology, and the string landscape. Dr. Cleaver is conducting research with former postdoctoral researcher (now lecturer) Dr. Tibra Ali, Ph.D. students Richard Obousy, Matt Robinson, and Tim Renner, and REU student Jared Greenwald. Drs. Ali and Cleaver are investigating half-flat manifolds for heterotic strings. With his students, Dr. Cleaver is conducting a long-term systematic study of the generic physical properties of the string landscape in the free-fermionic heterotic region.

Conferences:

Dr. Cleaver presented a 30 minute plenary lecture at the Tenth European Meeting "Planck '07" held in Warsaw, June 9 - 13, 2007. The conference, nicknamed Stuartfest, celebrated the 60th birthday of Dr. Stuart Raby, who was Dr. Cleaver's postdoctoral mentor at The Ohio State University during 1993-1996.

Dr. Cleaver was a featured speaker and the "scientist in residence" at the Evangelical Lutheran Church of America's 2007 Summer Theological Institute, entitled *Faith and Faithfulness: Christianity in the Age of Scientific Discovery*, at Texas Lutheran University, Seguin, Texas, July 9th-13th. Dr. Cleaver is co-editor of the STI proceedings.

Along with Dr. Anzhong Wang and two of their students, Dr. Cleaver also attended the *Origins of Dark Energy* conference, in Hamilton, Ontario, Canada, May 14-17.

Dr. Cleaver is on the organization committee for the 2 day symposium, *String Theory and the Multiverse: Philosophical and Theological Implications*, to be held March 26-27, 2008, at Wheaton College in Illinois.

Additional Scholarly Activities:

Dr. Cleaver accepted the invitation by Nova Science Publishers, Inc. to contribute a chapter to the upcoming book, **Trends in String Theory Research**. Dr Cleaver wrote his chapter, *In Search of the (Minimal Supersymmetric) Standard Model String*, during his fall '06 sabbatical. Dr. Cleaver led an April 26 Honors College Colloquium on Lenny Susskind's book, **The Cosmic Landscape**. Dr. Cleaver was also on the thesis committee for Dr. Anzhong Wang's Ph.D. student, Rui Wu.

In the last year Dr. Cleaver refereed 11 manuscripts for **Physics Essays,** 10 manuscripts for web publisher Scientific Journals International (to which he was appointed to the editorial board), and 2 project proposals for the U.S. Civilian Research and Development Foundation.

Dr. Cleaver received "Honorable Mention" for his CTNS/Templeton Foundation's Science and Transcendence: Advanced Research Series (STARS) grant application, entitled *String Theory, the Multiverse Hypothesis, and God*, written jointly with Dr. Robin Collins, Department of Philosophy, Messiah College.

Publications:

Randall-Sundrum and Flipped SU(5), with B. Dundee. Accepted for publication in Physical Review D.

Supersymmetry Breaking Casimir Warp Drive, with Richard Obousy, in AIP Conference Proceedings 880 (2007) 1163.

Stringent Phenomenological Investigation into Heterotic String Optical Unification, with J. Perkins, B. Dundee, R. Obousy, S. Hatten, E. Kasper, M. Robinson, C. Sloan, K. Stone, Physical Review D75 (2007) 026007.

Research Faculty Profiles

Jay R. Dittmann

Assistant Professor

Research Interests:

Experimental Particle Physics

Recent Publication:

T. Aaltonen, *et al*. (CDF Collaboration). Observation and Mass Measurement of the Baryon Ξ_b^-. Physical Review Letters **99**, 052002 (2007).

The Experimental High Energy Physics (HEP) group at Baylor is engaged in experimental elementary particle physics research at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, IL. At Fermilab, protons and antiprotons are accelerated to nearly the speed of light by the Tevatron, the most powerful particle accelerator in the world. Beams of protons and antiprotons collide at the center of two 5,000-ton detectors, and data recorded from these energetic collisions help physicists to identify the properties of the elementary particles that make up the universe.

Led by Dr. Jay Dittmann, the Baylor HEP group participates on the Collider Detector at Fermilab (CDF) experiment, which offers opportunities for physics data analysis, detector construction, and detector operation. Over the past year, one of the group's main projects has been the upgrade of the eXtremely Fast Tracker (XFT), an important part of the experimental apparatus that selects interesting proton-antiproton collisions for subsequent data analysis. Dr. Nils Krumnack, a Postdoctoral Research Associate working with Dr. Dittmann, led the commissioning of the XFT project at Fermilab. Dr. Krumnack coordinated personnel from six different universities including Baylor, the University of Illinois, The Ohio State University, Purdue University, U.C. Davis, and the University of Pisa. The new tracking system became operational in October 2006 and has greatly improved the quality of the collision data recorded by the CDF experiment.

Baylor's experimental HEP group currently includes three graduate students. Sam Hewamanage, a fourth-year graduate student, has made significant contributions by writing a variety of software diagnostic tools for the XFT system. Currently he is focused on a study of proton-antiproton collisions in which a photon emerges directly from the collision together with "jets" of energetic particles that indicate the production of quarks and gluons. Using these data, it is possible to test the predictions of Quantum Chromodynamics (QCD) and search for new types of particles. Martin Frank, a third-year grad student, is currently working on a project to enhance TRIGMON, a computer program that monitors the XFT system as data from collisions are collected. Together with Drs. Dittmann and Krumnack, Martin is part of an analysis group that is searching for the infamous Higgs boson, a particle that is predicted to exist but has never been observed. Its discovery would be one of the most outstanding discoveries in particle physics! Both Sam and Martin currently reside full-time near Fermilab. Karen Bland, a second-year grad student, has started to analyze collision data and is studying algorithms for identifying jets.

In the spring, Jonathan Wilson, a senior undergraduate University Scholar, graduated from Baylor and moved on to pursue graduate studies in high energy physics at The Ohio State University. This summer we welcomed Scott Ruhnau, a Baylor second-year physics major, into the group. Over the summer, Scott was doing experimental high energy physics research with two REU students, Soun-Ja Walters and Matt Naglak.

Dr. Dittmann is a member of the Executive Board of the CDF Collaboration at Fermilab. He is the chair of three "godparent" committees that are presently reviewing paper manuscripts for publication in Physical Review D and Physical Review Letters. He recently gave an invited presentation entitled *Jet Physics at CDF* at the Low x conference in Helsinki, Finland, where he also led a discussion session on hadronic final states. Funding for the Experimental HEP group is provided by grants from the U.S. Department of Energy and Baylor University.

Publications:

T. Aaltonen, *et al*. (CDF Collaboration). Measurement of the top-quark mass using missing E_T + jets events with secondary vertex *b*-tagging at CDF II. Physical Review D **75**, 111103 (2007).

A. Abulencia, *et al*. (CDF Collaboration). Observation of WZ Production. Physical Review Letters **98**, 161801 (2007).

Aerial photo of the Fermi National Accelerator Laboratory in Batavia, IL. The Baylor high energy physics group participates on the Collider Detector at Fermilab experiment. (Photo courtesy of Fermilab.)

Research Faculty Profiles

Truell W. Hyde

Professor
Director, CASPER
Vice Provost for Research

Research Interests:

Complex Plasmas

Space Physics

Astrophysics

Recent Publication:

K. Qiao, M. Benesh and T.W. Hyde

Structural Phase Transitions of Three-Dimensional Shielded Coulomb Clusters (Finite Yukawa System), IEEE Transactions on Plasma Science **35**, No. 2, pp. 346-351, April, 2007.

Dr. Hyde's research groups conduct research within a variety of theoretical and experimental research areas. Current areas of interest include:

Theoretical

Dispersion Relations in Complex Plasmas. The formation of 2D and 3D coulomb crystals in low temperature plasmas is one of several interesting problems in a new area of physics called complex plasmas. In a Yukawa system, charged microparticles interact with one another through a screened Coulomb potential allowing system ordering ranging from gas→liquid→solid phases. Determining the dispersion relations of such waves provides a sensitive diagnostic for use on experimental systems as well as provides data for basic physics research.

Micro-, Meso- and Nanoscale Formation in Complex Plasmas. The formation of micro- or mesoscale crystals, clusters and balls in low temperature plasmas is a recent (and very interesting) problem in complex plasmas. These particles self assemble into structured formations depending on the specific boundary conditions. This research area is of great interest in nanofabrication and manipulation and is on the cutting edge of nanoscience research.

Coagulation of charged micron-sized dust. The coagulation of micron-sized dust plays an essential role in the process of protoplanetary formation. Protoplanets are formed from the gas and dust left in the circumstellar disk of a newly formed star where the gas and dust coalesces on a relatively short time scale. Since the dust is immersed in a plasma environment, it will become charged.

Dynamics of charged grains in Saturn's F Ring. Saturn's F Ring is a dynamic system as shown in Voyager pictures revealing braids, kinks, and clumps evolving over a matter of weeks or months. The plasma conditions in the F Ring are unknown, but it is reasonable to assume that the micron sized dust contained in the ring is weakly charged. As such, Saturn's magnetic field imparts a significant perturbation to the orbits of these grains leading to a size-sorting mechanism which may influence the formation of braids and clumps.

Experimental

Complex Plasmas / Collidal Systems. Micron-sized dust immersed in a plasma is known as a complex plasmas. Within such plasmas, the grains can form an ordered (crystalline) lattice when the ratio of the kinetic energy of the dust grains to their potential energy is small. The primary instrument for examining such complex plasmas is a GEC RF Reference Cell modified to allow the formation of dust crystals. CASPER's two (2) GEC RF cells are currently being used to study such effects as size distributions of the dust grains, wave propagation through crystalline lattices, dispersion properties of the system and interparticle forces between individual grains.

Meso- and Nanoscale Physics. One of the primary instruments for examining meso- and nanoscale physics (dry) is (again) a GEC RF Reference Cell modified to allow the formation of dust crystals. CASPER's two (2) GEC RF cells (one of which is equipped with a Zyvex S100 nanomanipulator system) are currently being used to study such effects as micro and mesoscale structure formation, wave propagation through crystalline lattices, dispersion properties of the system and interparticle forces between individual grains. All of these areas are of interest in the new field of nanoscale science, particularly nanofabrication and manipulation.

Fusion Research. Over the past decade, dust particulate contamination has increasingly become an area of concern within the fusion research community. In a burning plasma machine design like the International Thermonuclear Experimental Reactor (ITER), dust contamination presents problems for diagnostic integration and may contribute to tritium safety issues. Since the dynamics of such dust can in general be explained employing a combination of the ion drag, Coulomb force, and ion presheath drifts, recent research in complex (dusty) plasma physics often offers unique insights for this research area. Research is currently underway to determine how experimental observations of the dust and plasma parameters within a GEC rf Reference Cell and the data collected from both impact and witness plates within the light gas accelerator might be employed to diagnose conditions within fusion reactors, hopefully providing insight into possible mechanisms for dust detection and removal.

Low Velocity Impact Studies. Spacecraft and satellites in orbit around the earth are constantly subject to impacts with dust traveling at speeds ranging from a few meters per second to a few kilometers per second. At the HIDPL, two Light Gas Accelerators and a Linear Accelerator are used to study impact craters, conduct research and development on impact detection sensors, and collect the data necessary to properly assess the durability of materials used in space.

Research Faculty Profiles

Lorin Swint Matthews

Assistant Professor

Research Interests:

Complex Plasmas

Theoretical Space Physics

Experimental Space Physics

CASPER

Recent Publication:

L. S. Matthews, R. L. Hayes, M. S. Freed, and T. W. Hyde

Formation of Cosmic Dust Bunnies, *IEEE Transactions in Plasma Physics*, **35**(2), 260-265, 2007.

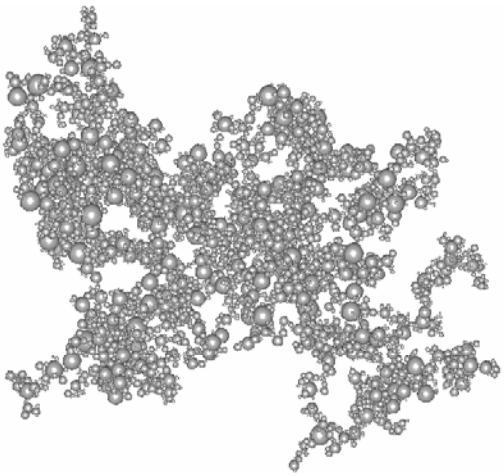
My research interests cover a variety of areas, both theoretical and experimental, in complex plasmas and space physics. Several of these projects combine theory and experiment, and most are collaborative efforts with graduate and undergraduate students, post-docs, and other faculty members in the physics and engineering departments. The project I have been working on most recently is the charging and coagulation of fractal aggregates.

The coagulation of micrometer sized particles in a complex (dusty) plasma is a fundamental process that plays an important role in the early parts of planet formation. Planets form through mutual collisions of planetesimals, bodies ranging in size from 1 to 10 km. The planetesimals in turn are thought to have formed from the dominant constituent material of circumstellar disks: gas and dust. Recent astronomical evidence shows that the coagulation process must be very efficient to have the planets form on relatively short time scales.

The primary factors that affect the coagulation rate are the relative velocity between grains, collisional cross-section, and sticking probability. Several experimental and numerical studies have made it evident that coagulation results in the formation of fluffy fractal aggregates. Fractal aggregates exhibit stronger gas-grain coupling, suppressing the relative velocities between aggregates, and have greater collisional cross sections due to their open nature. This has been shown to initially increase the coagulation rate and can lead to "runaway cluster growth" where a single aggregate rapidly accumulates a large fraction of the mass in the system.

In the primordial solar nebula, the dust is imbedded in a plasma and can become charged. For low dust densities, the greater thermal speeds of the electrons result in a higher flux of electrons than ions and consequently the dust grains become negatively charged. The resulting repulsive grain potential necessarily leads to reduced coagulation rates, though it is still possible for coagulation to occur as long as the dust grains have relative velocities large enough to overcome the Coulomb barrier. However, temperature fluctuations and differences in the secondary electron yield can lead to the formation of dust populations with oppositely charged grains. This in turn can lead to enhanced coagulation rates.

In my research, I employ a self-consistent N-body code, box_tree, to model the effects of grain charge on coagulation. By modeling a dust population with a given size distribution, the effects of a population with oppositely charged grains can be compared to those with grains that are neutral or charged to a mono-potential. The code also allows the three-dimensional geometry of the fractal aggregates to be tracked, enabling the investigation of the effects of the distribution of the charge on fractal aggregates, including the charge dipole moment and its influence on the force calculation.



Representative aggregate built from initial population of oppositely charged spherical grains with a power law size distribution. N = 11037, r_{max} = 579 μm. Large monomers are surrounded by very small monomers, due to the characteristics of the initial aggregation of the oppositely charged grains.

Professional Activities:

Investigation of Dust Wake Field Oscillations, J. Kong, T. Hyde, L. Matthews, M. Cook, J. Schmoke, and J. Carmona-Reyes, poster presented at the *16th IEEE International Pulsed Power Conference Proceedings*, 2007.

Charging of Fractal Dust Agglomerates in a Plasma Environment, L. S. Matthews and T.W. Hyde, poster presented at the *16th IEEE International Pulsed Power Conference Proceedings*, 2007.

Cosmic Dust Bunnies and Laboratory Dust Crystals, seminar presented to the Physics Department at Austin College, Denton, Texas, February 20, 2007.

Member of Program Committee for the APS-Division of Plasma Physics meeting to be held in Orlando, Florida, November 12-16.

Research Faculty Profiles

Jeffrey Stuart Olafsen

Associate Professor

Research Interests:

Nonlinear Systems

Biomechanics

Non-equilibrium Physics

Recent Publication:

G. W. Baxter and J. S. Olafsen

Experimental Evidence for Molecular Chaos in Granular Gases. Physical Review Letters, **99**, 028001 (2007).

Dr. Jeffrey Olafsen's research interests are interdisciplinary in nature, cutting across scientific disciplines to examine systems at the interface of physics, chemistry, biology and engineering. In particular, Dr. Olafsen is interested in processes that are driven far from equilibrium as well as systems that are inherently nonlinear in their dynamic behavior.

Unlike most research disciplines in physics, nonlinear dynamics typically extends across research topics and the investigations tend to be interdisciplinary by nature. This has advantages of incorporating techniques from many disciplines to attack unanswered problems. The majority of the research program so far has centered on "table top" investigations of driven granular gases, large collections of macroscopic particles for which deterministic equations exist but for which unique solutions cannot be determined for any one single particle.

The results of the investigations are applicable to a variety of different industrial processes from pharmaceuticals to grain transportation and storage. Granular physics applies to the handling of any material that is composed of a large number of macroscopic particles. Common examples are the handling and transportation of munitions, food grains and sand, and even improving the understanding of the formation of larger structures such as planets in the early solar system. Even though such media can appear to flow like a fluid, there are important differences that do not allow their behavior to be predicted with the Navier-Stokes equation, as is the case with classical fluids like water and oil. For instance, granular materials can randomly clog and jam very easily due the large amount of friction between particle surfaces. These behaviors are by definition nonlinear in nature and are extremely difficult to predict. Because of the lack of a constitutive equation, industrial processes in the past have been created on a case-by-case basis but the fundamental physics underlying such materials is not well understood.

The projects themselves are diverse, from insect biomechanics to granular plasmas, low dimensional chaos, imaging and predicting structural failure of buildings, and developing new sensing techniques for detecting land mines in shallow sand beds. The students who work in the nonlinear dynamics lab are thereby trained in a more interdisciplinary manner to help create the next generation of researchers who will be called upon to solve the challenges of an increasingly interdisciplinary research landscape. The majority of the previous investigations have been pursued by undergraduate researchers in the lab, a benefit of the experiments being "table top" in size and scope, perfect for an undergraduate laboratory research experience . As the pilot projects, originally pursued by the undergraduates, mature, they are handed over to graduate student researchers who have longer periods of time to invest in more thorough scientific investigations.

In the past year, several undergraduate students were hard at work in Dr. Olafsen's laboratory. In the spring, Vera Von Bergen and Leben Riebe were working on pilot data examining pit construction by antlions under perturbations in their environment and Kristin Combs worked on an experiment to follow up the lab's observation of molecular chaos in a system driven far from equilibrium. During the summer, Kristin continued her work in the lab and undergraduate Jacob Jantzi developed an experiment to examine mixing in granular flows due to rotational modes. REU student Corey LaFontaine developed a simulation to examine phase coherence in a bi-layer granular experiment. Data developed by these students was used in grant proposals to ACS, NSF and NASA.

Publications:

G. W. Baxter and J. S. Olafsen, "The temperature of a vibrated granular gas." Granular Matter, **9**, 135-139 (2007).

X. Zhao, S. M. Williams, J. S. Olafsen, "Water release from shaken silica substrates in a catalytic reactor." ASCE Conference Proceedings, **188**, 76 (2006).

M. D. Sturge (deceased) and J. S. Olafsen, A Solutions Manual for Statistical and Thermal Physics: Fundamentals and Applications by M. D. Sturge, Published by A.K. Peters, Ltd. (2005). Revised (2006).

J. S. Olafsen and J. S. Urbach, "Two-dimensional melting far from equilibrium in a granular monolayer." Physical Review Letters, **95**, 098002 (2005).

K. Kohlstedt, A. Snezhko, M.V. Sapoznikov, I. S. Aranson, J. S. Olafsen, and E. Ben-Naim, "Velocity Distributions of Granular Gases with Drag and with Long-Range Interactions." Physical Review Letters, **95**, 068001 (2005).

S. Feldt and J. S. Olafsen, "Inelastic Gravitational Billiards." Physical Review Letters, **94**, 224102 (2005).

J. Atwell and J. S. Olafsen, "Anisotropic dynamics in a shaken granular dimer gas experiment." Physical Review E, **71**, 062301 (2005).

Research Faculty Profiles

Linda Jean Olafsen

Associate Professor

Research Interests:

Semiconductor lasers

Mid-IR physics

Biophysics devices

Recent Publication:

Progress in Semiconductor Materials V -- Novel Materials and Electronic and Optoelectronic Applications,

edited by Linda J. Olafsen, Robert M. Biefeld, Michael C. Wanke, Adam W. Saxler (Mater. Res. Soc. Symp. Proc. **891**, Warrendale, PA, 2006).

Dr. Linda Olafsen's semiconductor laser optics group performs experimental research on the optical and electronic properties of layered semiconductors, particularly antimonide-based quantum well heterostructures designed to emit or absorb mid-infrared radiation. These devices have within their structures elaborate combinations of finite quantum wells and tunneling barriers, making them very practical applications of introductory quantum mechanics. The target wavelength range is between 3 and 5 μm, and these wavelengths are important for countermeasures and for developing chemical sensors that are at least 100 times more sensitive than those that operate in the near-infrared.

Senior Windrik Lynch is a University Scholar who is working on his thesis research in Dr. Olafsen's laboratory. He began working in the spring semester, and when he is not engaged in the mundane trouble-shooting of LabVIEW programs or boxcar/gated integrator operation, he is preparing to measure the beam profiles of mid-infrared semiconductor lasers using several techniques and to compare and reconcile those results.

Dr. Daniel Mixson joined the group for the summer as a participant in the Research Experience for Teachers. His study of "Current-Voltage and Output Light-Current Curves for Experimental Light-Emitting Diodes" not only provided measurements of both off-the-shelf near-IR diodes and specially-prepared mid-IR laser diodes, but also paved the way for future studies utilizing short-pulse electrical injection.

Ph.D. student Angela Douglass is the newest member of the group. She comes to Baylor from the University of Kentucky, where she earned a Master's degree in Physics. She has familiarized herself with the laser and optical parametric oscillator that are key instruments in the optical pumping experiments, and she already is contributing significantly to the research progress. In the future she will couple optical pumping and electrical injection to perform hybrid measurements, akin to pump-probe or optical modulation spectroscopy.

In addition to fine personnel, another new asset in the lab is a step-scan Fourier Transfer Infrared Spectrometer, with which it is possible to measure transmission and reflectivity of materials and the emission spectra of infrared semiconductor lasers. The group plans to add a nanosecond time-resolved spectroscopy accessory to this instrument, and this will be a fascinating addition as it will enable resolution of modulation induced by the 2–5 ns optical pumping pulses.

Drs. Jeff & Linda Olafsen were awarded a Faculty Research Investment Program grant that funded the acquisition of an infrared camera that is configured to measure mid-infrared output. The beam profile (*shown under Research Images on page 17 of the newsletter*) represents 2.1 μm output from the optical parametric oscillator which is being used to refine measurement techniques before characterizing mid-IR output from semiconductor lasers. The camera is being used to collect preliminary data to be included in a proposal submission to the National Science Foundation and/or Department of Defense agencies such as the Air Force Office of Scientific Research to assess mid-IR semiconductor laser output beam quality.

After last year teaching sections of 1422, the calculus-based General Physics I introductory course, Dr. Olafsen has the privilege of teaching an honors section of Physics 1420 this fall. The students enrolled are a superposition of University Scholars and honors students, and includes majors in Physics, Engineering, Chemistry, Biology, and Architecture. It is an enthusiastic bunch, and it is very nice to have a good number (7) of the new freshman Physics majors assembled in one class.

Publications:

J. T. Olesberg, C. Cao, J. R. Yager, J. P. Prineas, C. Coretsopoulos, M. A. Arnold, L. J. Olafsen, and M. Santilli, "Optical microsensor for continuous gluclose measurements in interstitial fluid," Proceedings of the SPIE, **6094**, 609403 (2006).

J. P. Prineas, J. R. Yager, J. T. Olesberg, S. Seydmohamadi, C. Cao, M. Reddy, C. Coresopoulos, J. L. Hicks, T. F. Boggess, M. Santilli, and L. J. Olafsen, "PIN versus PN homojunctions in GaInAsSb 2.0–2.5 micron mesa photodiodes," Proceedings of the SPIE, **6119**, 611903 (2006).

T. C. McAlpine, K. R. Greene, M. R. Santilli, and L. J. Olafsen, W. W. Bewley, C. L. Felix, I. Vurgaftman, and J. R. Meyer, H. Lee and R. U. Martinelli,Resonantly pumped optical pumping injection cavity lasers, Journal of Applied Physics, **96**, 4751 (2004).

Research Faculty Profiles

Kenneth Taesung Park

Associate Professor

Research Interests:

Surface Defects of Transition Metal Oxides

Interface between Metal and Thin Films of Organic Molecules

Recent Publication

Re-oxidation of TiO_2(110) via Ti interstitials and Line Defects, K.T. Park, M. Pan, V. Meunier, and E.W. Plummer, Phys. Rev. B **75**, 245415 (2007).

Dr. Park and his collaborators at the Center for Nanophase Materials Sciences have been working on a single crystal "model catalyst" such as TiO_2 to investigate surface morphology, defects, local electronic structure, and chemical properties using scanning tunneling microscopy (STM) and other surface sensitive probes. Recently the crucial role that Ti interstitials play in surface reconstructions and formation of sub-stoichiometric defects has been elucidated [1]. As for the first case study, they have extended their investigation into the relationship between distinct local structures and stoichiometry of these Ti interstitial-based, surface defects and their chemical reactivity, exemplified in the reaction with molecular oxygen [2]. *Ab initio* molecular dynamics calculations show that the row of Ti interstitials, as a highly under-coordinated cationic site, readily dissociates molecular oxygen. The dissociated oxygen surrounds a Ti interstitial to form an oxygen plane of a partial octahedron. On the other hand, the partially oxidized Ti_2O_2 strand exhibits much subdued reactivity. Although the line defect neither dissociates nor adsorbs molecular oxygen, it serves as a nucleation site for an oxidized Ti interstitial such as a TiO_2 molecule and for further growth of the line defect. The results from this work should be of broad interest as the interaction of oxygen with TiO_2 is essential in many photochemical and catalytic processes including the oxidation of CO by gold nanoparticles supported on titania as well as other reducible oxide supports.

Another active research topic is centered on the thin film formation of organic molecules on surface. Copper phthalocyanine (CuPc) and its family of Pc molecules have attracted considerable interest. This interest originates in part from the fact that the electrical and optical properties of these organic molecules can be easily manipulated by systematically altering the metal cations and ligands. The presence of a surface can affect the thin film morphology and their electronic structure. A recent paper by Mr. Manandhar illustrates that a variety of ordered molecular overlayers can be formed depending upon post-deposition annealing temperatures [3]. Moreover, CuPc molecules can polymerize into dendritic chains after annealing to 780 K for 30 minutes. This result highlights the significant influence in the formation of thin films by the substrate in addition to the central metal ions of phthalocyanines [4].

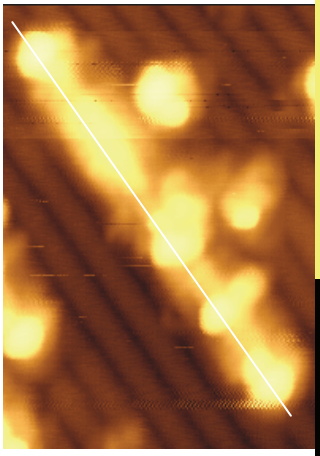
Publications

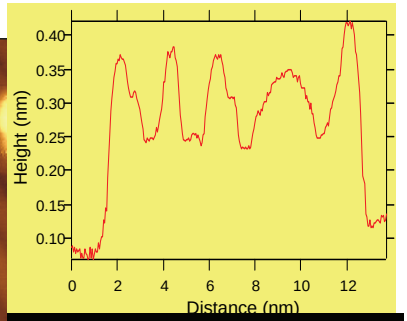
[1] "Surface Reconstructions of TiO_2(110) Driven by Sub-Oxides," K.T. Park, M. Pan, V. Meunier, and E.W. Plummer, Phys. Rev. Lett. **96**, 226105 (2006).

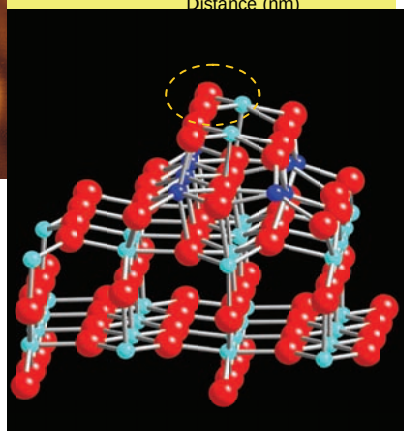
[2] "Re-oxidation of TiO_2(110) via Ti interstitials and Line Defects," K.T. Park, M. Pan, V. Meunier, and E.W. Plummer, Phys. Rev. B **75**, 245415 (2007).

[3] "A Scanning Tunneling Microscopy Study on the Effect of Post-Deposition Annealing of Copper Phthalocyanine Thin Films," K. Manandhar, K.T. Park, T. Ellis, Z. Song, T. Cai, and J. Hrbek, Surf. Sci. **601**, 3623 (2007).

[4] "Interactions of Metallo-Phthalocyanine (MPc, M = Co, Ni) on Au(001): A Ultraviolet Photoemission Spectroscopy and Low Energy Electron Diffraction Study," Trinity Ellis, Ken T. Park, Marc Ulrich, Steve L. Hulbert, and Jack E. Rowe, *J. Appl. Phys.* **100**, 093515 (2006).







See Research Images on page 17 for more images from Dr. Park's research.

STM images of single strands after the exposure to 8L of O_2 at room temperature (left: 1.48 V, 0.5 nA, 7.8 nm x 10.9 nm) and line profile (top right). DFT-relaxed structural model of a TiO_2 molecule (highlighted by an oval) adsorbed on the single strand defect (bottom right).

Research Faculty Profiles

Dwight Russell

Associate Professor

Research Interests:

Materials Science

Quantum Solids

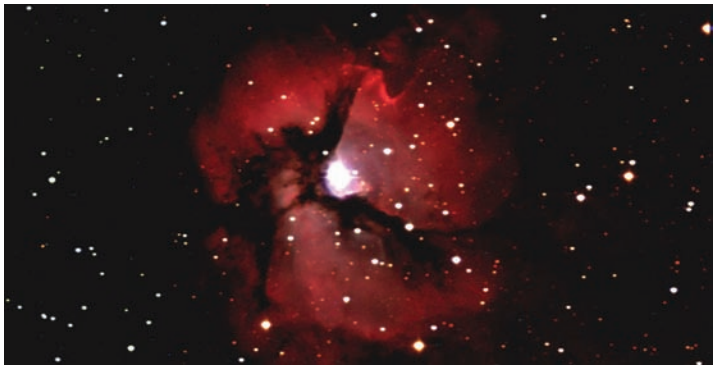
Astronomy

Recent Publication:

Role of Surface Dimer and Gas-Phase Excitation Models in Electron Stimulated Desorption of Ions from Sodium Chloride(100) Crystals, D. P. Russell, W. Durrer, Rad. Eff. and Def. in Solids- **160** 151 - 154 (2005).

This year my activities have covered four main areas: teaching intro astronomy, research on pulsating white dwarf stars, research on alkali halide surfaces and chairing the Texas section of the American Physical Society (TSAPS).

The introductory astronomy course continues to be a popular course with class sizes approaching 300 students. The field of astronomy certainly 'helps out' by providing a veritable flood of new and exciting discoveries. It is easy to say that the last fifteen years of astronomy are as significant in the increase and impact on our understanding of the physical universe and ant time in history. Happily, this trend shows no signs of slowing down. It truly is an exciting time to introduce students to the study of astronomy.



In a small way we are contributing to the body of knowledge in astronomy by participating photometric studies of pulsating white dwarf stars. This work is done in collaboration with Don Winget's group at UT-Austin and the Central Texas Astronomical Society's Meyer Observatory. This work involves the study of a unique instability strip on the HR-diagram. It has provided both summer students in the REU program and our own seniors with important interesting research projects.

In the area material science, my work on electron irradiation of alkali halides has continued. This year we have added a computer simulation project. Recent studies by Marek Szymoksi's group at the Jagolleon University in Austria has shown the importance of F* defects in the distribution of permanent defects in alkali halides and has demonstrated the role of surface pitting in the desorption of alkali metal atoms. Using these new insights, we have developed a new simulation of the growth of alkali-rich regions on the surface and in the near surface bulk under electron irradiation. The results of this work will be presented at the SESAPS meeting in Nashville TN, Oct 7-10, 2007.

As chair of the Texas Section of the APS (TSAPS) I have learn a great deal about richness and breadth of the physics community in Texas. The Texas section is celebrating its 25 anniversary this year. The TSAPS is introducing its first named award, the Robert Hyer Award. This award is to recognize excellence in research in Physics presented at Texas meetings. The award acknowledges the importance of mentoring in research by being jointly awarded to the student and their advisor. I will have the honor of presenting the first Robert Hyer award at the Fall TSAPS/TSAAPT/SPS meeting held a Texas A&M, Oct 18-20, 2007.

Publications:

Elastic interactions and the metallurgical and acoustic effects of carbon in the Caribbean steel drum, Ferreyra E, Murr LE, Russell DP, Bingert JF, Materials Characterization **47** (2001) 325-363.

Electron and Photon-Stimulated Desorption of Atomic Hydrogen from Radiation-Modified Alkali Halide Surface, L. T. Hudson, N. H. Tolk, C. Bao, P. Nordlander, D. P. Russell, J. Xu, Phys. Rev. B **62** (15) 10535 – 10543 (2000).

Materials Science and Metallurgy of the Steel Caribbean Steel Drum, Parts 1&2, (with L.E. Murr *et al.*) Journal of Materials Science **34** 967-979 (1999).

Research Faculty Profiles

Anzhong Wang

Professor

Research Interests:

Accelerating Universe in Superstring/M-Theory

Advanced Numerical Analysis of Observational Data String/Brane Cosmology

Higher Dimensional Black Holes, Their Thermodynamics & Formation

Recent Publication

Z.-H. Li and A. Wang, Mod. Phys. Lett. A **22**, 1663-1676 (2007) [arXiv:astro-ph/0607554].

GCAP (Gravity, Cosmology, and Astroparticle Physics Group) is one of the three theoretical research groups in CASPER, and was formed in the spring of 2006. Currently, it consists of 12 members, Dr. Anzhong Wang (Physics), the head of the group, Dr. Qin (Tim) Sheng (Mathematics), Dr. Yumei Wu (Physics), Dr. Rong-Gen Cai, an adjunct professor from the Institute of Theoretical Physics, Chinese Academy of Science, Dr. N. O. Santos, an adjunct professor from the Brazilian National Scientific Computation Lab (LNCC), six graduate students, Michael Devin, Yangqing Huang, Preet Sharma, Andreas Tziolas, Rui Wu, and Qiang Wu, and one undergraduate student, Pamela Vo. Recently, research topics include current acceleration of the universe in models of Superstring/M-Theory, advanced and highly effective and efficient numerical fittings of observational data, the cosmological constant and hierarchy problems, higher dimensional black holes, and their thermodynamics and formation.

One of the remarkable discoveries over the past decade in astronomy is that currently our universe is at its accelerating expansion. In Einstein's theory, to account for such an acceleration, a new component to the matter fields of the universe with a large negative pressure is needed, the dark energy. Recent astronomical observations indicate that our universe is flat and currently consists of approximately 70% dark energy, 25% dark matter, and 5% baryonic matter and radiation. A fundamental question in this direction is the nature and origin of the dark energy. The hierarchy and cosmological constant problems are other outstanding problems in particle physics and cosmology. To solve them, recently brane-world scenarios were proposed, in which our four-dimensional universe is considered as a brane embedded in a high dimensional bulk. An important result of such investigations is that high dimensional black holes are predicted to be produced in the next generation of colliders in laboratories.

In addition, theories of gravity, including general relativity, predict the existence of black holes and gravitational waves. Black holes, their thermodynamics and formation from gravitational collapse have been one of the main focuses in the last couple of decades. Recently these studies have further been promoted by several newly-built gravitational wave detectors, such as LIGO (USA), GE600 (Germany & England), Virgo (Italy & France), and TAM300 (Japan).

Publications:

G.A. Benesh and A. Wang, Gen. Relativ. Grav. **39**, 277-289 (2007)[arXiv:gr-qc/0603001].

Y. Gong and A. Wang, Phys. Rev. D **75**, 043520 (7 pages) (2007) [arXiv:astro-ph/0612196].

Y. Gong, B. Wang, and A. Wang, JCAP, **07**, 024 (19 pages) (2007)[arXiv:gr-qc/0610151].

A. Wang and Y. Wu, Gen. Relativ. Grav. **39**, 663-676 (2007) [arXiv:gr-qc/0506010].

Y. Gong and A. Wang, Phys. Lett. B **652**, 63-68 (2007) [arXiv:0705.0996].

Y. Gong, B. Wang, and A. Wang, Phys. Rev. D **75**, 123516 (5 pages) (2007) [arXiv:gr-qc/0611155].

Y. Gong, A. Wang, Q. Wu, and Y.-Z. Zhang, JCAP, **07**, 018 (12 pages) (2007) [arXiv:astro-ph/0703583].

Dr. Anzhong Wang is on research leave this fall doing work in Rio de Janiero, Brazil with collaborators. He sent along this picture. We're not sure, but we think this might be the view out his office window.

Research Faculty Profiles

B. F. L. Ward

Distinguished Professor

Research Interests:

Theoretical Physics

Particle Physics

Relativistic Quantum Mechanics

Quantum Field Theory

Recent Publication:

M. Yu. Kalmykov , B.F.L. Ward and S.A. Yost

All Order Epsilon-Expansion of Gauss Hypergeometric Functions with Integer and Half-Integer Values of Parameters, Journal of High Energy Physics **0702**, 040 (2007).

The goal of theoretical elementary particle physics is to understand the most fundamental laws which govern our universe, and to understand the structure and nature of the universe at the deepest level. Theorists at Baylor are approaching these questions from a variety of perspectives.

Standard Model Phenomenology

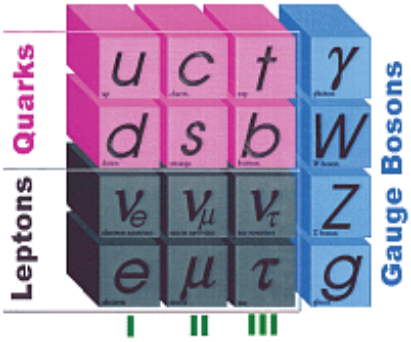
The interactions of all known subatomic particles can be described by a single theoretical framework known as the "Standard Model". This model describes matter in terms of leptons (including electrons, neutrinos, ...) and quarks, together with their interactions via force-carriers called "gauge bosons", which include the photon, W and Z bosons, and gluons. The theory is modeled by a gauge group $SU(2)_L$ x U(1) x $SU(3)_c$ which encompasses all known forces except gravity, which is too weak on small scales to have been observed in any particle physics experiments. An important constituent of the standard model is the Higgs boson, which is associated with a Higgs field which causes most of the particles in the standard model to acquire a mass.

Large high-energy physics laboratories such as the ones at Fermilab, SLAC, and CERN, have been very successful in verifying the predictions of the standard model, with the exception of finding the Higgs boson. Discovering and uncovering the properties of the Higgs boson is the primary goal of particle colliders currently under construction, including the Large Hadron Collider (LHC) at CERN. Interpreting the results of high-energy collisions in terms of the standard model requires high precision calculations of the various processes and backgrounds which are to be observed. The theoretical high energy physics phenomenology group at Baylor focuses on rigorous quantum field theoretic investigations an emphasis on the theory of higher order radiative corrections to the $SU(2)_L$ x U(1) x $SU(3)_c$ model of elementary particle interactions. Dr. Ward is engaged in constructing computer realizations of the quantum field theory calculations required for high-precision tests of the Standard Model.

Collision properties are calculated in the context of realistic detector simulations using "Monte Carlo" event generators, which randomly generate scattering events based on the predictions of quantum field theory. The Monte Carlo realization of the radiative corrections has played an essential role in precision Standard Model tests and new physics probes in the LEPII final data analysis, and in the preparation of the physics for the CERN LHC. These calculations also have immediate consequences for the ongoing studies at the lower-energy FNAL Tevatron and for precision Standard Model tests at the B-Factories and at the Φ-Factory. High precision is achieved via resummation methods based on the theory of Yennie, Frautschi and Suura (YFS), which have been extended to non-Abelian gauge theories like QCD.

The YFS methods, which allow one to resum the infrared terms in quantum field theory, can also be extended and applied to perturbative quantum gravity. Dr. Ward has been investigating this, and in the process has found a new way to analyze classes of quantum gravity graphs which may otherwise have been expected to produce divergences. This may provide a fruitful new approach to the long-standing problem of quantizing gravity.

More recently, this fall Dr. Ward was invited to lecture at the Werner-Heisenberg Institut, Max-Planck-Institut, Munich, Germany and to lecture at the 7th International Symposium on Radiative Corrections (RADCOR07) at the Galileo Galilei Institute in Florence, Italy. The lecture in the MPI was on his new result that shows the taming of the IR divergences in initial state radiation in massive QCD in the higher orders and the lecture at RADCOR was a summary of the new results of his group on their unique platform for precision LHC physics predictions via MC methods, the only such platform in the world now wherein quarks can be massive in higher order initial state radiation. In the RADCOR lecture, he also presented his latest results in his new approach to quantum general relativity. Dr. Ward is a member of the International Advisory Board for the RADCOR series of symposia.



Research Faculty Profiles

Walter Wilcox

Professor

Research Interests:

Lattice QCD

Disconnected Diagrams

Hadron Polarizability

Deflation Algorithms

Recent Publication

Deflated GMRES for systems with multiple shifts and multiple right hand sides. (with Dean Darnell and Ronald Morgan) submitted to "Linear Algebra and its Applications". (accepted for publication).

My main area of research is the study of the interactions of particles known as quarks and gluons; I do extensive numerical simulations of the theory which describes these particles, known as Quantum Chromodynamics (QCD). Lattice QCD represents a numerical attempt to solve, and compare to experiment, physically observable quantities from QCD. State of the art numerical methods, including matrix deflation, are used to solve the theory on high performance computers. My field is called "lattice" QCD because I simulate the interactions of the theory on a discrete space-time lattice using numerical methods on supercomputers. The variables in the lattice represent the QCD vacuum, the basis of all other particle states. These variables are determined via a Monte Carlo procedure in each "configuration", and once have been determined, all physical quantities are then defined by an average over these configurations. Lattice QCD benefits from a synergy of field theory, experimental particle physics and computer technology.

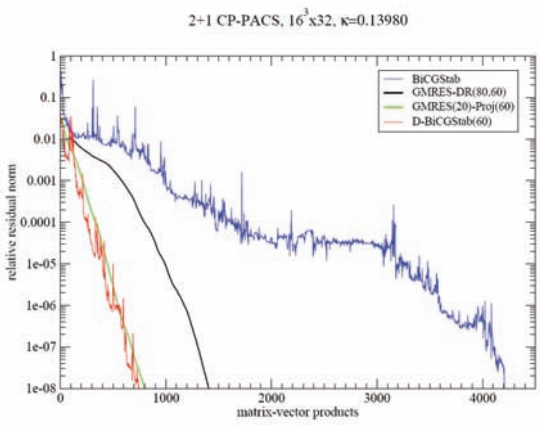
What is Deflation?

A good, working definition is that it consists of the removal or projection of the low lying eigenmodes of a matrix in order to speed up additional calculations with the same matrix. It is known, for Hermitian systems, that the convergence rate for numerically solving linear equations is approximately related to the condition number, which is defined as the square root of the ratio of the largest to the smallest eigenvalue:

$$\sqrt{\lambda_n/\lambda_1}$$

Reducing this ratio will effectively speed up the solution of the associated linear equations. For lattice QCD this occurs at small quark masses, and the general numerical problem being encountered is that of critical slow-down.

The effects of our deflating algorithms are illustrated in the accompanying figure. This matrix is a 16^3x24 2+1 (two light quarks plus strange) dynamical configuration we obtained from the Japanese group known as CP-PACS. It shows four residual norm curves for solving this system as a function of matrix vector products for very low quark mass. BiCGStab is a standard method, and is used for comparison. The solid black curve is from Ron's method called GMRES-DR. It deflates and calculates the low eigenvalues and passes them on to our other solvers. The green lines represent the results from our GMRES-Proj algorithm, and the red line gives the result from our deflated BiCGStab. The residual norm convergence on this lattice is accelerated by about a factor of 7 compared to BiCGStab.



Publications:

"Deflated iterative methods for linear equations with multiple right-hand sides", with Ronald Morgan, submitted to "Electronic Transactions on Numerical Analysis". (accepted for publication)

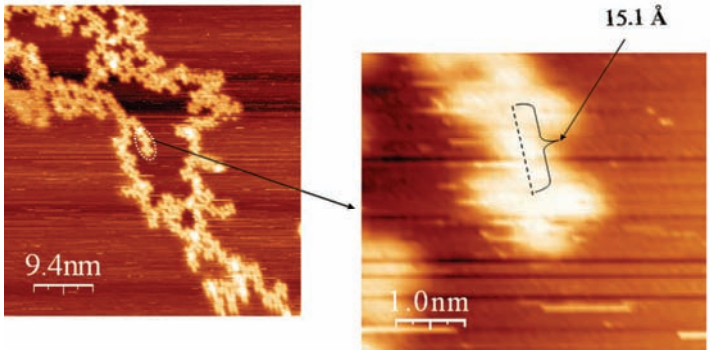
"Deflation Methods in Fermion Inverters", the XXV International Symposium on Lattice Field Theory ("Lattice 2007"), Regensburg, Germany, to be published in Proceedings of Science.

"Deflated BiCGStab for linear equation in QCD Problems", with Ron Morgan and Abdou Abdel-Rehim, the XXV International Symposium on Lattice Field Theory ("Lattice 2007"), Regensburg, Germany, to be published in Proceedings of Science.

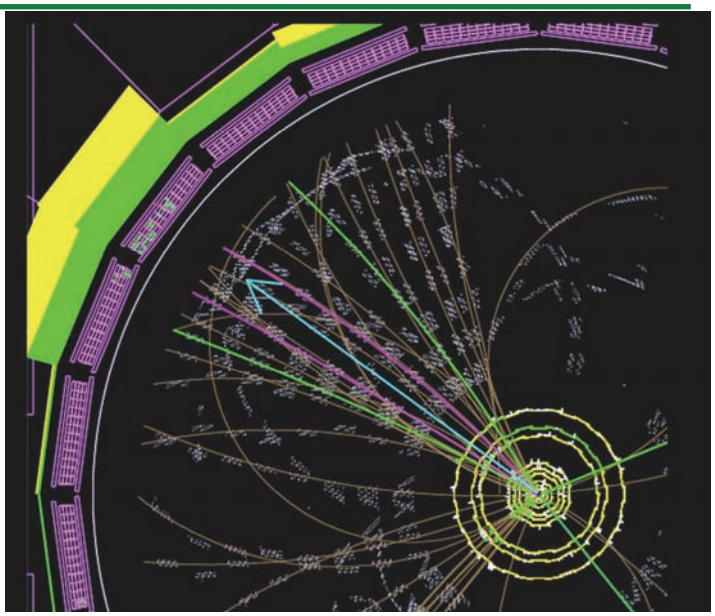
"Vacuum Expectation Values of Twisted Mass Fermion Operators", with Randy Lewis (Regina University) and Abdou Abdel-Rehim, the XXV International Symposium on Lattice Field Theory ("Lattice 2007"), Regensburg, Germany, to be published in Proceedings of Science.

"Magnetic Moments of Vector Mesons in the Background Field Method", with Frank Lee (George Washington University), the XXV International Symposium on Lattice Field Theory ("Lattice 2007"), Regensburg, Germany, to be published in Proceedings of Science.

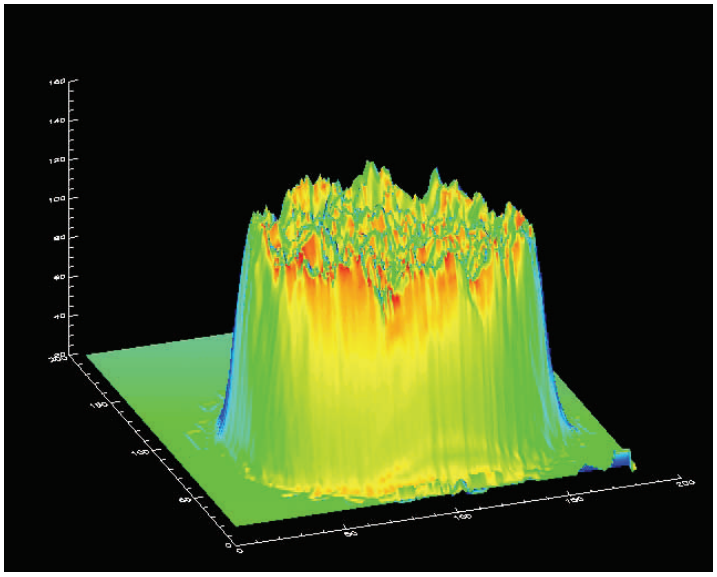
Research Images



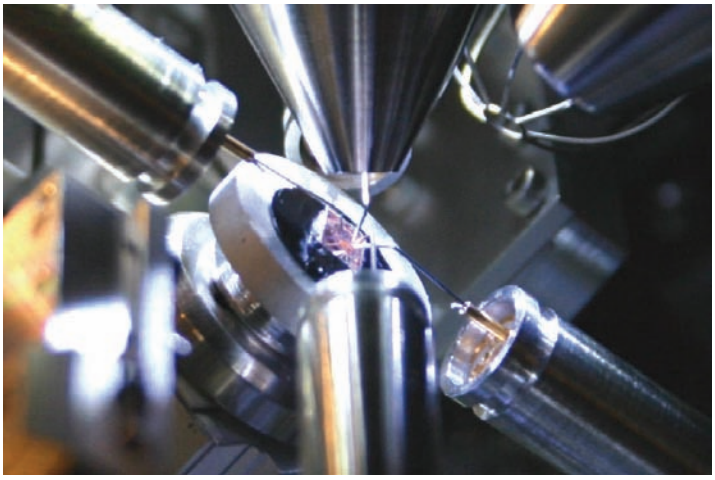
(Left) 0.6 ML of CuPc molecules form dendritic chains on Ag(111) after heating for 30 minutes at 780 K. (Right) A magnified view of CuPc dimers possibly resulted from the dehydrogenation of the benzene rings.
From Dr. Ken Park's research group



A collision event from the Collider Detector at Fermilab (CDF).



Infrared beam profile taken with a new IR camera sensitive in the range of 4 - 12 microns as part of a new collaboration between Drs. Jeffrey and Linda Olafsen to study beam profiles of semiconductor quantum lasers. Composite image processed by Jacob Jantzi.



One of CASPER's GEC RF cells equipped with a Zyvex S100 nano-manipulator system.

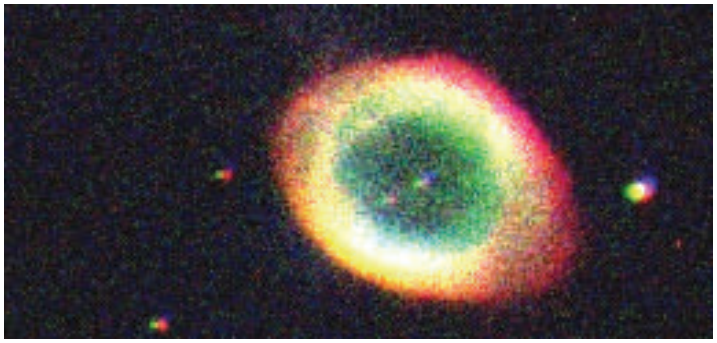
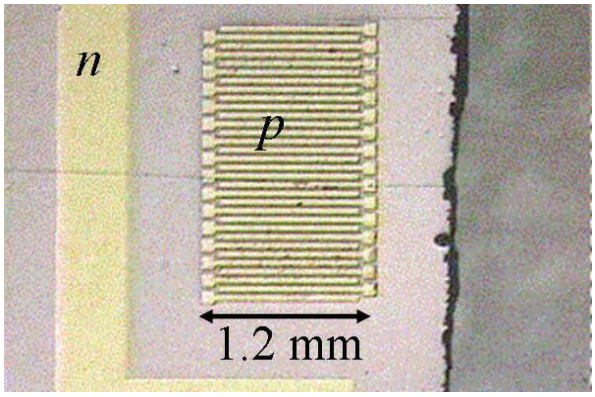


Image of the Planetary Nebula M57 by Dr. Dwight Russell and students.

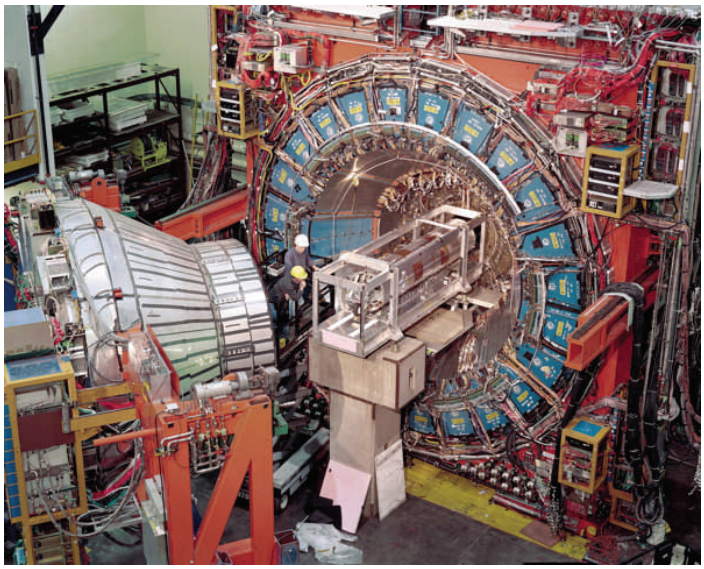


A glucose sensor from Dr. Linda Olafsen's research lab.

Special Research Focus: Experimental Elementary Particle Physics

Three Undergraduate Students Perform High Energy Physics Research − and take a trip to Fermilab!

Over the summer, three undergraduate students working in the Experimental High Energy Physics group had a special opportunity to visit Fermi National Accelerator Laboratory (or "Fermilab") which is located thirty miles west of Chicago, Illinois. Fermilab is the home of the Tevatron, currently the most powerful particle accelerator in the world. Within the Tevatron, protons and antiprotons are accelerated to over 99.9999% of the speed of light in a giant 4-mile-around underground ring. Orbiting in opposite directions, the protons and antiprotons collide at the center of an enormous 5000-ton detector called the Collider Detector at Fermilab. Data collected from the detector allow high energy physicists to learn more about the internal structure of the proton and to test the theories that describe the fundamental forces of nature. They can also search the data for the existence of new particles that have never been observed before.



The Collider Detector at Fermilab (CDF).

Scott Ruhnau, a Baylor sophomore physics major, spent 10 weeks during the summer working on an important component of the huge detector: the eXtremely Fast Tracker, or XFT. The job of the XFT is to identify the trajectories of charged particles produced in the proton-antiproton collisions. Scott learned the Java programming language and wrote software which will be very useful for diagnosing malfunctions within the XFT system and fixing them quickly. He spent four weeks during the summer located at Fermilab − that's where the action is!

Two undergraduate students in Baylor's Research Experiences for Undergraduates (REU) program also spent the summer engaged in high energy physics research. Matt Naglak, from the University of Arkansas, worked together with Scott on the XFT project. Soun-Ja Walters, from New Mexico State University, worked with Baylor grad student Karen Bland on a study of computer algorithms used to identify "jets" produced from quarks or gluons that are created in high energy collisions.

From July 22 to 25, Matt and Soun-Ja had a unique opportunity to travel to Fermilab with Dr. Jay Dittmann. Since Scott had already arrived for a longer stay, it was a great chance for Dr. Dittmann to give all three students a tour of the laboratory and spend a little time in downtown Chicago. It was a great experience for everyone!

- Submitted by Jay Dittmann.

Undergraduate Researchers Matt Naglak, Soun-Ja Walters, and Scott Ruhnau at the Fermi National Accelerator Laboratory. Photo by Dr. Jay Dittmann.

Special Research Focus: Theoretical Elementary Particle Physics

As a part of his ongoing efforts in the areas pursued by Dr. B.F.L. Ward's theory group, his 2007 summer was highlighted by two trips, one to the Theory Division, PH Department, CERN (European Laboratory for Elementary Particle Physics), Geneva, Switzerland, and one to the Academia Sinica and the National Center for Theoretical Sciences (NCTS), Taipei, Taiwan as well as to the 23rd International Symposium on Lepton-Photon Interactions at High Energy (LP07) in Daegu, S. Korea. The trip to CERN, where he is a Short-Term Visiting Consultant, allowed him to continue the exciting and challenging preparations for the imminent turn-on of the Large Hadron Collider (LHC), the largest peace-time physics experiment in the history of civilization. The objective is to probe the deep underpinnings of the origin of mass in the Standard Model of elementary particles, where it should be noted that the simplest paradigm involves the Higgs particle which could then be one of the main discoveries of the LHC.

Dr. Ward's research group (Prof. Scott Yost, who has moved to Princeton this fall; Dr. Mikhail Kalmykov, who has moved to the II. Institute for Theoretical Physics, University of Hamburg, Hamburg, Germany this fall; Dr. Swapan Majhi; Mr. Sammy Joseph, graduate student, and Dr. Ward, himself) is focused on the precision theory of LHC physics, always keeping an eye as well toward the possible application of their work for the precision theory needs of the physics of the International Linear Collider, a project that is still in its developmental stages but which promises to deliver 1TeV e^+e^- annihilation energies (a possible site for it is Fermi National Accelerator Laboratory just outside Chicago). The group has recently achieved pioneering results aimed at supporting the analysis of LHC data for discoveries, such as further progress on their newly developed hypergeometric function representation of the attendant higher order Feynman diagrams, further progress on the exact result for the massive pentagon corrections in such scenarios, a proof that the amplitude-based resummation theory developed by S. Jadach and Dr. Ward tames the uncancelled IR divergences of massive QCD in the higher orders of its perturbation theory, etc. It is also noteworthy that, at the June 19th **Review of US Program for Detector R&D for the ILC**, held at Argonne National Laboratory in Chicago, Prof. M. Hildreth of the University of Norte Dame listed their Baylor proposal to upgrade our MC BHLUMI to version 5 as the only solid candidate theory capable of realizing the needed 0.01% luminosity precision tag for the ILC physics program objectives.

See Professor Hildreth's presentation at

http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=1640

In the trip to Taiwan and LP07 in Daegu, S. Korea, Dr. Ward presented two talks in Taiwan, one at the Academia Sinica and one at the National Center for Theoretical Sciences, having contributed seven papers to LP07. In the lecture at Academia Sinica, Dr. Ward presented the latest developments in his new UV-finite approach to quantum general relativity, (for example, see http://www.arxiv.org/abs/hep-ph/0610232). We are pleased that this paper won Honorable Mention and it was rated as one of the top 35 papers among the many hundreds submitted world-wide in the year-long competition in the Gravity Research Foundation Essay competition which ended in Spring, 2007, see http://www.gravityresearchfoundation.org/announcements.html for the announcement.

This shows that his new solution to the one problem that Einstein could not solve is gaining acceptance. In the lecture in NCTS, Dr. Ward presented the current status of their pioneering research on precision LHC theory (as referenced above) where they stress the interplay between their QEDXQCD resummation theory and their shower/matrix element matching schemes with the need for exact results to the respective matrix elements at $O(\alpha_s^2)$ and higher. The eye is always toward MC methods for comparison with LHC/ILC data. The participation by Baylor at LP07, which is the 23rd in this series of big international symposia, is essential to Baylor's continued recognition as an institution in contact with the mainstream of particle physics worldwide. Dr. Ward's involvement as a part of the American delegation to the meeting helps to assure that the USA's interests on the world stage of the field will move forward and that Baylor will be attuned to that movement to the extent that we can influence it.

Newsletter Highlights
September / October 2006

New posters show off Physics history

The halls of the physics department received some dressing up recently, as the department acquired the *A Century of Physics* poster series, produced in 1999 by the American Physical Society to celebrate the Centennial meeting of the physics society.

Spanning the period from 1895 to 1995, the 11 poster series now adorns the wall of the main inner hall of the 3rd Floor E wing of the Physics Department.

The department would like to thank Dr. Linda Olafsen who initiated this acquisition.

The department continues to have a First Thursday Coffee at 10:30 a.m. in the Physics conference room. Many of our emeriti faculty are regular attendees. Please join us on the first Thursday of each month.

November / December 2006

Department celebrates Homecoming with Alumni

The Department of Physics hosted several activities in conjunction with Baylor Homecoming 2006. In addition to tours of the teaching laboratories (by Linda Kinslow with graduate students Matt Robinson and Chenfang Xia) and research facilities (led by Ken Park) the department also hosted a special Friday Physics Colloquium, *Physics Meets Medicine*, given by Dr. Melissa Miller Blough. Dr. Blough received her B.S. in Physics from Baylor in 1994. She is currently the Associate Director of Medical Physics at the Cancer Therapy and Research Center in San Antonio.

The annual Physics Homecoming Reception followed Dr. Blough's presentation in E.301. The Reception was an interesting mix of the past and the present, displaying both photos of previous faculty and students as well as showing off the new annual departmental newsletter, which was mailed out to alumni this year as part of Homecoming.

January / February 2007

Physics Department Submits Strategic & Operational Plans

The Department of Physics worked diligently to complete the submission of the operational and strategic plans by the December 15, 2006 deadline. The auspicious plan would grow the department in key areas while expanding the curricular and research efforts of the faculty. The Herculean effort would not have been possible without everyone's efforts to write, read and provide feedback on the goals and challenges the department faces in the future.

Dear Colleagues,
[T]he major strategic proposal and operational plan [were] submitted earlier today. They're in!! Thanks to all of you for your hard work in creating these documents. A special word of thanks to Lorin, Jerry, Jeff, and Linda [Olafsen] for taking charge of the various sections of the major proposal. And a very special thanks to Linda for assembling the various parts, rewriting, and constructing a document that makes our case persuasively and with a single voice. Excellent work!
Best Wishes, Greg

Newsletter Highlights
March / April 2007

Dwight Russell named Chairman of Texas Section of APS

For the first time in over twenty years, the chairman of the Texas Section of the American Physical Society is a Professor here at Baylor University. Our own Dwight Russell has made the transition from chairman-elect to present chairman of the august body. Dwight's involvement in the administration of the Texas Section of the APS goes back to his nomination as vice-chairman in 2005. Dwight was generous enough to share with all of us glimpses of his recent jaunt to Washington, D.C.

The congressional visit was very interesting and busy. We visited the offices of two Senators, Cornyn and Hutchison and four Representatives, Edwards, Culberson, Gonzalez and Granger. We were well received in all offices, usually meeting with legislative assistants. We did have the opportunity to meet with Rep. Culberson personally and were impressed by his VERY enthusiastic support of science and technology. He felt Government was not doing nearly enough to support research.

We also had the chance to say hello to Rep. Gonzalez after meeting with his legislative director. For the most part we had meetings with high level assistants or the congressmen themselves. The high level profile was encouraging. Particularly since we were there on the day of the Iraq vote.

In preparation the Washington APS staff developed a packet of information to help us in our meetings. Since congress has changed (quite a bit since this time last year) there is more uncertainty on what issues will resonate the most. Fortunately, science and technology is key to so many areas it is easy to argue relevancy.

May / June 2007

Dr. John Vasut named "Advisor of the Year"

John Vasut of the Department of Physics was named Advisor of the Year at the 14th Annual Baylor Advisor Appreciation Banquet held on April 16, 2007. John was nominated for his advising work with the Baylor Chapter of the American Student Dental Association (the pre-dental organization). The nomination letter by the ASDA speaks for itself:

"Dr. Vasut encourages our members to always do their best in their classes and is willing to provide tutorial services during his office hours and helps us to network with other professors if he is unable to help us. He also sets a positive example to all of the members by keeping a good attitude and always has interesting stories or facts to tell us. Dr. Vasut is not only an involved advisor for ASDA, but also a kind and caring husband and father. Last semester ASDA was assigned to paint a house for our *Steppin' Out* service project and I remember him bringing his wife and four year old daughter along to help."

Summer 2007

Baylor Distinguished Professor Honored

Editor's note: This story was taken from a Baylor press release authored by Matt Pene

Dr. Bennie F.L Ward, distinguished professor of physics at Baylor University, has received an honorable mention in an international essay competition conducted by the Gravity Research Foundation.

The year-long competition seeks "the most pioneering essays in research on the subject of gravitation, its theory, application or effects."

"Resummed Quantum Gravity" presents a new solution to the famous problem that Albert Einstein could not solve - the union of the quantum mechanics theory of Bohr and the fundamental general theory of relativity by Einstein. "I am excited and honored to have been recognized in this exceedingly strong competition," Ward said. "The recognition shows that Baylor's physics department is creating physics on the cutting-edge, something essential for any physics department that hopes to become a top-tier department."

Lecturer Biographies

Edward Schaub

Ed Schaub has been involved in the Baylor Physics department for the past 20 years, first as an instrumentation engineer on the NASA CRAF/CoDEM project under the leadership of Dr. Merle Alexander, and more recently as a full-time lecturer. Previous to his Baylor employment, Schaub held a number of positions in industry. He was a production engineer with Texas Instruments in the Government Products Division, a research engineer with AFS Research Corporation investigating alternate energy resources, and a consulting engineer on a number of hazardous waste remediation projects. Schaub holds an M.S. in Physics and an M.S. in Environmental Studies.

Linda Kinslow

This is Linda Kinslow's sixth year teaching at Baylor. She also coordinates the undergraduate physics labs. Prior to coming to Baylor she worked for BP as a exploration geophysicist. Linda earned her PhD degree from Baylor University.

John Vasut

John Vasut received his PhD from Baylor University in 2001 and has been working as a full-time lecturer in the department since 2002. He was named Advisor of the Year at the 14th Annual Baylor Advisor Appreciation Banquet held on April 16, 2007.

Yumei Wu

Yumei received her PhD from the University of Ioannina in Greece in 1992. In addition to lecturing, she continues to do theoretical research in viscoelastic systems.

Bob Farmer

Bob teaches the Modern Physics course in the department. He received his PhD degree from Rice University in 1960.

Tibra Ali

Born in Bangladesh, Tibra received his bachelor and masters degrees from Dhaka University (birthplace of Bose-Einstein statistics). He obtained his PhD in High Energy Physics in the Department of Applied Mathematics and Theoretical Physics at Cambridge University. After a postdoctoral position here at Baylor, Tibra joined the department as a lecturer teaching PHY 1420 & 1430 and is supervising the introductory sequence tutorials.

Emeritus Faculty Continue Departmental Relationship

The Department is blessed with a very fruitful and ongoing relationship with our Emeritus Faculty. In addition to the First Thursday Coffees, the Emeritus Faculty have been seen dining with the Department during our Wednesday lunch excursions to local eateries and they continue to visit during both profession and social functions of the department.

George Wang and his wife, May, are on the left in this picture chatting with Greg and Dana Benesh during the Department's Fall Picnic in September.

The Emeritus Faculty are an important part of the Department, sharing with us their wisdom and perspective to help us shape the future of the department.

Emeritus Faculty:

Bill Adams	Don Hardcastle
Robert G. Packard	George Wang

A Brief Devotional:

The Lord God has given me the tongue of the learned, that I should know how to speak a word in season to him who is weary. —Isaiah 50:4

An interesting anecdote about Einstein speaking at Swarthmore College sheds important light on the above verse. Both the verse and the anecdote are discussed on the "Our Daily Bread" website, a resource that is helpful to making time for a daily reflection on God's Word. The particular verse and story are available at the following link: **http://www.rbc.org/odb/odb-06-18-03.shtml**

Duke Alumnus visits

December 1, 2006 brought a new level of critical mass to the Physics Department in the mode of Duke Alumni. Dr. Steven Lautenschlager presented the Physics Colloquium entitled: What a Tangled Web: The History, Shortcomings and Extraordinary Potential of the World Wide Web.

Steve is on the left in the picture here, standing next to fellow Duke Alumni Drs. Jay Dittmann, Linda and Jeffrey Olafsen (holding their son John Olafsen) who are all faculty here at Baylor University and had been graduate students with Steve back at Duke University in the 90's. It's even rumored that John is scheduled to be a Duke graduate student, as Dr. John Thomas at Duke University has apparently laid claim to him when John starts graduate school in the year 2027. (*John Thomas's group is known for being difficult to join*!)

Departmental Scholarships

Baylor University
Department of Physics

Physics Funds

Cy Lynch Physics Scholarship

This scholarship is merit-based for graduate students.

Gordon K. Teal Physics Scholarship

This scholarship is for physics majors with outstanding grades.

Herbert Schwetman Physics Scholarship

This scholarship is merit-based for physics majors.

Physics Department Special Scholarship

Funds to benefit the departmental scholarship program.

Physics Endowment and Excellence Fund

Physics general fund to promote excellence within the Department.

Roy W. Stiegler, Jr., Endowed Physics Scholarship Fund

This scholarship is need-based for physics undergraduate and graduate students.

Shim and Theresa Park Physics Scholarship

This scholarship is merit-based for international students.

People sometimes ask us how they can help us accomplish our goals of growing as a Department. One important way in which all of our alumni and friends can help is to give to the ongoing support of the scholarships that we offer to students within our Department. A list of these scholarships and their goals are provided here. Last year, ten undergraduates and four graduate students received awards ranging from several hundred to a few thousand dollars given on the basis of merit and need. One of the great benefits of having these scholarships is the good that can be accomplished by gifts of any size made to these funds.

Department grows minors, too!

John, Maggie, and Jane Andao Vasut are pleased to announce the birth of:

Joseph Anzhen Vasut

Arrived 2:58 a.m. September 18, 2007

7 pounds 10 ounces, 20" long

Anzhen comes from the Chinese words:

An: Peacefully Settled on-

Zhen: The Truth

{Jesus is the Way, the Truth, and the Life}

Behold, children are a gift from the Lord. - Psalm 127:3

Lorin and Chris Matthews welcomed a new daughter into the family this summer.

Zayn Matthews was born June 26, 2007, weighing 6 lbs and measuring 19" long.

Trinity Ellis received his Ph.D. in August 2005 for his work with Dr. Ken Park on "Heteroepitaxial Metallophthalocyanine thin films on Gold: Atomic and Interfacial Electronic Structures," and then moved to the Intel's facility at Hillsboro, OR as a lithographic engineer.

"Here is a picture of my new daughter Lillian Hoa Truc Ellis. She was born on Saturday Sep. 1st at 4:38 pm." →

All of these beautiful babies join a growing group of children within our larger Baylor physics family and can be seen at several of our Departmental social functions.

Undergraduate Students



Senior Recognition Luncheon and Sigma Pi Sigma Induction

Faculty, staff, family, friends, and fellow students gathered for lunch on Friday, April 27, to honor the graduating seniors in the Physics Department:

- **Rachel Harder** graduated with a B.S. in physics, and plans to teach high school physics in the New Braunfels area after getting married in July.
- **Sean Thornton** graduated with a degree in electrical and computer engineering with minors in physics and mathematics. Sean is attending Vanderbilt University (thanks to Dr. Russell's recommendation) to study cognitive robotics. "After that I may go for PhD in physics or an MBA, depending on whether or not I'm sick of school."
- **Jon Wilson**, a University Scholar with emphases in physics and music, moved to Ohio this summer to work on a research project with Dr. K. K. Gan before starting graduate studies in physics at Ohio State University.

The seniors were each presented with a Baylor graduation bear, the bears garbed in graduation caps and "dresses." The barbecue luncheon was arranged by the Society of Physics Students. At the end of lunch, new newest members were inducted into Sigma Pi Sigma, the physics honors society. 2007 inductees were Pamela Vo and Will Brian. Congratulations to our graduates and inductees!



Rachel Harder Sean Thornton Jon Wilson

Undergraduate Summer Research 2007:

Matthew Benesh was accepted into Baylor's REU program and Pamela Vo was accepted into the REU program at Michigan State. Undergraduates Kristin Combs and Jacob Jantzi worked with Dr. Jeffrey Olafsen doing research in granular physics. Will Brian worked with Dr. Markus Hunziker in the Math Department doing research in the area of geometry. Scott Ruhnau worked with Dr. Jay Dittmann in Experimental High Energy Physics on the CDF Experiment at Fermilab.

Graduate Students



Graduate Student News

- Rui (Ray) Wu successfully defended his Master's thesis work with Dr. Anzhong Wang on August 30, 2007. The title of his thesis is "Gravitational Collapse and Formation of Black Holes in the Brans-Dicke Theory of Gravity with (2+1) Dimensions."
- Mark Mastin successfully defended his Master's thesis work with Dr. Greg Benesh on June 29, 2007. The title of his thesis is "An SEGF Study of the Rh(001) Surface." Mark continues his role with ITS here at Baylor University.
- Roger Dooley successfully defended his Ph.D. dissertation with Dr. Greg Benesh on March 22, 2007. The title of his thesis is "Surface Magnetism in Ni(001), Co(001) and Fe(001): An Embedding Green Function Approach."

Sam Hewamanage, a graduate research assistant located at Fermilab, was accepted to attend the fourteenth CTEQ Summer School on QCD Analysis and Phenomenology in Madison, Wisconsin, from May 30 to June 7, 2007. This Summer School is a terrific opportunity for young physicists to learn about many aspects of Quantum Chromodynamics and its connection to experimental high energy physics.

Dr. Walter Wilcox became the new Graduate Program Director on June 1, 2007. He replaces Dr. Ken Park.

The department welcomed several new graduate students at the beginning of the Fall 2007 semester. Angela Douglass, Jay Murphree, Kristen Pechan, Te Ha, Zhaunhao Zhang, Yongqing Huang, Jessica Norcia, Alex Price, and Zhenbin Wu have all begun their graduate studies here within the department.

Nan-hsin "Nancy" Yu has traveled to the Center for Nanophase Materials Sciences in Oak Ridge National Laboratory and spent two months (July and August of 2007) working with the CNMS scientists to investigate the nanoscale defects of transition metal oxides and their role in the formation of nanoparticles. She has developed her expertise in etching the STM tips that would produce atomic resolution in images. She claims "[A]nd with lots of practice, I now know the tips to make good STM tips."

The department was successful in obtaining an increase in graduate student salaries in the last year. However, even after that increase, the faculty are still not satisfied with the level of support for our graduate students. The faculty continues to work to improve the situation for all of the graduate students within the department.


Faraday Institute

Greg Benesh attended the Faraday Institute summer workshop in Cambridge, England July 20-26. The Faraday Institute for Science and Religion is an academic research enterprise based at St. Edmund's College, Cambridge that encourages scholarly research and publication on science and religion, including the organization of invited experts to write joint publications. The Institute derives its name from Michael Faraday, who saw his faith as integral to his scientific research. It is supported in part by the John Templeton Foundation.

Editor's note: Since Greg couldn't seem to fill this space with his news story, and since he hasn't made time to point it out himself, we'd like to point out that he was named the new Chair of the Department in August after having served last year on an interim basis. Congratulations, Greg!

Parent - Faculty Coffee

Good (enough) weather was a blessing to the Parent - Faculty Coffee held on October 6, 2007 as part of Parent's Weekend. The two-day event includes several opportunities, such as the coffee, for parents of Baylor students to interact with the faculty, administrators and the students themselves over several different venues.

Departmental participation in the coffee was at its typically strong level this year, with Drs. Benesh, Wu, Vasut, Kinslow, Russell, Cleaver, Schaub, Dittmann, Ali, and Linda and Jeffrey Olafsen all attending. The coffee was held early Saturday morning, and while it was humid, the early morning rain cooled the temperatures just long enough for the two-hour event. It also gave the Department the opportunity to meet several of the families of our new freshmen physics majors. Pictured here, Dr. Linda Olafsen speaks with freshman Physics major Matt Wicker and his family.

Speaking of Coffee ... (Homecoming Events!)

The Physics Department will once again be holding special events in conjunction with Homecoming this year at Baylor University. On Friday, November 2, 2007 Dr. Michael Henry, who earned a B.S. degree in Physics in 2003 from Baylor University and his Ph.D. in 2007 from Massachusetts Institute of Technology, will be our special guest speaker from 2 - 3 p.m. in Room A.108 of the Baylor Sciences Building. Following his talk, the Physics Department will be hosting a Homecoming Coffee from 3 - 5 p.m. in Room E.301 of the Baylor Sciences Building. Please join us for both the talk and the coffee, both to reminisce with faculty and friends as well as to bring us up to date on what you're currently doing. On Saturday, November 3, Chris and Lorin Matthews will be opening The Palladium (729 Austin Ave. located at Austin Avenue and 8th St.) at 8 a.m. and hosting a Physics Department Coffee and Donuts reception to watch the Homecoming Parade. *Park off Washington Ave. between 7th and 8th Sts.*

And if you *really* enjoy coffee, or if you happen to be in town on Thursday, November 1, 2007, that will of course be the date of our very next First Thursday Retiree Coffee, held at 10:30 a.m. in the Physics Department Conference Room. You may even be able to surprise a few of our emeritus faculty who attend.

Advances in Computational Physics at Baylor

Editor's note: This year, the Physics Department began offering a concentration in computational physics. In conjunction with this, we are pleased to reprint the following two Baylor news stories that demonstrate the growing research efforts in computational physics.

Researchers Make Significant Breakthrough in Quantum Chromodynamics

Oct. 1, 2007 by Matt Pene

Two Baylor University researchers have developed a new mathematical algorithm that solves the linear equations of the Lattice Quantum Chormodynamics (Lattice QCD) much faster, marking the first time an effective method has been developed to overcome a problem experienced by all Lattice QCD researchers.

In physics, Lattice QCD is a theory of quarks and gluons formulated and solved on a finite space-time lattice of points, however the process of solving millions of linear equations is slowed due to small eigenvalues in the matrix. Eigenvalues help determine energy levels of atoms and how buildings vibrate, but they also determine how fast solution methods for linear equations converge. The algorithms created by Dr. Ron Morgan, professor of mathematics at Baylor, and Dr. Walter Wilcox, professor of physics at Baylor, essentially "throw out" the small eigenvalues, thus speeding up the process.

"It seems the bigger the problem, the better it works," Wilcox said. "These methods are the culmination of a remarkable collaboration between mathematics and physics researchers and we are very pleased with the result. This will allow researchers in my field to do more, at a faster pace."

The research has appeared in the physics journal Nuclear Physics B and several Society for Industrial and Applied Mathematics journals. Wilcox also presented the research at the International Symposium on Lattice Field Theory, which was hosted by University of Regensburg in Germany.

Baylor Strengthens Research Infrastructure With HP High-Performance Computing Cluster

Sept. 20, 2007, Media contact: Lori Fogleman, director of media communications

Baylor University will soon add a new high performance computing cluster from Hewlett Packard that will further strengthen Baylor's research computing capabilities to address the growing demand for parallel computing resources.

The addition of the 128-node, 1024-processor-core high performance computing system will provide Baylor researchers with a powerful system for computationally intensive applications, parallel computing applications that require multiple processors, and grid computing with other institutions. The system, which is not limited to any department or any particular type of research, should arrive at Baylor next month. It will reside in the Information Technology Services server facility and is supported by the Academic and Research Computing Services group (ARCS).

"This latest addition to Baylor's high performance computing capability provides Baylor researchers the computational ability necessary to tackle world-class problems that heretofore would have been impossible to work on at Baylor due to their scope," said Dr. Truell Hyde, vice provost for research at Baylor and director of the Center for Astrophysics, Space Physics and Engineering Research. "It also makes the university much more attractive to prospective faculty that would not have been able to easily continue their research without such facilities on-site. The cluster expansion also provides Baylor the opportunity to pursue partnerships with other high performance centers around the nation that could greatly benefit the university. Taken together, this is just one more example of 2012 at work."

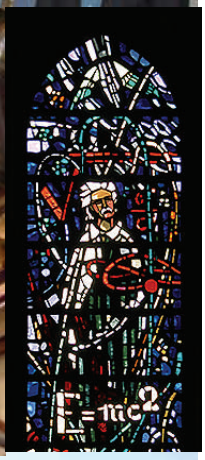
Among the faculty researchers who will be early users of the system are Dr. Walter Wilcox, professor of physics; Dr. Gouri Jas, associate professor of chemistry and biochemistry; and Dr. Ray Nazzario, a member of the CASPER faculty and a senior analyst/ programmer with Baylor's Information Technology Services.

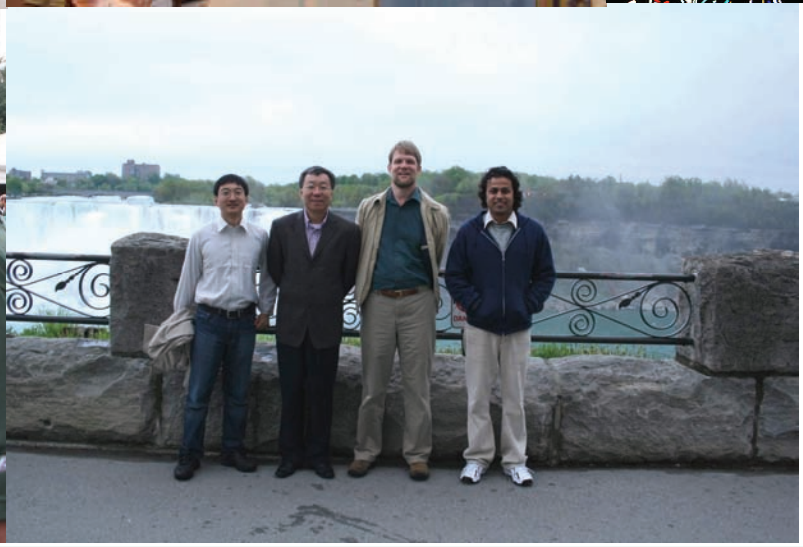
Wilcox conducts research in the area elementary particle physics, applying complex mathematical algorithms to better understand the structure of elementary particles. He said with the new computing cluster at Baylor, work that normally would have taken five days to complete, will now take just one day.

"The new high-performance computer will be able to take our research projects from A to Z," Wilcox said. "There is a testing part of our research and a production part. We will now be able to conduct both parts here at Baylor. We do not have to go other places to do it."

Hutcheson said the new cluster consists of 128 compute nodes, each with 16 gigabytes of RAM and two Intel Xeon 5355 quad-core processors for a total of 1,024 processor cores. The nodes will communicate over an Infiniband network, and the system will include a disk storage capacity of 17 terabytes.

The Department in Pictures ...





What have you done with your Physics Degree?

Please fill out this survey because we'd really like to know how Physics has shaped your career, so we can better communicate the options to potential Physics Majors.

Name: _____

Graduating Class: _____

Address: _____

_____

E-mail address: _____

Phone Number(s): _____

Present Position: _____

Family News:

Comments about Your Work (please give a short answer here, or if you have more information please submit it to our newsletter at: Physics_Newsletter@baylor.edu)

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DEPARTMENT OF PHYSICS

Baylor University
One Bear Place #97316
Waco, TX 76798-7316

Phone: (254) 710 – 2511
Fax: (254) 710 – 3878
Physics_Newsletter@baylor.edu

Dr. Gregory A. Benesh, Professor and Chair
Department of Physics
Baylor University
One Bear Place #97316
Waco, TX 76798-7316

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