Annual Issue

DEPARTMENT OF PHYSICS, BAYLOR UNIVERSITY

Fall 2011

Ursa Baylor

The Annual Newsletter of the Department of Physics

Special Points Of Interest:

- Homecoming 2011
- Summer Activities
- Devotional on Light
- Scholarship Funds
- Special Research Focus on Lasers

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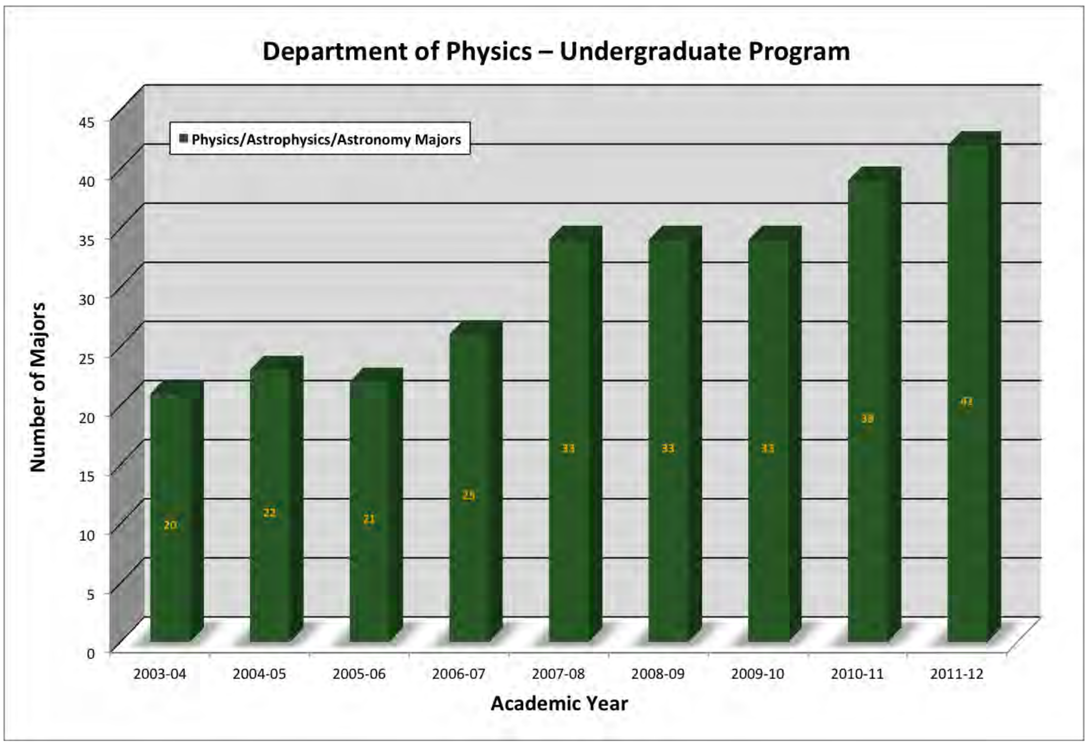


Department makes gains in the number of majors

There are many ways in which to measure the growth of the Department of Physics. One metric is the number of undergraduate majors in departmental degree programs. Over the past five years, the department has endeavored not only to increase the size of the undergraduate program, but also to improve the quality of the instruction. Honors sections of introductory courses, rearrangement of the senior research course sequence to begin the sophomore year, and new degrees in Astronomy and Astrophysics are only a few of the curricular changes that have been made in the last five years. In that time, the number of majors have not only doubled, but demonstrate a trend of continued growth: The senior research sequence for the Bachelor of Science degrees has actually ***tripled*** its enrollment over the last five years, indicating even further growth for the future. This increase has actually occurred in advance of graduating our first seniors in new majors of Astronomy and Astrophysics, which are benefitting from recent changes to recruitment and advertising of the degree programs to potential Baylor University students.

Dr. Greg Benesh
Chairman
Department of Physics

"We hope to see many of you at Homecoming on November 4th and 5th."

- Greg Benesh

The Annual Message from the Chair

From the Chair ...

October 2011

Dear Friends,

Greetings from the Baylor Physics Department! The fall semester is underway, and there is at least a hint that cooler temperatures are in the offing. It was a record summer in Waco this year, as many of you know, with 90 days of 100-degree weather. As a result, our annual Physics Department Picnic was moved from the first week of classes (when the temperature was forecast to be 110˚F) until Sept. 16th. We thank the second-year graduate students for making the picnic a big success!

We have plenty of new people to welcome this year: one new faculty member, one new (full-time) staff member, eighteen new undergraduate majors, and five new graduate students. Our new faculty member is Daniel Bolton, who comes to us from the University of Washington, and fills the Lecturer position vacated by Ed Schaub. We also have a new laboratory coordinator, Randy Hall, who replaces Linda Kinslow in that position.

If you drop by the Department this fall, be sure to see the new Graduate Student Study Area! We have recently converted a room for the exclusive use of our graduate students. So far, it has lots of work space, white boards, a couple of sofas, a printer, and a coat rack. There is plenty of room for group projects and late-night conversations.

Over the summer, Dr. Zhenrong Zhang's new first-floor laboratory became operational. Her scanning tunneling microscopy lab was worthy of a front page Lariat article in the first issue of the academic year. The STM images of TiO_2 are simply stunning—with individual atoms clearly imaged. We plan to include a public grand opening of her lab during Homecoming activities—so be sure to attend!

On August 19th, the Department gathered for our Fall Faculty Retreat/Workshop. We have been conducting these sessions the past three years to briefly review the progress made in the previous year, and then to make plans for the upcoming year. Some of the items marked for emphasis this year are the astronomy/astrophysics program—which is in need of faculty positions, making plans for a Baylor planetarium and observatory, re-formulating our advisory board, taking steps to increase our grant proposal success, revising our department's strategic plan as the University moves beyond 2012, and developing a departmental giving initiative. Jeff and Linda Olafsen have kicked off the latter with a generous gift to the Physics Department's Endowed Excellence Fund. We are hoping that other faculty members will meet their challenge gift—and then, later this fall, we plan to tell you more about it!

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 you at Homecoming on November 4th-5th . We have scheduled the Grand Opening of Dr. Zhenrong Zhang's Scanning Tunneling Microscopy Lab on Friday afternoon, Nov. 4th, in room C.161R of the Baylor Sciences Building from 3-4 p.m. That will be followed by our annual Physics Homecoming Reception in BSB room E.301 from 4-6 p.m.

With warmest best wishes,

Greg Benesh

Professor & Chairman

The Department by the Numbers

Number of Full-time Faculty: **18**

Tenured or Tenure-Track Faculty: **15**

Lecturers: **3**

Undergraduate Physics, Astronomy & Astrophysics Majors: **41**

Physics Graduate Students: **29**

Postdoctoral Fellows: **5**

2010 - 2011 Enrollments

Number of Students Enrolled in Physics Classes: **2469**

Summer 2010: **82** Fall 2010: **1162** Spring 2011: **1225**

Number of Students Enrolled in Undergraduate Laboratories & Tutorials: **2702**

Summer 2010: **72** Fall 2010: **1266** Spring 2011: **1364**

Number of Undergraduate Laboratory & Tutorial Sections: **140**

Summer 2010: **8** Fall 2010: **62** Spring 2011: **70**

In 2010 - 2011:

Number of Funded Grants: **19**

Scholarly Publications (including Conference Proceedings): **144**

Conferences attended by Department Members: **41**

US News & World Report's average ranking of the national universities from which our tenured and tenure-track faculty received their PhD degrees: **25**

US News & World Report's Department Ranking: **113**

Academic Analytics Department Ranking: **70**

National Research Council Department Rankings: **R-Rank range: 96 - 147**

S-Rank range: 118 - 149

The Department benefits from prestigious visitors to give colloquia on exciting, contemporary physics.

"If you drop by the Department this fall, be sure to see the new Graduate Student Study Area!"

- Greg Benesh

Making "Liquid Nitrogen" Ice Cream at the Fall Picnic

The Fall Picnic is one way the Faculty and the new graduate students get to spend some social time together.

"Gratifyingly, the total number of submitted [graduate] applications increased by 57% over last year." - Walter Wilcox

Physics Graduate Students benefit from Departmental (Wednesdays) & Graduate (Fridays) Colloquia.

The Graduate Program

Dear Physics Alumni and friends,

I would like to extend a warm welcome to all Baylor Physics people at this Homecoming season!

Our graduate program continues to be vibrant and active. Many improvements in the graduate program of study at Baylor have been incorporated. The Department has been very productive over the past year, graduating 5 new PhD students and 2 new MS students. We admitted 5 new physics graduate TAs this year. A new graduate student study area has been opened up in the Physics research wing. We continue to lead the university in the number of papers published per student by a wide margin. Our annual graduate stipend is now in excess of $20,000 for the first time. In addition, one new student TA position was added this year.

The Physics graduate program has incorporated a number of changes in graduate recruitment procedures this year that have helped attract more and better applications. First, our new and improved physics website has been active the entire recruiting cycle this time. This site is both more attractive and more informational. Second, a new graduate poster was printed and distributed. We specifically targeted it to new international and domestic locations. Along with this, we adopted a more aggressive emailing campaign based upon obtaining lists of students who had taken the physics subject GRE exam. Another important ingredient was our new Speaker Outreach Program (SOP). Each of the graduate faculty has been assigned two colleges or universities in Texas. Letters were sent out offering our faculty for research talks at the schools. These talks have helped communicate the excitement and interest we have in our research fields, and have increased the communication between the various physics programs. We think Baylor Physics will gain from this new program in the form of increased graduate student interest and applications. Our newest enhancement in graduate recruiting was the first Physics Recruitment Weekend, held on Feb. 25 and 26. The event brought 10 potential graduate students to campus to meet with faculty, tour the department and learn more about the graduate program in physics at Baylor. These efforts were very generously supported by the Baylor Graduate School. Gratifyingly, the total number of submitted applications increased by 57% over last year. We seem to be on the right track!

We are grateful for the opportunity to teach and produce new knowledge at Baylor University. We are having a positive impact on the people, ideas and our community.

Very best wishes,

Walter Wilcox

Professor and Graduate Program Director

The Undergraduate Program

Dear Alumni and Friends of the Department of Physics,

One of the most frequent questions asked of me by prospective physics students is "What can I do with a physics major?" It's a terrific question. Considering the current state of the economy, and the plight of many who are desperately seeking employment, it makes good sense for all undergraduates to think hard about how their choice of major will affect their ability to pursue a fulfilling career after graduation.

I believe a very appropriate answer to "What can I do with a physics major?" is *anything you want to do*. An education in physics teaches you how to ***think***. By learning skills in problem solving, mathematical reasoning, computer programming, and organizing and interpreting data, students can move into all kinds of jobs that require an ability to think logically and creatively. While some graduates who earn a degree in physics go on to become professional physicists, the majority pursues careers in fields where they can put their knowledge to a wide variety of practical applications. Nearly 90% of all "physicists" are working in medicine, education, industry, or other professions. Physics graduates are in demand for their analytical skills, and their ability to tackle real-life problems make them highly attractive to employers.

Here at Baylor, we are pleased to offer our students exactly this kind of solid education in physics, astrophysics, or astronomy. Our program has been growing each year, and this fall we welcome the largest incoming class of new freshmen and transfer students – 18 total!

Our new astronomy and astrophysics degree programs are starting to attract considerable attention from prospective students. Majors in astronomy and astrophysics begin their coursework together with physics majors and later branch out into more specialized courses. We currently have 12 students studying astrophysics and astronomy. This semester we are offering PHY 4150 (Instructional Observing) and PHY 4350 (Introduction to Stellar Structure and Evolution) for the first time. PHY 4351 (Introduction to Modern Cosmology) will be offered next spring. The department is awaiting administrative approval to hire additional tenure-track professors, and astronomy/astrophysics is one of the target areas for expansion.

We are especially pleased to congratulate five of our students who completed either a B.A. or B.S. degree in physics during 2010–2011: Gilberto Villela, David George, Ian Reeves, Roxy Stein, and Andrew Yost.

We are truly thankful for our students. Together, let us help them. Please consider a contribution to support undergraduate scholarships in the Department of Physics. We would also love to hear your experiences with regard to careers in physics. As students ponder their many career options and reflect on the question "What can I do with my physics major?", your stories could have a profound impact!

With warm regards,

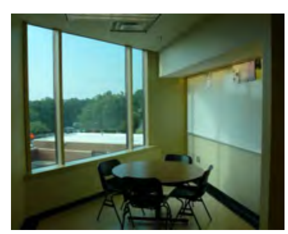
Jay R. Dittmann

Associate Professor and Director of Undergraduate Studies

Students celebrating graduation at a reception hosted by the Department in May 2011.

"An education in physics teaches you how to **think***."*

- Jay Dittmann



We benefit not only from the research facilities in the BSB (Baylor Sciences Building) but also generous spaces for student study.

Faculty Research Profiles

Wickramasinghe Ariyasinghe (Ari)

Associate Professor

Research Interests:

Atomic & molecular physics

Auger electron spectroscopy

Electron scattering

Dr. W. Ariyasinghe engages in atomic and molecular 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 and molecules. He utilizes these facilities to measure the total electron scattering cross sections, the most reliable experimental scattering cross section, of atoms and molecules at low and intermediate energies. Accurate measurement in this region of energies requires extremely good energy and angular resolution to avoid effects due to forward-scattered electrons. With this in mind, he has developed an experimental station to measure the total cross section accurately. Recently, he has been studying the total electron scattering cross section of hydrocarbons and fluorocarbons, research of great importance 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 total electron scattering cross sections for the users in the 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:

An empirical expression for total scattering cross sections of normal hydrocarbons, and experimental cross sections of C_3H_4 and C_4H_6, W. M. Ariyasinghe and G. Vilela, *Nucl. Inst. and Meth. Phys. Res. B* **268,** 2217 – 2220 (2010) .

Electron scattering from alkenes in the energy range 200 – 4500 eV, P. Wickramachchi, P. Palihawadana, G. Villela and W. M. Ariyasinghe, *Nucl. Inst. and Meth. Phys. Res. B* **267** (2009).

Total Electron Scattering Cross Sections of alkanes at intermediate energies, W. M. Ariyasinghe, P. Wickramarachchi, and P. Palihwadana, *Nucl. Inst. and Meth. Phys. Res. B* **259**, 841 - 846 (2007) .

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**, 191 - 197 (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**, 389 - 395 (2004).

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

Total electron scattering cross sections of CF_4 and C_2F_6 in the energy range 100 – 1500 eV *Journal of Rad. Phys. Chem*. **68**, 79 (2003).

Total electron scattering cross seections of CH_4, C_2H_2, C_2H_4 and C_2H_6 in the energy range 200-1400 eV 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. *Phys. Rev. A* **53**, 1537 (1996)

Faculty Research Profiles

Gregory A. Benesh

Professor & Chair

Department of Physics

Research Interests:

Surface Electronic Structure

Embedding Problems

Gravitational Collapse

Professor Greg Benesh's research deals primarily with embedding problems. In metal surfaces the redistribution of charge upon adsorption of atoms or molecules determines the nature of the surface chemical bond. Charge redistribution also causes changes in surface work functions and affects the core-level binding energies of atoms near the adsorption site. Many metal surfaces, such as those of platinum, tungsten, silver, and gold, display spontaneous phase transitions from the bulk crystal 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 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 affect the energies of surface states and surface resonances. The analysis of a surface system can be formulated more generally as an embedding problem: how to find the properties of an interacting system of particles that is subject to boundary conditions imposed by an underlying medium. Examples of embedding problems include local magnetic moments arising from transition metal impurities in paramagnetic crystals, vacancies, chemisorbed molecules on surfaces, and surfaces themselves—which are merely two-dimensional impurities in a three-dimensional crystal. Professor Benesh and collaborators have developed a computational technique in which the surface atomic layers of a crystal are embedded onto the semi-infinite bulk substrate by means of an embedding potential derived from the bulk Green function. The embedding potential is an additional term in the surface region's Hamiltonian, which causes the wave function solutions to match in amplitude and derivative to solutions in the substrate across an embedding surface. The Surface Embedded Green function (SEGF) method has proved to be extremely accurate for determining work functions and the energetics of surface states and resonances. Further refinements and extensions of the method, including time-dependent embedding, are under development.

Currently, Dr. Benesh is focusing attention on several surfaces of rhodium and silver. 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 has recently been collaborating with Prof. Roger Haydock of the University of Oregon on a project that employs the maximum breaking of time-reversal symmetry (MBTS) boundary condition to embed systems of interest. Prof. Haydock and Dr. C.M.M. Nex have previously derived the MBTS condition for single bands in discrete systems. The current project focuses on a boundary condition for continuous wavefunctions when a finite system is being embedded into an infinite one. The conditions for one- and two-band continuous systems have now been derived, and we are presently applying the condition to different model potentials.

On the lighter side, Dr. Benesh is also interested in the physics of everyday phenomena—including the positioning of a gazebo to mark the summer solstice, the death of Spider-Man's original girlfriend Gwen Stacy, the drowning of Charlie in the underwater (Looking Glass) station on the television series LOST, and the results of various MYTHBUSTERS tests. Dr. Benesh has recently submitted a paper with Dr. Jeffrey Olafsen on the results of a theoretical and experimental study of the stability of a can of soda (Dr Pepper®, of course!) on an accelerating horizontal surface—such as the dashboard of a car.

Select Publications:

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

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).

Faculty Research Profiles

Gerald Bryan Cleaver

Associate Professor

Research Interests:

String/M-theory phenomenology

String/M Landscape

String Model Building

String Cosmology

Dr. Gerald Cleaver's research specialty is superstring theory, which unifies all forces in nature (gravity, electromagnetics, and the strong and weak nuclear forces). In superstring theory each elementary particle 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 include the construction of phenomenologically realistic superstring models, string/M-theory cosmology, and the string landscape. Dr. Cleaver's research group is conducting a long-term systematic study of the global physical properties of the string landscape in the free-fermionic heterotic region. Current members include Ph.D. students Jared Greenwald, Douglas Moore, and Yanbin Deng. Past members include former lecturer and postdoc Dr. Tibra Ali (now at the Perimeter Institutue), Ph.D. students John Perkins (at AMD), Richard Obousy (member of Tau Zero project), Matt Robinson (private consultant), Tim Renner (August 2011 graduate), and M.S. students Kristen Pechan (Ph.D. student at Texas A&M), and Ben Dundee (Fincad in Vancouver, B.C.).

Dr. Cleaver was invited to be a member of the Texas Education Agency's State Review Panel for Supplemental Science Material Adoption. The panel met June 13-17 in Austin to review material (predominantly software and interactive websites) submitted to the TEA by publishing companies to supplement traditional textbooks for high school physics, chemistry, biology and integrated physics/chemistry courses. He was on a committee evaluating physics and integrated physics/chemistry material. The review process verifies that the submissions met the minimum content guidelines as set forth by TAKS standards. Texas school districts choosing to use TEA-approved material receive a partial reimbursement from the TEA for the cost for the material.

Conferences:

Cleaver's research group presented three papers at the String Vacuum Project Fall 2010 (Nov. 5-8) meeting at Ohio State University:

- A Systematic, Statistical Search of Gauge Content in Free Fermionic Heterotic String Models
- Systematic Extensions of the NAHE and NAHE Variation in the Free Fermionic String Landscape
- On the Correlation of Extra MSSM Higgs to Stringent Flat Directions in Heterotic String Theory.

Additional Scholarly Activities:

Dr. Cleaver is the Associate Editor of the *Journal of Physics*, and the *Journal of Astrophysics* and *Physical Cosmology*. He is a referee for *Modern Physics Letters A*, *General Relativity and Gravitation*, *ISRN Mathematical Physics*, *Physics Essays*, and *Scientific Research and Essays*.

Select Recent Publications:

Redundancies in Explicitly Constructed Ten Dimensional Heterotic String Models, with T. Renner, J. Greenwald, and D. Moore. arXiv:1107.3138. Submitted to *Modern Physics Letters A*.

Systematic Investigations of the Free Fermionic Heterotic String Gauge Group Statistics: Layer One Results. with D. Moore, J. Greenwald, T. Renner, M. Robinson, C. Buescher, M. Janas, G. Miller, and S. Ruhnau. arXiv:1107.5758, Submitted to *Modern Physics Letters A*.

Investigations of Quasi-Realistic Heterotic String Models with Reduced Higgs Spectrum, with A. Faraggi, J. Greenwald, D. Moore, K. Pechan, E. Remkus, and T. Renner, arXiv:1105.0447. Submitted to *International Journal of Modern Physics A*.

Note on a NAHE Variation, with Jared Greenwald, Douglas Moore, Kristen Pechan, Tim Renner, and Tibra Ali, *Nucl. Phys. B* **850** (2011) 445-462.

Branes in the MD x Md+ x Md- Compactifications of Type II String on S1/Z2 and Their Cosmological Applications, with Michael Devin, Anzhong Wang, and Qiang Wu. arXiv:0907.1756 [hep-ph], *JHEP* **0915** (2009) 1756.

A Non-Standard String Embedding of E8, with R. Obousy and M. Robinson, arXiv:0810.1038 [hep-ph]. *Mod. Phys. Lett A* **24** (2009) 1577-1582.

Books:

First Principles and the Standard Model, with M. Robinson, K. Bland, J. Dittmann, and M. Serna. Published by Springer, August 2011. (First in a 3 to 7 volume series.)

Faculty Research Profiles

Jay R. Dittmann

Associate Professor

Director of Undergraduate Studies

Research Interests:

High Energy Physics / The Higgs Boson

Elementary Particle Physics

Fermilab Tevatron Collider

Large Hadron Collider at CERN

The CDF and CMS Experiments

The primary goal of *High Energy Physics (HEP)*, often called *Elementary Particle Physics*, is to discover the elementary constituents of matter and energy, probe the interactions between them, and explore the basic nature of space and time.

As the first experimental HEP physicist at Baylor, Dr. Dittmann laid the foundation for a new research program and built up a HEP group from scratch. Since its beginning in 2003, the experimental HEP group has grown tremendously and is involved in several cutting-edge research projects. The group currently consists of nine members including Dr. Dittmann and Dr. Kenichi Hatakeyama, two postdoctoral research associates (Drs. Azeddine Kasmi and Hongxuan Liu), and four graduate students. In addition, over the years, about 15 undergraduates have participated in experimental HEP research for honors theses, senior research projects, and summer internships.

Dr. Dittmann leads Baylor's HEP research at Fermilab in Batavia, IL, where Baylor is affiliated with the world-renowned Collider Detector at Fermilab (CDF) experiment. Despite its success for over 25 years, the experiment has recently ceased the collection of new data. The last proton-antiproton collisions in the Tevatron collider at Fermilab occurred on September 30, 2011. Nonetheless, plenty of data remains to be analyzed, and the CDF experiment will continue to publish new results for a few years.

In anticipation of the end of the Tevatron at Fermilab, the Baylor HEP group has actively pursued other experimental collaborations. In 2010, Baylor created a new affiliation with the CMS experiment at CERN, the location of the Large Hadron Collider (LHC) in Geneva, Switzerland. As a relatively small university group, it was an honor to be accepted into a world-class experimental collaboration like CMS, which includes many prominent U.S. universities. Baylor's acceptance into the CMS collaboration was an acknowledgment of the group's significant contributions to the research field. As Dr. Dittmann's research on the CDF experiment ramps down, and his Ph.D. students complete their degrees, he will become increasingly involved on the CMS experiment.

The Baylor HEP group reached a tremendous milestone in May 2011 with the graduation of Drs. Samantha Hewamanage and Martin Frank, the group's first Ph.D. students. Sam searched for "anomalous" physics in proton-antiproton collisions in which a photon is produced with "jets" of energetic particles. Upon graduating, Sam began a new postdoctoral research position at Florida International University working on the CMS experiment. Martin was a key player in the quest to discover the infamous Higgs boson in the *WH* channel, and his results improved the experimental limits on Higgs boson production. Martin has moved on to a postdoctoral research position at the University of Virginia, where he pursues experimental HEP on the NOvA and Mu2e collaborations.

Dr. Dittmann currently works with two other Ph.D. students, Karen Bland and Zhenbin (Ben) Wu, who are busily engaged in data analyses for their Ph.D. theses. Karen is actively investigating the case where a Higgs boson decays into two photons. Her work, together with that of Baylor's CDF postdoc, Dr. Kasmi, has captured the attention of the international HEP community, and a manuscript based on their work has recently been submitted to *Physical Review Letters*. Ben is studying the production and decay of top quarks, particularly rare cases where a top quark is produced by itself instead of in conjunction with an antiparticle partner. Ben is one of the key players on this analysis at CDF and he has given multiple presentations of his work at CDF collaboration meetings.

Dr. Dittmann is a member of the Executive Board of the CDF Collaboration at Fermilab. He is a co-author of many publications in *Physical Review Letters* and *Physical Review D*. Funding for the Experimental High Energy Physics group at Baylor has been provided over the years by grants from the U.S. Department of Energy, Fermilab, and Baylor University, with external grant funds totaling over $720,000.

Recent Selected Publications:

Limits on Anomalous Trilinear Gauge Couplings in $Z\gamma$ Events from Proton-Antiproton Collisions at 1.96 TeV, T. Aaltonen *et al.* (CDF Collaboration), Phys. Rev. Lett. **107**, 051802 (2011).

Evidence for a mass dependent forward-backward asymmetry in top quark pair production, T. Aaltonen *et al.* (CDF Collaboration), Phys. Rev. D **83**, 112003 (2011).

Faculty Research Profiles

K. Hatakeyama

Assistant Professor

Research Interests:

Experimental Elementary Particle Physics

The goal of elementary particle physics is to understand the nature of subatomic particles and their interactions at the most fundamental level. Presently, we have a theoretical model called the "Standard Model" which provides a very successful description of most of the experimental observations on elementary particles. Predicted quarks, leptons, and four force-carrier bosons have all been experimentally observed and the measured properties of those particles and four fundamental forces are consistent with what is expected from the Standard Model.

In spite of the success of the Standard Model, there are numerous important questions that are left unanswered in particle physics. For example, the mechanism of how elementary particles acquire masses is still not well understood. In addition, questions such as why we live in a matter-dominated world and what is the source of dark matter and dark energy are unanswered.

Dr. Hatakeyama has been working on two high energy particle physics experiments, the CDF experiment at Fermilab, IL and the CMS experiment at the Large Hadron Collider (LHC), CERN, Switzerland to find clues to some of these unanswered questions and to find "new physics" beyond the Standard Model. At the CDF experiment which has been collecting data for more than 20 years, while Dr. Dittmann has been searching for the Higgs boson which will explain the source of particle masses, Dr. Hatakeyama has searched for the sign of quark substructure, i.e., even smaller fundamental particles, and new massive particles which are expected from various theoretical models in proton-antiproton collisions including high energy "jets". Jets are clusters of particles originating from energetic quarks and Dr. Hatakeyama is an expert of this signature. Although these searches did not find a signal, they provided crucial information for better understanding Quantum Chromodynamics, the strong interaction sector of the Standard Model, and the structure of the proton.

Dr. Hatakeyama is now focused on a newer experiment, CMS, at the LHC. After many years of preparation, the LHC finally started to deliver proton-proton collisions at $\sqrt{s}$ = 7 TeV since March 2010, which is 3.5 times higher than the highest possible energy at the Fermilab Tevatron proton-antiproton collider. He has been searching for a signature of "Supersymmetry" in proton-proton collision events with multiple jets and "missing" energy. Supersymmetry is currently one of the most favored physics model beyond the Standard Model. The missing energy in a proton-proton collision is the sign of a very weakly interacting particle, and is the dark matter candidate. Supersymmetry not only offers the candidate of dark matter but also solves several unnatural issues present in the Standard Model. Dr. Hatakeyama was in charge of the data quality monitoring system for jets and missing energy in the CMS data, and since 2011 he lead the missing ET working group of CMS. These activities are critical not only for this Supersymmetry search, but also for all CMS data analyses using jets and/or missing energy. The initial Supersummetry searches using the 2010 data and 2011 data up to summer have not show a significant indication of the Supersymmetric particle production; however, these searches have already shown much higher sensitivities than the data analysis by the previous experiments. The CMS searches have just started, and there is a good discovery potential in the upcoming years.

He has also made a measurement on the internal structure of jets. This knowledge is critical in, for example, some of the Higgs searches at the LHC. He believes that the data from the LHC are going to give us very interesting physics results in coming years.

Recent Publications:

Search for new physics at CMS with jets and missing momentum. CMS Collaboration, *JHEP* **1108**, 155 (2011); arXiv:1106.4503.

Missing transverse energy performance of the CMS detector. CMS Collaboration, *JINST* **6**:P09001,2011; arXiv:1106.5048.

CMS Collaboration, "Searches for Dijet Resonances in 7 TeV pp Collisions at CMS," *Phys. Rev. Lett.* **105**, 211801 (2010).

T. Aaltonen, et al., CDF Collaboration, "Search for new particles decaying into dijets in proton-antiproton collisions at $\sqrt{s}$ = 1.96 TeV," *Phys. Rev. D* **79**, 112002 (2009).

T. Aaltonen, et al., CDF Collaboration, "Measurement of the inclusive jet cross section at the Fermilab Tevatron ppbar collider using a cone-based jet algorithm," *Phys. Rev. D* **78**, 052006 (2008).

Faculty Research Profiles

Truell W. Hyde

Professor

Director, CASPER

Vice Provost for Research

Research Interests:

Complex Plasmas

Astrophysics and Space Physics

Small Satellites

***In-Situ* Instrumentation**

In addition to his VP for Research duties, Dr. Hyde continues to maintain an active research agenda within his CASPER research group, conducting research over a variety of theoretical and experimental areas in complex plasmas. During the 2010 / 2011 academic year, Dr. Hyde collaborated with Dr. Matthews and twenty six members of their combined research groups which includes two physics faculty, Dr. Truell Hyde, Dr. Lorin Matthews; seven adjunct professors, Dr. Phillip Anz-Meador (NASA JSC), John Fitch (Birkeland Current), Dr. Peter Hartmann (Eotvos Lorand University), Dr. Georg Herdrich (Institute of Space Systems, University of Stuttgart), Dr. Andrew Zwicker (PPL, Princeton), Dr. Rainer Sandau (DLR) and Dr. Ralf Srama (Heidelberg Dust Research Group, Max Planck Institute for Nuclear Physics); seven research faculty, postdocs or staff, Jorge Carmona Reyes, Mike Cook, Dr. Jie Kong, Dr. Victor Land, Dr. Rene Laufer, Dr. Ke Qiao and Jimmy Schmoke; and nine graduate students, James Creel, Angela Douglass, Brandon Harris, Theresa Ma, Mudi Chen, Jay Murphree, Jonathan Perry, Alex Price and Victor Zhang.

Graduates in 2010 / 2011:
James Creel, Jay Murphree and Alex Price

Research Interests

Complex Plasmas. The interaction of charged dust, the formation of 2D and 3D coulomb crystals, small particle clusters, ordered particle chains and the coagulation of dust in low temperature plasmas are just a few of the interesting phenomena exhibited in a (relatively) new area of physics known as complex plasmas. Within the plane perpendicular to the gravitational force, interparticle interactions can be assumed to be Yukawa in form; as a result, charged microparticles interact with one another through a screened Coulomb potential allowing user selectable system ordering of gas/liquid/solid phases depending on the ratio of the kinetic energy of the dust grains to their potential energy. Research in this area is of interest in fundamental physics, the nanofabrication and semiconductor industries, fusion physics, space physics and astrophysics. The primary instrument for examining such meso- and nanoscale physics in complex plasmas is the GEC RF Reference Cell. CASPER has two (2) such GEC RF cells currently in use, one of which is equipped with a Zyvex S100 nanomanipulator system.

Coagulation of charged dust. The coagulation of charged dust plays an important role in protoplanetary formation. Protoplanets are formed from the gas and dust comprising the circumstellar disk of a newly formed star. In this case, the gas and dust can coalesce on a relatively short time scale with charged dust coagulation playing a formative role. Dust also plays an essential role in planetary ring systems, as can be seen in Voyager pictures of Saturn's F ring revealing braids, kinks, and clumps evolving over a matter of weeks or months, and in Titan's weather. In each of these, the coagulation of dust in plasma plays the seminal role; this is currently being examined both theoretically and experimentally within CASPER, the only place in the world with this capability.

Dust Interactions with Spacecraft. The interaction of charged dust with spacecraft and small satellites, either in orbit around the Earth or on planetary or lunar surfaces, has long been of interest to both NASA and the space science community. Dust contamination and/or sticking to spacecraft surfaces has proven to be a problem on orbit and on both the lunar surface and Mars. Additionally, spacecraft on orbit are subjected to impacts from dust traveling at speeds ranging from a few meters per second to a few kilometers per second. CASPER operates two Light Gas Accelerators to examine such impacts, conduct research and development on impact detection sensors, and collect the data necessary to properly assess the durability of materials in space.

Fusion Research. Over the past decade, dust particulate contamination has increasingly become an area of concern within the fusion community. In a burning plasma machine design, such as that seen in the International Thermonuclear Experimental Reactor (ITER), dust presents problems for diagnostic integration and contributes to tritium safety issues. Since the dynamics of such charged dust can in general be explained employing a combination of the ion drag, Coulomb force, and ion pre-sheath drifts, recent research in complex (dusty) plasma physics again offers unique insights into this research area.

Grants:
Dr. Hyde currently holds over $12 Million in active funding from the NSF, NASA, SBA, and the US Dept. of Education.

Faculty Research Profiles

Lorin Swint Matthews

Assistant Professor

Research Interests:

Complex Plasmas

Theoretical Space Physics

Experimental Space Physics

CASPER

Dr. Matthews' 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, undergraduate, and high school students, post-docs, and other faculty members in the physics department and CASPER.

Latest results in dust bunny research (coagulation of charged dust):

Building dust aggregates in the lab. Analysis of aggregate dynamics and morphology allows refinement of numerical models (c.f. Figure 1). (Work done by Kristen Deline, Brandon Doyle, and Jorge Carmona).

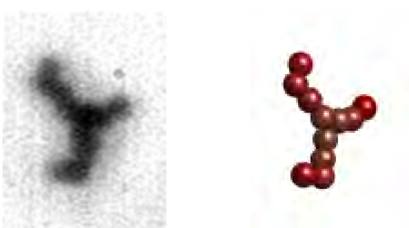


Figure 1. (left) Aggregate created in the lab and (right) a computer representation of the same aggregate.

Coagulation of non-spherical monomers. Aggregates built from ellipsoidal monomers have a large range of porosities, which affects their coagulation rates (c.f. Figure 2). (Work done by Jonathan Perry, Erwin Gostomoski, and Jesse Kimery.)

Charging of aggregates including secondary electron emission and UV-induced photoemission. Aggregates have regions with both positive and negative charge (Figure 3 b), and a time-history of the charging process shows a "flip-flop" in the polarity of charge. (Work done by Qinayu Ma and Victor Land).

Figure 2. Aggregates made form ellipsoidal monomers with 1:1:3 and 3:3:1 axes ratios.

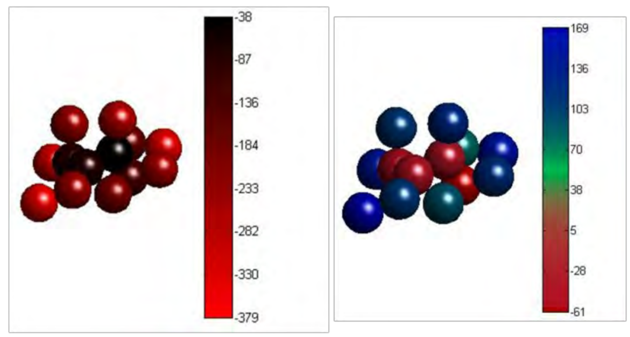


Figure 3. Aggregate charged by (a) plasma only and (b) plasma and photoemission.

Professional Activities:

Drs. Matthews and Land gave invited talks and presented a poster at the 6th International Conference on the Physics of Dusty Plasmas in Garmisch, Germany, May 16-20, 2011. Collaborators were T. Hyde, J. Carmona-Reyes, J. Perry, Q. Ma, E. Gostomski, D. Coleman, A. Douglass, and K. Qiao.

One paper and two posters presented at the 21st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 7-11, 2011, with J. Perry, Q. Ma, L. Buckingham, E. Gostomski, and T. Hyde.

Cosmic Dust Bunnies and Laboratory Dust Crystals: An introduction to complex plasma research, seminar presented to the Dept. of Physics at TAMU-Commerce, April 21, 2011.

Current Complex Plasma Research at CASPER, seminar presented to the Depts. of Physics and Electrical Engineering and the UTD chapter of Sigma Xi, February, 11, 2011.

Recent Publication:

Douglass, A, V. Land, L. S. Matthews, and T. W. Hyde, Dust particle charge in plasma with ion flow and electron depletion near plasma boundaries, *PoP*, **18**, 083706, 2011.

Faculty Research Profiles

Jeffrey Stuart Olafsen

Associate Professor

Director of Undergraduate Research

Research Interests:

Nonlinear & Non-equilibrium Physics

Biomechanics

Chaotic and Dynamical Systems

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 and systems that are inherently nonlinear in their dynamic behavior.

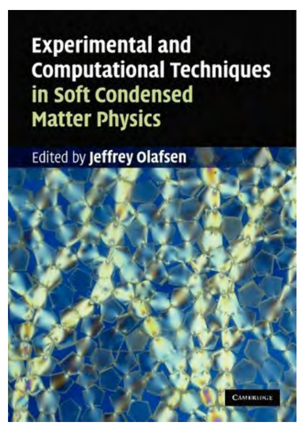
Unlike most research disciplines in physics, nonlinear dynamics typically extends across research topics and the investigations tend to be interdisciplinary by nature. This has advantages of incorporating techniques from many disciplines to attack unanswered problems. The majority of the research program 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 constituitive 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.

Publications:

Z. F. Alemdar, J. Browning and J. Olafsen, "Photogrammetric Measurements of RC Bridge Column Deformations." *Engineering Structures*, **33**, 2407-2415 (2011).



J. Olafsen "Image Acquisition and Analysis in Soft Condensed Matter." Chapter appearing in Experimental and Computational Techniques in Soft Condensed Matter Physics, Cambridge University Press, September 2010.

J. Olafsen (ed.) Experimental and Computational Techniques in Soft Condensed Matter Physics, Cambridge University Press, September 2010.

K. Combs and J. S. Olafsen, "Energy Injection in a Non-Equilibrium Granular Gas Experiment." *AIP Conference Proceedings* **1145**, 997-1000 (2009).

K. Combs, J. S. Olafsen, A. Burdeau, and P. Viot, "Thermostatistics of a single particle on a granular dimer lattice: Influence of defects." *Physical Review E* **78**, 042301 (2008).

I. S. Aranson, A. Snezhko, J. S. Olafsen, and J. S. Urbach, Comment on 'Long-Lived Giant Number Fluctuations in a Swarming Granular Nematic.' *Science* **320**, 612 (2008).

G. W. Baxter and J. S. Olafsen, "Experimental Evidence for Molecular Chaos in Granular Gases.." *Physical Review Letters* **99**, 028001 (2007).

Faculty Research Profiles

Linda Jean Olafsen

Associate Professor

Research Interests:

Semiconductor physics

Mid-IR lasers

Infrared beam profiling

Glucose monitoring/Biosensors

Dr. Linda Olafsen leads the semiconductor laser optics laboratory, an experimental research group focused on the optical and electronic properties of layered semiconductors, particularly antimonide-based quantum well heterostructures designed to emit or absorb mid-infrared radiation. These "wave-function engineering" 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 operating in the near-infrared. Her laboratory has a unique capability for tuning the near-infrared optical pumping wavelength using an optical parametric oscillator, and she is working to more directly connect optical pumping and electrical injection experiments in the development of mid-infrared devices.

Ph.D. student Jeremy Kunz joined the research group in the spring and has been immersing himself in the relevant literature as well as developing a foundation in laboratory techniques. Physics major Ian Eaves Reeves completed his senior thesis, "Computational Mid-Infrared Beam Analysis." Ian's work on infrared beam imaging analysis was a joint project with Dr. Jeffrey Olafsen's research group. In this project, we were able to image near-infrared output from an optical parametric oscillator in both synchronized and free-running modes at more than five different near-IR wavelengths, ranging from ~1850 nm to ~2100 nm. Based on Ian's work, Dr. Linda Olafsen presented a talk, "Synchronized Mid-infrared Beam Characterization of Narrow Gap Semiconductors," at the 15th International Conference on Narrow Gap Systems at Virginia Tech in Blacksburg, VA (1–5 August). Ian graduated in May and is now a graduate student in the Department of Physics at Drexel University.

In addition to the presentation at the international meeting in Blacksburg, Dr. Olafsen kicked off 2011 presenting a talk, "Room-temperature 4.0-μm broadened optical pumping injection cavity lasers," at SPIE Photonics West in San Francisco, CA. With the 2011 March Meeting of the American Physical Society in nearby Dallas, Dr. Olafsen contributed to Baylor Physics' presence at the meeting by presenting a talk (Gain-Induced Refractive Index Changes in Resonantly Pumped Optical Pumping Injection Cavity Lasers) and chairing a session (Semiconducting Devices and Applications), and Ian Reeves presented a poster (Spatio-temporal beam profiling of pulsed infrared laser sources). A highlight of the presentations and posters in the past year has been the participation of four undergraduate co-authors (Ian Reeves and REU participants Lauren Bain, Ben Ball, and Lauren Ice).

The presence of the research group outside the laboratory was not limited to professional meetings and conferences. With the support of an Education Outreach grant from SPIE, Dr. Olafsen delivered lectures about lasers at Live Oak Classical School, Vanguard Preparatory School (twice!), and Texas Christian Academy. In the coming year she plans to make similar presentations at other local schools. This program was in part a celebration of the 50th anniversary of the first laser, and the support from SPIE enabled the purchase of Optics Discovery Kits and laser pointers for the hosting schools.

In the coming year, the group's plans include the study of new optically pumped structures from Air Force Research Laboratory, fabrication of laser devices at the Microelectronics Research Center at the University of Texas at Austin, and looking into the feasibility of graphene as a transparent conducting contact in the near- and mid-infrared.

Recent Publications:

L. J. Olafsen, L. D. Ice, and B. Ball, "Nonlinear Temperature Dependence of Resonant Pump Wavelengths in Optical Pumping Injection Cavity Lasers," *IEEE Journal of Selected Topics in Quantum Electronics* **17**, 1453–1459 (2011).

L. J. Olafsen, L. E. Bain, W. W. Bewley, I. Vurgaftman, J. R. Meyer, H. Lee, and R. U. Martinelli, "Room-temperature 4.0-μm broadened optical pumping injection cavity lasers," *Proceedings of the SPIE* **7953**, 795314 (2011).

L. J. Olafsen and T. C. McAlpine, "Transparency pump intensity and differential gain in resonantly pumped W optical pumping injection cavity lasers," *Journal of Applied Physics* **108**, 053106 (2010).

Faculty Research Profiles

Kenneth Taesung Park

Associate Professor

Research Interests:

Surface Defects of Transition Metal Oxides

Interface between Metal and Thin Films of Organic Molecules

Dr. Park and his collaborators have been studying surface defects in single crystal TiO_2 to gain understanding of their structure-property relationship. With numerous, stable sub-stoichiometric species known in the Ti-O phase diagram, they can form local structures and properties are markedly different from those of the mother compound. Consequently, partially reduced oxides of the binary system can become increasingly complex and heterogeneous in structure and properties.

The formation of sub-stoichiometric defects and local electronic structures have been elucidated using scanning tunneling microscopy (STM) and first-principle theory calculations. Once Ti interstitials are driven out to the (110) surface, they readily dissociate molecular oxygen as highly under-coordinated cationic defects. The dissociated oxygen atoms surround a Ti interstitial to form an oxygen plane of a partial octahedron. The line defects of sub-oxides with face-sharing octahedra further serve as basic building blocks for surface reconstruction, for example (1x1) and (1x2) phases. In addition to the sub-oxide species, the Ti interstitials also can form fully stoichiometric defects in shape of topographically distinct dots, observed in STM. Due to broken bonds and small size, their atomic structure is significantly altered from that of bulk and contains both cationic and anionic coordination defects. In particular, a single-coordinated oxygen atom of the defect and surface bridging O atoms provide an exceptionally strong bonding site for gold atoms. The Au atoms attached to the TiO_2 defect exhibit a number of key features expected from catalytically active Au nanoparticles.

Unlike the most thermodynamically stable (110) surface, TiO_2(001) is known to undergo extensive surface reconstruction due to high surface energy. The two distinctive phases of reconstructions have been reported using low energy electron diffraction (LEED) in the past: {011}- and {114}- faceted structures for below and above 900 K, respectively. However, our recent results show that even the {114}-faceted structure can be increasingly complex, possessing a mixture of {112} and {114} micro-facets (Figure). Currently, detailed structural analysis using STM and LEED data is in progress.

Recent Publication:

"Evidence of Coulomb Blockage Behavior in a Quasi-zero Dimensional Quantum Well on TiO_2 Surface," V. Meunier, M. H. Pan, F. Moreau, K. T. Park, and E. W. Plummer, *Proc. Natl. Acad. Sci.* U.S.A. (2010) doi: 10.1073/pnas.1009310107.

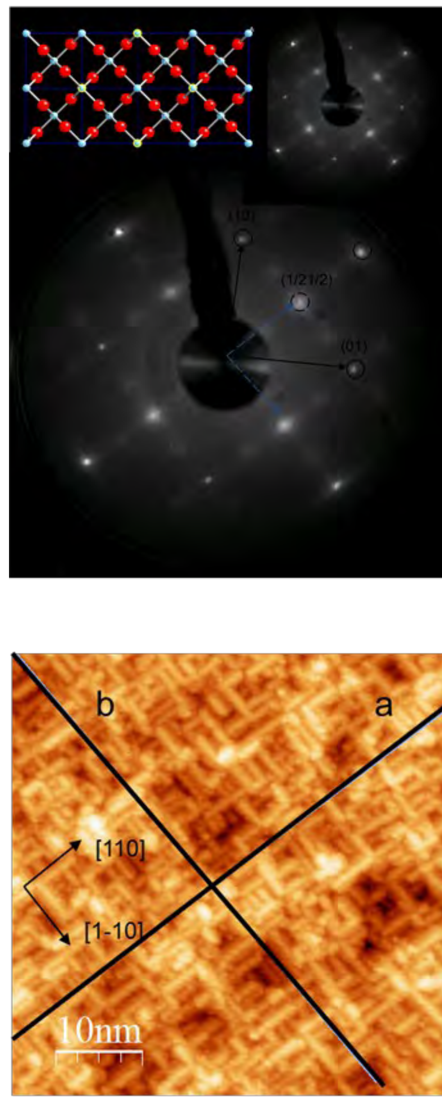


Figure (Top) LEED pattern and (Bottom) STM image from TiO_2(001)

Faculty Research Profiles

Dwight Russell

Associate Professor

Research Interests:

Materials Science

Surface Science

Astronomy

Activities:

This year my activities have covered three main areas: teaching intro astronomy, examining plans for an observatory and planetarium, and research on alkali halide surfaces.

While the introductory astronomy course continues to be a popular course with class sizes approaching 300 students, our new astronomy degree options continue to grow. The first course in the new degree plans, Phy 2455- Foundations in Astronomy, is being offer in its third year and the next course in the astronomy major, Phy 4105 Instructional Observing, has been added this fall.

The field of astronomy certainly helps out by providing a 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 as at any time in history. It truly is an exciting time to introduce students to the study of astronomy.

Our on campus telescope and camera systems are up and operational now and providing us with our own images for analysis. We are also continuing our collaboration with the Central Texas Astronomical Society's Meyer Observatory. Our new camera and the observing time at the Meyer Observatory are both being incorporated into our new astronomy curriculum. Also at the Meyer Observatory, I mentored an NSF-REU student Katherine Boedges this summer. We were investigating light curves of Saturn's moon Hyperion in order to measure Hyperion's rotation rate.

In the area of material science, my work on electron irradiation of alkali halides has continued. Our test chamber vacuum system is running.

In the summer I had the opportunity to participate in the Baylor Summer Faculty Institute lead by Tom Hanks and Lenore Wright. 18 faculty from a wide range of discipline met each weekday for the month of June to discuss and improve our courses and teaching. A great program — I recommend to anyone.

Recent Publication:

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

Other 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).

Students in our Astronomy & Astrophysics majors learn how to perform image analysis using the MATLAB platform.

Faculty Research Profiles

Anzhong Wang

Professor

Research Interests:

Brane Worlds in String/M-Theory

Horava-Lifshitz Theory

Advanced Numerical Analysis of Observational Data

Black Holes, Their Thermodynamics & AdS/CFT Correspondence

GCAP (Gravity, Cosmology, and Astroparticle Physics Group), founded in 2006, is one of the Particle Physics Groups in Physics Department, and one of the three theoretical research groups in CASPER. Currently, it consists of four Baylor faculty members, Dr. Anzhong Wang, the head of the group (Physics), Dr. Klaus Kirsten (Math), Dr. Qin (Tim) Sheng (Math), and Dr. Yumei Wu (Physics); four adjunct professors, Dr. Rong-Gen Cai, from the Institute of Theoretical Physics, Chinese Academy of Science, Dr. Yungui Gong, from College of Mathematics and Physics, Chongqing University of Posts and Telecommunications, Chongqing, Dr. Jianxin Lu from Interdisciplinary Center for Theoretical Study, the University of Science and Technology of China, and Dr. N. O. Santos, from Queen Mary College, London University and the Brazilian National Scientific Computation Lab (LNCC); one undergraduate student, Janie Hoormann; and three graduate students, Ahmad Borzou, Yongqing Huang, and V. H. Satheeshkumar. Recent research topics include the Horava-Lifshitz theory of quantum gravity, its applications to cosmology and astrophysics; the nature and origin of the late cosmic acceleration; branes in string/M theory, and their applications to astrophysics and cosmology; highly efficient and effective computer simulations; and Casimir effects, and their applications to astrophysics and cosmology.

Very recently, Horava proposed a new theory of quantum gravity motivated by the Lifshitz theory in solid state physics. The Horava-Lifshitz theory is non-relativistic, power-counting renormalizable. The effective speed of light diverges in the UV, and this potentially resolves the horizon problem without invoking the inflationary scenario. In addition, almost scale-invariant super-horizon curvature perturbations can be produced without inflation. With an additional U(1) symmetry, the universe is necessarily flat. As the theory was still in its infant time, a comprehensive understanding of it is highly demanded.

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 so-called dark energy. A fundamental question now is the nature and origin of dark energy. The hierarchy and cosmological constant problems are other outstanding problems in particle physics and cosmology. To solve these problems, 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 TeV energy scale, which shall be explored directly by colliders in laboratories, such as LHC.

In addition, theories of gravity, including general relativity, predict the existence of black holes and gravitational waves. Forthcoming CMB polarization experiments, pulsar timing arrays, and terrestrial/space-based interferometers will probe a wide range of frequencies of the gravitational waves. On the other hand, black holes, their thermodynamics and formation from gravitational collapse have been some of the main focuses in gravitational physics in the last couple of decades. Our studies on these subjects are both analytical and numerical.

Casimir efforts are physical forces arising from a quantized field. A typical example is of two uncharged metallic plates in a vacuum, placed a few micrometers apart, without any external electromagnetic field. We are investigating these efforts among branes in string/M theory.

Recent Publications:

P. Sharma, A. Tziolas, A. Wang, and Z.-C. Wu, Spacetime Singularities in String and its Low Dimensional Effective Theory, *Inter. J. Mod. Phys. A* **26**, 273-300 (2011) [arXiv:0901.2676].

A. Wang, f(R) theory and geometric origin of the dark sector in Horava-Lifshitz gravity, *Mod. Phys. Lett. A* **26**, 387-398 (2011) [arXiv:1003.5152].

A. Wang and Q. Wu, Stability of spin-0 graviton and strong coupling in Horava-Lifshitz theory of gravity, *Phys. Rev. D* **83**, 044025 (13 pages) (2011) [arXiv:1009.0268].

A. Wang and Y. Wu, Cosmology in nonrelativistic general covariant theory of gravity, *Phys. Rev. D* **83**, 044031 (8 pages) ((2011) [arXiv:1009.2089].

Y. Huang and A. Wang, Stability, ghost, and strong coupling in nonrelativistic general covariant theory of gravity with lambda not equal to 1, *Phys. Rev. D* **83**, 104012 (11 pages) (2011) [arXiv:1011.0739].

Faculty Research Profiles

B. F. L. Ward

Distinguished Professor

Research Interests:

Theoretical Physics

Particle Physics

Relativistic Quantum Mechanics

Quantum Field Theory

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 one of the primary goals of particle colliders currently active or 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 with 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. His recent estimate of the cosmological constant [arxiv.org:1008.1046] gives further evidence of the correctness of the approach.

More recently, this past year Dr. Ward was invited to visit the CERN theory unit on research leave for 8 1/2 months to continue his development and implementation of the new MC-HERWIRI 1.031 which realizes his new IR-improved DGLAP-CS theory (see *Ann. Of Phys.* **323** (2008) 2147) for precision QCD predictions for LHC physics scenarios. He was invited to present his latest results with HERWIRI 1.031 in the CERN TH-LPCC LHC Theory Institute on August 5th. In addition, during the leave he was invited to present the recent progress on his new approach to quantum general relativity, resummed quantum gravity (see *Open Nucl. Part. Phys. J.* **2** (2009) 1) at the University of Barcelona, University of Madrid and SISSA in Trieste, Italy.

Recent Publications:

S. Joseph, S. Majhi, B.F.L. Ward, S.A.Yost, "HERWIRI 1.0: MC Realization of IR-Improved DGLAP-CS Parton Shower", *Phys. Lett. B* **685** (2010) 283-292.

B.F.L. Ward, "Magic Spinor Product Methods in Loop Integrals", *Phys. Rev. D* **83** (2011) 113014.

B.F.L. Ward, "New Approach to GUTs", *Eur. Phys. Jour.* C **71** (2011) 1686.

Faculty Research Profiles

Walter Wilcox

Professor

Physics Graduate Program Director

Research Interests:

Lattice QCD

Deflation Algorithms

Finite Quark Matter

Teaching interest:

Physics textbooks

Research Area Description

My main area of research is the study of the interactions of particles known as quarks and gluons. One of the significant recent developments in quantum field theory is the recognition that solution techniques involving computers are crucial in this field. The theory of quark and gluon interactions is called Quantum Chromodynamics (QCD). "Lattice QCD" represents a numerical attempt to solve, and compare to experiment, physically observable quantities using a discrete space-time lattice of points. State-of-the-art numerical methods are used to solve the theory on high performance computers. Lattice QCD benefits from a synergy of field theory, experimental particle physics and computer technology.

Recent Activities

My work in Lattice QCD is centered on three areas: extension of matrix deflation algorithms (with Ron Morgan and Arnulfo Perez), noise suppression using new eigenspectrum subtraction algorithms (with Ron Morgan and Victor Guerrero), and measurement of hadron electromagnetic properties, including electric and magnetic polarizabilities (with Joe Christensen at Thomas More College and Frank X. Lee at George Washington University). In the area of deflation, our work is centered on developing new mathematical techniques to speed up the solution of ill-conditioned linear equations, especially for lattice QCD (where it is termed "fermion matrix inversion") which affects lattice QCD simulations at small quark masses. In addition, it turns out that at small quark masses the numerical methods used to isolate physical signals in lattice QCD become swamped with statistical noise. Ron Morgan, Victor Guerrero and I are continuing our investigation of a new technique we call "eigenspectrum noise subtraction" which dramatically improves the simulations, especially when combined with a previous technique called perturbative subtraction. In addition, the work on electromagnetic properties on parallel systems at Jefferson Lab uses the deflation algorithms developed in collaboration with Ron Morgan. Finally, preliminary investigation of novel fermion action expressions has begun in collaboration with Andy Liu.

I have also begun investigating a new analytic model of hadron structure based upon the semi-classical Thomas-Fermi (TF) statistical model, in collaboration with Andy Liu. The TF approach is normally used to model atomic interactions, but I have applied it instead to assemblies of quarks. It turns out to be a natural application of the method. The quarks move in a collective potential and are confined by a vacuum pressure term. There are nonrelativistic and relativistic versions of the model, which can also be generalized to include quark sea contribution or spin interactions. I am developing it to guide more expensive lattice simulations in the search for high multi-quark hadronic states. I think the model has the potential to shed light on the stability characteristics of such states, and to be applied to other types of exotic matter. We are presently investigating numerical aspects of the 3 flavor nonrelativistic version of the model.

I am also continuing to develop the texts and materials on the Baylor OPEN TEXT physics website (http://homepages.baylor.edu/open_text/). Included on the site are full undergraduate texts on classical mechanics and quantum mechanics, as well as a full graduate text on electrodynamics. I have also posted some new materials, including notes from a Schwinger quantum mechanics class I TA'ed at UCLA in 1979 as well as the first two parts of particle physics books authored by members of Gerald Cleaver's particle physics collaboration. There is in addition a partial undergraduate electrodynamics text.

Based upon my OPEN TEXT efforts, I have continued my foray into the textbook publishing business. The undergraduate quantum textbook based upon my OPEN TEXT source is called "Quantum Principles and Particles" (QPP), and is being published by Taylor and Francis (CRC Press in the US). QPP includes material which overlaps with particle physics, including a number of interesting particle applications. It is now in the proofing stage. A solutions manual has also been prepared. It is available on Amazon.com for pre-ordering. The OPEN TEXT graduate electrodynamics textbook, "Macroscopic Electrodynamics" (ME), co-authored with Dr. Chris Thron of Texas A&M University-Central Texas, is now accepted for publication by World Scientific. ME is a comprehensive two-semester graduate level textbook on classical electrodynamics for use in physics and engineering programs. ME emphasizes principles and practical analysis techniques and is written directly to the student in a clear minded but informal and friendly way. The text is presently being extensively modified and prepared in LaTeX format. It will also include a solutions manual. The current publication date is 2013.

Recent Publications:

"Eigenspectrum Noise Subtraction", Victor Guerrero, Walter Wilcox and Ronald Morgan, *Proceedings of Science* (2009): 041.

"Thomas-Fermi Statistical Models of Finite Quark Matter", Walter Wilcox, *Nucl. Phys. A* **826** (2009) 49–73.

"Deflated and restarted symmetric Lanczos methods for eigenvalues and linear equations with multiple right-hand sides", Abdou M. Abdel-Rehim, Ronald B. Morgan, Dywayne A. Nicely, and Walter Wilcox, *SIAM J. Sci. Comput.* **32**, 1, pp. 129-149 (2010).

Faculty Research Profiles

Zhenrong Zhang

Assistant Professor

Research Interests:

Surface Chemical Physics

Scanning Tunneling Microscopy

Heterogeneous Catalysis

Oxide Nanostructure and Thin Film Growth

Dr. Zhang's research interest is to understand energy and environment related reaction mechanisms and dynamics on model oxide catalysts at the molecular-level for designing nanocatalysts with desired reactivity and selectivity. The current research project is to understand how the local structure influences the photo-conversion of CO_2 with H_2O to liquid fuel related hydrocarbons on inverse model oxide nanocatalysts (i.e. metal supported oxide nanocatalysts). "Inverse" model catalysts offer the selection that is not possible in "regular" model catalysts but are important in energy and environmental applications. The approach will be to 1) synthesize ordered oxide (ZrO_x and TiO_x) nanostructures and ultrathin films on the metal single crystal surfaces, and 2) probe the thermally and photo-activated surface reaction processes (adsorption, dissociation, diffusion and orientation dynamics) of molecular species (reactant molecules, possible intermediates and product molecules) on these oxides.

Model nanocatalysts will be synthesized in both UHV Scanning Probe Microscopy (SPM) apparatus and the Metal-Organic Chemical Vapor Deposition (MOCVD) apparatus. Using SPM, the growth of the oxide overlayer on the metal surface will be monitored to gain critical information on the catalysts design — size and structure of the catalysts, nucleation during growth, stability and aggregation during calcinations. The same area comparison could provide the site-specific information in adsorption and dissociation processes. More important, using isothermal time-dependent imaging at elevated temperatures we can extend our study to a quantitative level, i.e. extract the energetics and dynamics of the molecules and reactive sites.

In the past year, Zhang's group successfully set up the custom-designed STM (SPECS) apparatus and obtained atomic resolution images on the oxide surfaces (See the Figure). Two undergraduate students (Amir Ali and Stephen Pickett) have worked in the group. Stephen mainly worked on the installation and testing of the in situ UV light illumination system. Amir mainly worked on the sample cleaning and the installation of in situ adsorbate delivery system. Amir has been designing and implementing an STM tip etcher. Two graduate students, Yaobia (Eric) Xia and Raziyeh (Razie) Yousefi have started taking data for their theses. Yaobiao is working on photocatalytic reactions on rutile TiO_2(110). Razie is working on catalytic reactions on anatase TiO_2(001). The results obtained were used in grant proposal to NSF.

Dr. Zhang obtained a second ultra high vacuum STM system which leads to the finalization of the long planned combination of Drs. Park and Zhang's groups. This action will synergize the surface chemical physics research program.

Professional Activities:

Dr. Zhang spent the summer working at Environmental Molecular Sciences Laboratory (EMSL), a DOE national scientific user facility located at Pacific Northwest National Laboratory (PNNL). She collaborated with Dr. Zdenek Dohnalek on the Catalytic Oxidation of Organics on TiO_2(110). The adsorption and dissociation of glycol molecules on rutile TiO_2(110) surfaces were studied. The travel fund was supported by Baylor Physics Department and PNNL's Alternate Sponsored Fellowship.

Dr. Zhang serves on a standing EMSL Peer user research proposal Review Panel.

Recent Publications:

Z. Li, Z. Zhang, B. D. Kay, Z. Dohnálek, Polymerization of Formaldehyde and Acetaldehyde on Ordered $(WO_3)_3$ Films on Pt(111), *J. Phys. Chem.* C, **115** (2011) 9692–9700

Z. Li, Z. Zhang, Y.K. Kim, R. Smith, F. Netzer, Bruce Kay, Rousseau, Roger; Dohnalek, Zdenek, Growth of Ordered Ultra-thin Tungsten Oxide Films on Pt(111), *J. Phys. Chem.* C, **115** (2011) 5773–5783

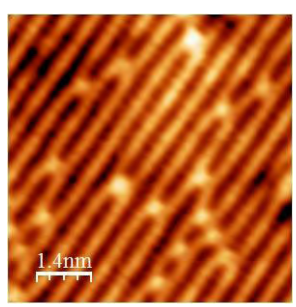


Figure: In situ STM imaging during UV illumination on TiO_2 (110).

Lecturer Profiles

Daniel Bolton

Daniel Bolton is in his first year as a full-time Lecturer at Baylor. He earned a BS in engineering physics from the Colorado School of Mines in 2006, and completed his PhD in theoretical nuclear physics this summer at the University of Washington in Seattle. Daniel and his wife Laura are enjoying adjusting to life in a warmer, and less rainy, city.

In addition to lecturing, Daniel continues to work on theoretical physics research. His PhD thesis produced three publications and can be found at arxiv.org/abs/1108.1217. His research is in the fields of Effective Field Theory and Lattice Quantum Chromodynamics.

Editor's Note: We thought there was no one better qualified to tell you about our new lecturer, Daniel Bolton, than himself:

Firstly, Daniel wants to say how excited he is to be a part of the Baylor Physics Department. He thanks everyone for being so welcoming and helpful. It is unusual to meet a group of physicists this nice! He was particularly amazed to observe how much you all seem to care for each other. He looks forward to getting to know everyone better throughout the year.

Daniel and his wife Laura just moved from Seattle, Washington. Daniel recently finished his PhD in nuclear theory, and Laura her MS in biochemistry, both from the University of Washington. They are looking forward to a winter with a little more sun and a little less drizzle.

They both grew up in a town north of Denver, Colorado and met in their high school youth group. They will have been married for three years this December. Their cat Hobbes (who thinks he's a tiger) joined the family last year and they just recently added a Labrador puppy as well. Daniel loves being outdoors, hiking, and running. He especially enjoys climbing Colorado's 14er's (14k ft. mountains) on trips back home. He and Laura also enjoy playing Settlers of Catan and the card game Hand and Foot.

The Bolton's are grateful to God for all His blessings in the past year: graduation, three family weddings (younger brother, younger sister, and cousin), and a successful move across the country. They look forward seeing what He has in store for them in Waco, and to growing in faith with new colleagues.

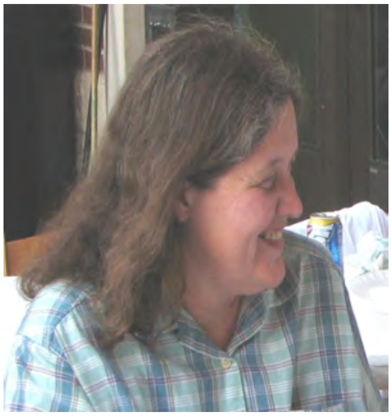
Randy Hall

Randy Hall has been a lecturer in the Baylor Physics Department since 2008. He received his Bachelor of Science degree in Physics and Mathematics from Baylor in 1971 and a Master of Science degree in Mathematics from Baylor in 1972. Randy did additional graduate work in Mathematics and Computer Science (1973 – 75) at the University of Texas at Austin. He now serves as lab coordinator in the Department.

Randy was president and CEO of DIGATEX, Inc., a developer and supplier of route accounting and management software for soft drink bottlers and other food and beverage distributors (1978 – 2007). He has also taught at the University of Texas at Austin (Computer Science) and Austin Community College (Mathematics). He is married to Cathey L Hall (BSEd Baylor 1973) and they have a daughter Jessica (BBA Baylor 2006) who is an attorney in Southlake, Texas. Randy also works with software development for CASPER (the Astrophysics research group). He was named an Outstanding Professor for 2009-10 by the Baylor University student athletes.

Lecturer Profiles

Linda Kinslow



Linda Kinslow has been teaching at Baylor University for nine years. She had previously coordinated the undergraduate physics labs in the Dept-ment. Prior to coming to Baylor she worked for BP as a exploration geophysicist. Linda earned her PhD degree from Baylor.

Edward Schaub

If you've been in the department recently, you may have noticed a new, yet somehow strangely familiar, lecturer teaching a couple of courses this fall. Your eyes do not deceive you. Our very own Ed Schaub has returned to help teach where we have need.

Ed Schaub has been involved in the Baylor Physics department for more than 24 years, first as an instrumentation engineer on the NASA CRAF/CoDEM project under the leadership of Dr. Merle Alexander, and most recently as a full-time lecturer.

Previous to his Baylor employment, Ed Schaub held a number of positions in industry. He was a production engineer with Texas Instruments in the Government Products Division and a research engineer with AFS Research Corporation investigating alternate energy resources.

Mr. Schaub holds an M.S. in Physics and an M.S. in Environmental Studies. With 30 years as part of the Baylor family, the feelings run deep for how much we love Ed - as both a gentleman and a physicist.

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. John is the advisor for the Baylor chapter of the American Student Dental Association. He was named Advisor of the Year at the 14th Annual Baylor Advisor Appreciation Banquet held on April 16, 2007. John runs marathons in his spare time.

Yumei Wu

Yumei Wu received her PhD from University of Ioannina in Greece in 1992 and had been an associate professor in the department of mathematics at the Federal University of Rio de Janeiro, Brazil from 1995 to 2007.

Yumei then joined the department as a lecturer.

In addition to lecturing, she continues to do theoretical research on dynamic systems & applications to gravity and cosmology.

She recently published the papers:

A. Wang and Y. Wu, Cosmology in nonrelativistic general covariant theory of gravity. *Phys. Rev. D* **83**, 0443031 (2011).

A. Wang and Y. Wu, Thermodynamics and classification of cosmological models in the Horava-Lifshitz theory of gravity, *JCAP*, **07**, 012 (41 pages) (2009)[arXiv:0905.4117] .

Undergraduate Research Notes

In the spring of 2011, the Department of Physics transitioned the senior research sequence for the Bachelor of Science department majors. In the past, students were involved in a two-course sequence during the senior year, PHY 4195 and PHY 4196. While many students who had previously had research experience were capable of gaining much from the courses, not all students had engaged in an undergraduate research experience prior to their senior year. To address this, the course sequence has been revamped into PHY 2190, which will from now on be offered in the spring of the sophomore year, and PHY 4190, which will now serve as the terminal research course in the fall of the senior year. The latter course will focus on the dissemination of research results in written, oral and audio-visual formats.

By expanding the time between the two one-hour courses, and renovating their content, students will be encouraged to seek out research experiences in their undergraduate careers by the end of their sophomore year, allowing them two years to develop their research projects before completing the course sequence in the fall of their senior year. In addition, the changes leave open time in the spring of the senior year for students and their research advisors to author undergraduate theses and journal articles prior to a typical May graduation in the four year scheme.

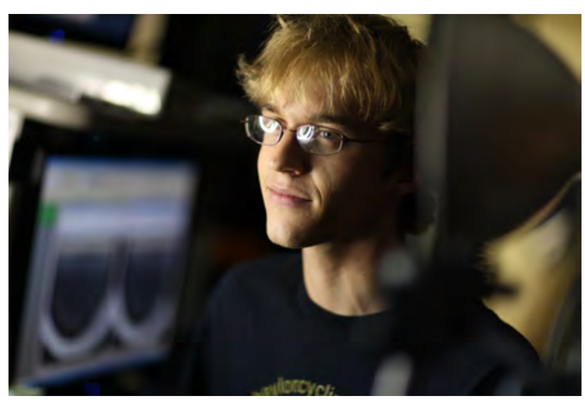
At nearly the same time, the Department of Physics created a Director of Undergraduate Research to both act as a liaison between undergraduate students and research faculty mentors as well to monitor the progress of the undergraduate researchers between the sophomore and senior years, The current Director of Undergraduate Research in the Department of Physics is Dr. Jeffrey Olafsen. Dr. Olafsen has also been overseeing the transition from PHY 4195/4196 to the new PHY 2190/4190 courses. Of the 18 students who were enrolled in the three sections of PHY 2190, 4195 and 4196 necessary to make the transition in the spring of 2011, 16 of the students were involved in a summer research experience. The students were supported by a variety of research funding programs including SURPh (Summer Undergraduate Research in Physics), URSA (Undergraduate Research & Scholarly Achievement), and REU (Research Experiences for Undergraduate) programs, as well as external grants.

In addition, at the end of the 2011 summer, Dr. Olafsen organized an Undergraduate Research Symposium (now in its third year) on August 25, 2011 in Room D.110 of the Baylor Sciences Buildings (BSB). The afternoon event featured talks by 13 of the 16 undergraduate majors who spent the summer pursuing research topics both here on campus and across the country. Also, Matt Swift from the Baylor publication *The Pulse* participated in the program, inviting interested undergraduate researchers to submit manuscripts for the spring issue of *The Pulse* that focuses on science research. The event was also the subject of a Baylor News article that can be found at:

http://www.baylor.edu/pr/news.php?action=story&story=98720

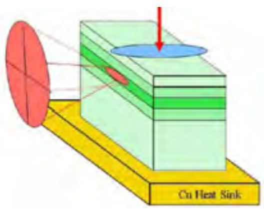
Finally, in the Fall of 2011, Dr. Jeffrey Olafsen was named the faculty representative at Baylor University for the **Barry M. Goldwater Scholarship** program. As the faculty representative, Dr. Olafsen will be holding a workshop on Tuesday November 8, 2011 at 5 p.m. in room E.125 of the BSB. The workshop will not only help potential applicants understand the application procedure, but will also offer advice to students on how to make their application as strong as possible. Baylor University is allowed to nominate up to four students at the sophomore or junior level for the competition. Because of this, all applications will first go through an internal Baylor competition for selection. The deadline for the internal application stage is Friday, December 2, 2011.

The **Barry M. Goldwater Scholarship and Excellence in Education Program** was authorized by the United States Congress in 1986 to honor Senator Barry M. Goldwater, and the program was designed to foster and encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences and engineering.



Jacob Jantzi (BU '10), a former physics undergraduate researcher.

Special Research Focus: *Semiconductor Lasers*



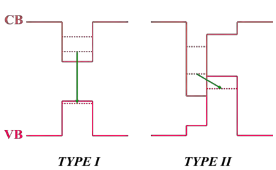
Schematic of an optically-pumped, edge-emitting, semiconductor laser.

Dr. Linda Olafsen's Semiconductor Laser Optics group studies semiconductor heterostructures designed to be efficient, room-temperature lasers emitting in the mid-infrared region of the electromagnetic spectrum. These heterostructures are stacks of different semiconductor layers, with individual layer thicknesses ranging from a few Angstroms (10^{-10} m) to 1 μm. Embedded in these heterostructures is an active region with a series of thin layers that make up quantum wells—making these layered semiconductor materials a practical implementation of the finite square wells introduced in modern physics and quantum mechanics. The materials most commonly studied in Dr. Olafsen's laboratory are III-V semiconductors, which are alloys that combine one or more elements from column III of the periodic table (Ga, In, Al) with one or more elements from column V (As, Sb). Combinations such as GaSb, InAs, AlSb, InGaSb, and AlAsSb are part of the antimonide-based semiconductor family.

> *"...these layered semiconductor materials are a practical implementation of the finite square wells ..."*

Semiconductors are materials with electrical properties that lie between those of a metal and an insulator. At zero temperature, semiconductors behave as insulators, while at finite temperatures they are conducting, though typically not as highly conductive as a metal. Semiconductors also have a band gap—the energy difference between the highest energy valence electrons and the lowest energy excited (conduction) electrons—and consequently these materials can absorb or emit light. The size of this energy gap depends on the composition of atoms in the lattice, and is inversely proportional to the emission wavelength ($E = hc/\lambda$). Thus, longer wavelength emitters have smaller band gaps.

As sources are sought for mid-infrared and even longer wavelengths, the band gap of raw semiconductor material can be a limiting factor; the energy minimum is the band gap energy, and the corresponding wavelength is the longest possible wavelength for that material. It is possible to achieve even longer wavelengths and smaller energies by layering semiconductor materials to create finite square wells. Energy transitions can occur between the conduction band and the valence band, between energy levels in the same well (type-I, e.g., within the conduction band), or between energy levels in adjacent layers (type-II). The type-II configuration has the advantage that by adjusting the layer composition and thickness, the energy level separation can be tailored to be arbitrarily small, hence extending emission or absorption to longer wavelengths.



Examples of type–I and type-II band alignment in semiconductor wells.

The type-II configuration is helpful for achieving longer wavelengths, but on the surface can pose problems since the electrons sit in one layer, the holes (empty states) sit in an adjacent layer, and thus the probability of the electron making the radiative transition that yields a photon is reduced as there is not strong overlap between the respective wave functions of the electrons and holes. A clever way to overcome this difficulty is to separate a pair of quantum wells by a relatively short barrier, with these three layers surrounded by larger barriers. This double-well or "W" configuration manifests electron wave functions that spread symmetrically across the small intervening barrier—where the holes sit—which greatly increases the probability that an electron will drop in energy and fill the hole state, and the energy that the electron loses in that transition yields a mid-infrared photon. The very high surrounding barriers that form the outside of the "W" prevent electrons from jumping over wells or tunneling out of the quantum wells before they make the desired energy transition that yields a photon. The first to propose such a configuration was Jerry Meyer and colleagues at Naval Research Laboratory in 1995 [1]. This type-II W quantum well structure is central

Special Research Focus: *Semiconductor Lasers*

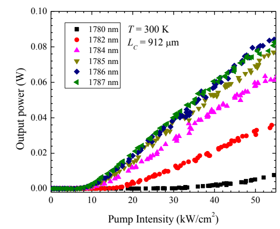
to the devices studied in Dr. Olafsen's laboratory at Baylor. The quantum wells are typically composed of InAs, the center barrier that contains the holes is GaSb (or InGaSb with a relatively small concentration of In), and the larger outer barriers of the "W" are comprised of AlSb or AlAsSb.

In any laser, it is necessary to populate electrons in the upper energy state so that they are available to make the radiative transition to the lower state. Semiconductor lasers are commonly "electrically injected," which means that current passes through the structure so electrons may populate the upper level, but it is also possible to excite electrons to the upper state with "optical pumping" which is the absorption of a higher energy (shorter wavelength) photon that excites the electron to an even higher level and can then relax via non-radiative processes to the desired upper lasing state. Dr. Olafsen has developed a unique optical pumping configuration in her laboratory for the study of quantum wells and semiconductor lasers designed for mid-infrared emission. A neodymium-doped yttrium-aluminum-garnet (YAG) laser illuminates an optical parametric oscillator—an instrument with a non-linear crystal that converts the 355 nm photons from the Nd:YAG to two photons with the same total energy. One photon is in the visible, and the other is in the near-infrared. It is the near-infrared output that is used to excite electrons in the mid-infrared semiconductor lasers. The near-infrared wavelength is then tuned so that the semiconductor material may be studied as a function of pumping wavelength. Finding the optimal pump wavelength at which the efficiency is maximized (the most light out for the minimum pumping intensity) and the threshold is minimized (the minimum pumping intensity required to achieve lasing) reveals important information about the energy level structure that can then be used to improve the design of the next generation of quantum wells and heterostructures to make mid-infrared semiconductor lasers that are more efficient and operate at higher temperatures. Dr. Olafsen's group collaborates with scientists at Air Force Research Laboratory and Naval Research Laboratory to study and improve antimonide-based semiconductor heterostructures designed for 3–5 μm emission. The short pulses (4 ns) and low repetition rate (10 Hz) generated by this optical pumping system allow the study of the physics of the system without the deleterious effects of heating.

Mid-infrared semiconductor lasers, particularly those designed to emit in the 3–5 μm wavelength range, are desirable for a variety of applications. In this region of the electromagnetic spectrum, chemical sensitivities are 100–10,000 times higher than in the near-infrared due to fundamental rotational and vibrational modes of the molecules, giving these lasers great potential for chemical sensing applications. Such sensors may be used for environmental monitoring or for medical diagnostics. For example, the detection of nitrous oxide in exhaled breath is an excellent early indicator of asthma and ulcers and has potential for identifying other medical conditions such as diabetes and certain cancers [2]. These laser sources also are desirable for infrared countermeasures, i.e. diversion of heat-seeking missiles from aircraft or ships, free space communication, and spectroscopy, including infrared sensing for astronomy.

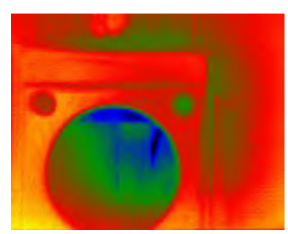
[1] J. R. Meyer, C. A. Hoffman, F. J. Bartoli, and L. R. Ram-Mohan, "Type-II quantum-well lasers for the mid-wavelength infrared," *Applied Physics Letters* **67**, 757–759 (1995).

[2] http://www.ekipstech.com/pages/home_page/breathmeter/webpage_category.xml



Light output vs. optical pumping intensity for a range of pump wavelengths.

Dr. Olafsen has developed a unique optical pumping configuration in her laboratory for the study of quantum wells and semiconductor lasers designed for mid-infrared emission.



Infrared image of an electrically injected semiconductor device mounted inside a dewar.

Women in Physics lunches began in 2010. From a 2006 AIP survey, only 21 other physics PhD institutions have five or more female faculty members.

"Lasers are involved in a lot of things you don't realize in everyday life"

-

Dr. Linda Olafsen,

Baylor University

On the 50th anniversary of the laser.

Dr. Ken Hatakeyama attended the High Energy Physics Summer School in Lauterbad, Germany from July 26 – August 4, 2010

Newsletter Highlights

September/October 2010

On May 10th, Ph.D. student Karen Bland presented the results from a "Search for a Standard Model Higgs Boson in the Diphoton Final State at the CDF Detector" at the Phenomenology 2010 Symposium in Madison, Wisconsin. The focus of this annual conference is to share the latest topics in particle phenomenology and theory. Karen presented a poster with the same title at the Fermilab Users' Meeting on June 2-3, where she won ***first prize*** in a competition for the best graduate student poster among dozens of participants from many universities. **Congratulations, Karen!** Finally, Karen presented her search for the Higgs Boson in the diphoton channel at this summer's Collider Detector at Fermilab Collaboration Meeting on June 11, 2010.

Senior Ian Reeves has received a $2,500 award from the Directed Energy Professional Society to support his Senior Capstone Project that will culminate in an Honors Thesis. The title of the project is "Optically Pumped Semiconductor Analysis in the Mid-Infrared." This work is being conducted under the supervision of Dr. Linda Olafsen. The Directed Energy Professional Society focuses on research and education in directed energy (e.g., lasers) for national defense and civilian applications, with programs focusing on communication and education.

November/December 2010

As a special event for Alumni weekend, Baylor University and the Physics Department welcomed Denis Alexander, director of the Faraday Institute for Science and Religion at St. Edmunds College, Cambridge to campus. On Thursday, October 21st, Dr. Alexander presented the 3:30 pm Physics Colloquium "Is there an Anthropic Principle in Biology?" (preceded at 3 p.m. by a reception in the Physics Conference Room.) This was followed at 7 pm by Dr. Alexander's public lecture entitled "The Dawkins Delusion: Debunking the Conflict between Science and Religion." Additional sponsors of Dr. Alexander's visit were the Templeton Foundation-funded Baylor Society for Conversations in Religion, Ethics, and Science (of which Dr. Gerald Cleaver is co-director), the Institute for Faith and Learning, the Baylor chapter of the American Scientific Affiliation, and the Office of the Vice-Provost for Research.

Prior to his arrival at the Faraday Institute, Dr. Alexander was an open scholar at Oxford University. More recently, he worked at the Imperial Cancer Research Fund (now Cancer Research UK), and since 1989 at The Babraham Institute where he was chair of the molecular immunology program and head of the Laboratory of Lymphocyte Signalling and Development.

January/February 2011

The continuing trajectory of improvement for Baylor University's department of physics now is being recognized on the national level. The recently released rankings by the National Research Council show substantial progress between 1995 and 2006 on all of the various measures and indices. Even more recent and detailed data from Academic Analytics, a private company ranking Ph.D. programs, shows that the upward climb has continued since 2006.

The Academic Analytics data for 2008 show that the department's high overall ranking of faculty scholarly productivity — the FSP Index of publications, grants and awards — places Baylor physics in the company of large state-supported programs such as those at the University of Florida and Texas. The Baylor physics faculty rank No. 1 nationally among doctoral physics programs in the percentage of authors whose works are cited and are among the top 20 in dollars per research grant. Dr. Larry Lyon, dean of the Baylor Graduate School, congratulated the physics department on their achievements. "I am especially impressed by the Academic Analytic rankings in publishing cited research and bringing in high-dollar grants," Lyon said.

Newsletter Highlights

March/April 2011

The Department of Physics at Baylor University held its first graduate recruitment weekend on February 25th and 26th. The event brought ten potential graduate students to campus to meet with faculty, tour the department and learn more about the graduate program in physics at Baylor. The Director of Graduate Studies, Walter Wilcox, organized the event to improve graduate student recruitment to the program: "I want to give a big 'thank you' to the host families who opened their homes to several of these students." Host families included Angela Douglass as well as Drs. Lorin Matthews, Jay Dittmann, and Greg Benesh.

The schedule for the visit included several events held within the Baylor Sciences Building on both days including a welcome and orientation, a visit to the graduate seminar, a poster session and laboratory tours for the potential students and dinner in the BSB atrium on Friday as well as a continental breakfast, round-robin meetings with research faculty, a campus tour, lunch, and a final question-and-answer period on Saturday. The recruitment weekend follows on the heels of other student recruitment efforts by the department this year, including the Speaker Outreach Program, pairing physics faculty with undergraduate physics departments throughout Texas.

Dr. Linda Olafsen accepted one of 32 educational outreach grants from SPIE at the Photonics West Meeting in January 2011.

May/June 2011

The Department of Physics had the pleasure of hosting Dr. Carlos Stroud, Professor of Optics and Professor of Physics at the University of Rochester on April 11-12. In addition to individual visits and conversations, Professor Stroud made four presentations. The first lecture, "Vacuum Fluctuations, Quantum Jumps, Quantum Noise, Casimir Force: Different Guises, Same Physics," was attended by Dr. Ken Park's Quantum Mechanics II class, Dr. John Vasut's Physics 1430 Honors section, and several other interested physics majors and graduate students.

The second presentation, "Optics: Light Work," discussed optics as a profession, and was made to students in the Laser Electro-Optics Technology program at Texas State Technical College. Professor Stroud delivered a Physics colloquium, "Rydberg Electron Wave Packets: the classical limit of an atom," and presented a public lecture, "Quantum Weirdness: Technology of the Future?" with an attendance of approximately 200. Many students and members of the greater Waco community went up and asked him questions after his talk. He visited Baylor as a Distinguished Traveling Lecturer in Laser Science of the American Physical Society. The events were also featured in a Baylor news article.

"The Department continues to lead the University in the number of papers published per graduate student"

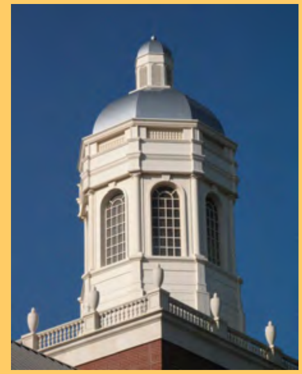
Summer 2011

Once again the Baylor Department of Physics and CASPER hosted the NSF REU (Research Experience for Undergraduates) and RET (Research Experience for Teachers) programs. This year we had twelve undergraduate students and two high school teachers participating in the program. One high school student also participated in summer research through the High School Summer Science Research Program (HSSSRP) sponsored by the College of Arts and Sciences.

REU participants included (many pictured at the right):

Boedges, Katherine	Austin Peay State University	Bombardier, Kevin	Wichita State University
Doyle, Brandon	Baylor University	Burkart, Audrey	Augustana College
Hicks, William	Brown University	Losey, Dylan	Vanderbilt University
Middlemas, Erin	East Tennessee State University	Paro, Autumn	Worcester Poly. Inst.
Rauch, Joseph	University of Denver	Sullivan, Mark	Union College
Van Oeveren, Eric	Grand Valley State University	Vestal, Lesley	U. of British Columbia

Baylor University Department of Physics Scholarships



How you can help

People sometimes ask how they can help us in accomplishing our departmental goals. One important way in which all of our alumni and friends can help is by giving to the Physics Endowment and Excellence Fund (032 MAUN). Excellence funds are used on a variety of projects. For example, excellence funds were used to help equip Dr. Zhenrong Zhang's scanning tunneling microscopy (STM) laboratory. In addition to the excellence fund, there are a number of department scholarships that are designed to assist undergraduate and graduate students. 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.

A complete list of Physics Department funds and their uses appears below:

Physics Endowment and Excellence Fund (032 MAUN)

Physics general fund to promote excellence within the Department.

Cy Lynch Physics Scholarship (032 SBUX)

This scholarship is merit-based for graduate students.

Gordon K. Teal Physics Scholarship (032 SBVA)

This scholarship is for physics majors with outstanding grades.

Herbert Schwetman Physics Scholarship (032 SBUZ)

This scholarship is merit-based for physics majors.

Physics Department Special Scholarship (032 SBUY)

Funds to benefit the departmental scholarship program.

Roy W. Stiegler, Jr., Endowed Physics Scholarship Fund (032 SDFN)

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

Shim and Theresa Park Physics Scholarship (032 SCPS)

This scholarship is merit-based for international students.

Special Endowment Focus: Investing in the Future

Editor's Note: The following article, Microscope brings atom imaging to campus, originally appeared in the Baylor Lariat on September 8, 2011 and was written by Robyn Sanders, Reporter.

The Baylor department of physics is now able to image individual atoms using a Scanning Tunneling Microscope, under the direction of Dr. Zhenrong Zhang, assistant professor of physics.

"We never thought that we'd be able to individually image atoms," Dr. Greg Benesh, professor and chair of the physics department, said.

Benesh said the microscope has a probe that moves along a surface and moves up and down according to the density of electronic charge of the atom or atoms.

"And so by putting together the up and down motion, then we can get an image of the surface on an atomic level," Benesh said.

The lab is located in the "C" wing of the Baylor Sciences Building on the first floor. Zhang says the lab is in this part of the building because the instruments in the lab are sensitive to noise and vibration.

"I'm very thankful for the university to be able to provide the support and build a new lab in the ground floor," Zhang said.

Dr. Zhang's research will also examine the catalytic conversion of carbon dioxide to liquid fuel, as well as ways to produce alternative energy sources such as hydrogen.

"For now our focus is on titanium dioxide, which has a wide range of applications — photo catalytic applications, that is: UV light, or sunlight- to convert molecules to useful chemicals," Zhang said. "That's one of the properties that we're interested in as well: to incorporate sunlight into useful energy. Titanium dioxide can also be used to clean up organic pollution, to convert the harmful organics into unharmful molecules."

The microscope will also be able to examine different surfaces that speed up chemical reactions.

"We're still trying to understand what it is about certain surfaces that makes these chemical reactions go faster," Benesh said, "We're trying to scrub pollutants out of emitted gasses as quickly as possible so that our atmosphere isn't polluted."

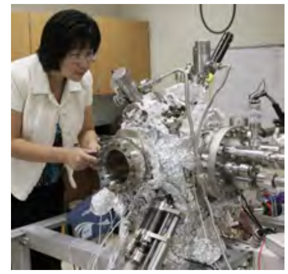
Zhang has two graduate students working in the lab, and two undergraduate students worked in the lab during the summer. She said that it's a great opportunity for the students to conduct advanced research.

"I think that's the best way to be able to engage them into science and to research, which is very important for the future, for the science and engineering area," Zhang said. "They will receive the training on the most advanced nano-technology instrument, and it will be great for their future career. I think this is a really great opportunity for them to be able to really use this instrument."

This summer, Zhang was able to obtain another Scanning Tunneling Microscope for the lab, which was purchased by Baylor. "This is another great opportunity," she said.

"This will enlarge our opportunities to obtain external funding for research," Zhang said. "So I think this is a great advantage now that we have two instruments and [it] will really increase our chance to get funded."

Zhang said she has submitted research proposals to organizations such as the National Science Foundation and the Petroleum Research Fund in hopes of gaining funding.

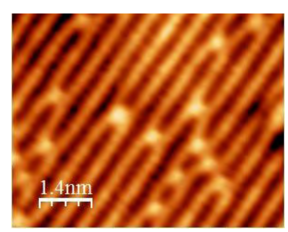


Dr. Zhenrong Zhang, demonstrates the STM.

Matt Hellman
Lariat Photo Editor

"Excellence funds were used to help equip Dr. Zhenrong Zhang's scanning tunneling microscopy (STM) laboratory."

- Greg Benesh



STM image during *in situ* illumination of TiO_2 (110).

Snapshots from Summer

Editor's Note: While summer may conjure up different expectations from an earlier time, the summer months are some of the most productive for Baylor Physics faculty members.

I have been able to spend a month each of the past three summers visiting the Theory of Condensed Matter Group at the Cavendish Laboratory of the University of Cambridge. The TCM Group is headed by Prof. Mike Payne—who was a Cambridge graduate student when I was a postdoc in TCM in 1980-82. The Cavendish Lab is the Physics Department of the University of Cambridge. It was founded in the 1870s under the leadership of James Clerk Maxwell. Other famous Cavendish Professors include Lord Raleigh, J.J. Thomson, Lord Rutherford, William Lawrence Bragg, and Neville Mott. My collaborative work has been primarily with Prof. Roger Haydock of the University of Oregon, who visits the Cavendish every summer. Our current research interest is in MBTS states: solutions of the Schrødinger equation that maximally break time-reversal symmetry. These states are being used to embed impurity systems into otherwise perfectly-ordered substrates.—Greg Benesh

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"The algorithm he was using wouldn't work correctly in general, and wasn't easily modifiable."

- Randy Hall

On the morning of July 6 this past summer, Randy Hall, the department laboratory manager and lecturer, awoke to find one of those emails in his inbox that one typically deletes without reading. "Help needed with physics problem" the title read, from a sender that Randy didn't recognize. Instead of deleting the email, Randy opened it and found a request from Steve Glinberg, a developer of children's educational game software for Apple products from Madison, Wisconsin. It seems that he was trying to program the two-dimensional elastic collision of two balls graphically and was getting some strange results. He sent the email to Randy, among others, because he had found Randy listed as teaching physics during the summer via a Google search. Sensing the opportunity to do a little programming, Randy responded to the email asking for details, including some data samples and the algorithm he was trying to use. "It was apparent from looking at the code and the data he sent along what the problem was. The ball object he had defined was storing the velocity vector in a magnitude and direction form, but the algorithm understandably was using components. That means that when he was done and transformed the resultant components back into magnitude and direction form, he used the inverse tangent method to set the angle, not realizing that the inverse tangent method would only return an angle in the first or fourth quadrants."

That was an easy problem to fix knowing the components. But then Randy realized that his algorithm had a more serious problem. The ball object contained a mass data element and the algorithm that he was using assumed that the masses of the two balls were the same. "That meant that the algorithm he was using wouldn't work correctly in general, and wasn't easily modifiable since the same mass assumption meant that the momentum in the tangential direction was completely transferred in the collision and that meant that several necessary terms went away. So I spent a little time and found the correct equations to use for general masses and wrote a Java program to allow keyboard input and display collision results and sent it to him to try out. He was writing in Objective C (a compiler for which I don't have) but a Java program that is mainly procedural is easily converted to any of the C variants."

It turned out to be just what the developer needed. "This solution is perfect," wrote Mr. Glinberg that evening. His shot in the dark email had struck pay dirt. Total time spent to fix his problem was around three hours. Just another service of your Baylor Department of Physics. - Randy Hall

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Baylor HEP group at Fermilab. Summer 2011

This summer, two undergraduate stents, Forrest Phillips and Evan Bauner, and two graduate students, Tara Scarborough and Bo Zhang visited Fermilab in order to conduct their summer research. They all drove from Waco to Fermilab; one way drive takes about 18 hours. They stayed at a house inside Fermilab. Together with Dr. Liu, a Baylor's postdoctoral fellow stationed at Fermilab, and Dr. Hatakeyama, Forrest, Evan, and Tara joined the data analysis team, which searches for Supersymmetry in the CMS experiment's data, collected at the

Snapshots from Summer (continued)

Large Hadron Collider (LHC). Supersymmetry (SUSY) is a very attractive physics theory, which can offer answers to several major questions in physics, such as the origin of the dark matter and grand unification. SUSY search is one of the major efforts at the LHC. This is a very complicated analysis, and requires a collaborative effort to complete it. The Baylor group collaborated with people from University of Hamburg, Rockefeller University, Fermilab, University of Illinois at Chicago, University of California at Riverside, University of California at Santa Barbara, and CERN.

Tara's work involved skimming the interesting proton-proton collision events for this analysis from the CMS's large data and Monte Carlo simulation samples, and understanding the event reconstruction failure pattern in these samples, the very important first step of the analysis. Forrest worked on the estimation of one of the most significant backgrounds in this search, called "invisible Z". In these events, the Z boson decays to neutrinos, which pass through the CMS detector without interacting. They mimic the signature of the lightest SUSY particles, which we are looking for.

Evan's most significant project was on the interpretation of the analysis result. We did not observe significant signal indicating the presence of SUSY in the current CMS data; however, our work was not done yet. We needed to provide the information on what SUSY models are already excluded and what models can be still hiding in the CMS data and may be discovered in future. He produced the plot showing this interpretation by using the statistical method called CLs. - Ken Hatakeyama

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One of the most important activities in which we were able to participate was the interaction with the CERN LHC physicists, both theorists and experimentalists, on the actual implications of the data, both for our theoretical developments and for the theoretical developments of others. Recently, these interactions, taken together with those of the other LHC physicists at CERN, have been able to sustain argumentation that the famous Higgs particle may have already been seen at the LHC: in one way of looking at the recent ATLAS and CMS results, there is 4 sigma evidence for the particle. This type of combination of the data will be done systematically and officially for the upcoming Lepton-Photon Symposium in Mumbai, India, with almost twice as much data, so that, if what we saw in the data was real, the effect could by that time, August 22-26, be at 5.6 sigma, i.e., it could make it to the newspapers! This has not happened so that we need to wait a bit more. The excitement of being at CERN when the first real evidence of the Higgs may have actually been observed is special. We cannot really describe in words the feeling of being just a small part of the discussions in the corridors, in coffee, etc., that has been constant this summer. This was priceless. The last time something like this happened was during the discovery of the famous Psi/J resonances that were hidden charm in November, 1974, at SLAC in Stanford University during our second year there as a post-doc. To repeat, this is special. - BFL Ward

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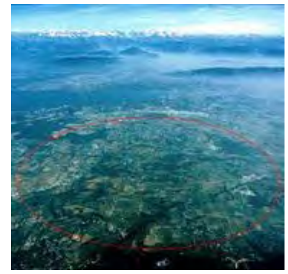
The summer just kept getting more and more eventful for the Olafsens as time passed. Drs. Jeffrey and Linda Olafsen welcomed the newest addition to their family, Susanna Elaine Olafsen, on June 23, 2011. While some might think this an excellent opportunity to take the summer off, both Jeff and Linda were working hard to meet a deadline for a meeting at Virginia Tech. So, at six weeks old, young Susanna and her older brother John joined their parents on a cross country trip so that Dr. Linda Olafsen could present "Synchronized Mid-Infrared Beam Characterization of Narrow Gap Semiconductors," a talk at the 15th International Conference on Narrow Gap Systems. The conference was held August 1–5 at Virginia Tech in Blacksburg, VA. Co-authors and collaborators on this talk were May Physics graduate Ian Eaves (Reeves) and Dr. Jeffrey Olafsen. And if that wasn't enough excitement for the family, Linda was on campus during the lockdown on August 4th when a gunman had been reported on campus. Ask Linda about the wonderful notification system they have on campus, as she got to see it in action firsthand! - Jeffrey Olafsen



An aerial view of CERN.

"[T]he famous Higgs particle may have already been seen at the LHC."

- B.F.L. Ward

Linda Olafsen at the NGS 15 Conference at Virginia Tech in August, 2011.

Mark Reeves, III
BU '62

Homecoming Events for

November 4, 2011

3 - 4 pm: Grand Opening of Dr. Zhang's STM Laboratory, C.161R (BSB)

4 - 6 pm: Physics Homecoming Reception, E.301 (BSB)

Karl Glastad
BU '81

Alumni News

All of us in the Department of Physics were pleased to hear from many alumni over the course of the previous year, sharing in both your joys and sorrows in life. We would like to encourage all of our alumni to use the last page of this newsletter to mail to us your most up-to-date contact information and family and professional news. So please take a few minutes to detach the last page, write down your information, fold and secure the page closed with the physics department address on the outside, affix a stamp and drop the note in the mail. We really do want to hear from all of you!

We've heard from:

- Linda Storm, widow of Baylor University Alumnus Charles Stephen Storm who died on August 15, 2008 after a 37-year career as a physics teacher for students in both high school and college. Our condolences at the news of Charles' passing and our pride at his lengthy career!

- Karl Glastad, who received a Bachelor's of Science degree in Physics in 1981, wrote to tell us not only of his current position as the Medical Director of MRI at Baylor University Medical Center in Dallas, but also of his family including his wife Allison, and four children: Karl Michael, Kristin, Jacob, and Luke.

- Sheila Smith, who received a Bachelor's of Arts degree in 1994 wrote to tell us about her work as a high school physics & math teacher, as well as to let us know that her husband, SSG Richard Munson, was in his second deployment in three years in Afghanistan.

- Dr. Tim Frank, who received a Bachelor's of Science degree in Physics in 1990 and is currently a professor of engineering at South Mountain Community College in Phoenix, Arizona. While he is very busy teaching engineering courses, running and internship program for their students at Honeywell as well as the faculty-senate president at SMCC, he also proudly told us about his daughters Kristen, Courtney and Caitlin as well as his wife, Karen Frank. From his note, it sounds like we should be looking for his daughter Kristen to arrive at Baylor in the fall of 2012! *Sic'em Bears!*

- James E. Roberts, Baylor '62, is now the Chair of Computer and Information Sciences at Charleston Southern University in Charleston, South Carolina. James Roberts arrived at CSU in 1981 with twelve years experience from various Air Force satellite development and air operation programs.

- Mark Reeves, III from Katy, Texas, whom we were saddened to hear had passed away. Mark had an extensive career in theoretical physics and scientific programming that began with his undergraduate degree at Baylor. Our condolences go to his wife, Mittie E. Wisenbaker Reeves, who also graduated from Baylor University in 1962. In our November/December 2010 issue of the newsletter, Mittie shared with us Mark's extensive career and milestones.

Please visit the department webpage to catch up on all of the issues of the monthly newsletter!

A Devotional

The Editor would like to thank our own Ed Schaub for providing this year's devotional to the Newsletter.

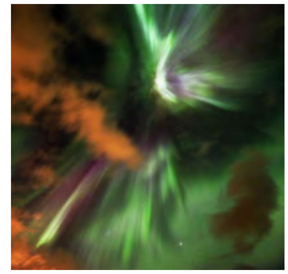
> **And God said, "Let there be light," and there was light. And God saw that the light was good. And God separated the light from the darkness. (Gen 1:3 – 4, ESV)**
>
> **Walk as children of light. (Eph 5:8, ESV)**

The existence and wonder of light has fascinated us for millennia. From the investigations of the ancients into the geometric properties of rays of light, to the multi-faceted contributions of Einstein and others regarding the photoelectric effect and the wave-particle duality of light, to the phenomenal breakthroughs of the laser laboratories, electromagnetic radiation has continued to defy any ultimate, comprehensive explanation. Just when we think we have a reasonable understanding of its characteristics, new discoveries open new doors for exciting theoretical and experimental study. Even more important than the intellectual pursuit towards an understanding of light is its essential nature for human existence. Energy transfer from sun to the earth, photosynthesis, availability of vitamin D for the human body – all contribute to our health, welfare and survival.

When writers of sacred scripture would search for language to describe God and the reality that is not seen by human eye, more often than not the imagery and symbolism of light would be employed. The apostle Paul would write that God "lives in unapproachable light." (1 Tim 6:16) James would speak of "every good and perfect gift" coming down from the "Father of the heavenly lights." (Jas 1:17) When John would employ language to reveal the beauty and power of his vision of God's throne in heaven, he would describe the scene in terms of a rainbow, light reflecting from precious jewels, and flashing lightning. (Rev 4) The psalmist would describe God's word as a "lamp to my feet and a light to my path." (Ps 119:105) The coming of the Son of God into the world as the Messiah would be announced by Isaiah the prophet as a "great light" that would appear to those walking in darkness (Isa 9:2) and Matthew would record the fulfillment of that prophecy when Jesus began his public ministry in Galilee (Mtt 4:12-17). More than any other apostolic writer of scripture, the apostle John employs the metaphor of light in describing the person and work of the Messiah. "In Him (Jesus) was life", John would declare, "and that life was the light of men." (Jn 1:4) He describes Jesus as "the bright Morning Star." (Rev 22:16) John would also record the declaration of Jesus: "I am the light of the world. Whoever follows me will never walk in darkness, but will have the light of life." (Jn 8:12) All those who choose to be disciples of Jesus are described by the apostle Paul as being "qualified to share in the inheritance of the saints in the kingdom of light." (Col 1:12) As the people of God, the apostle Peter writes that we are privileged to declare the praises of Him who has called us out of darkness into His wonderful light." (1 Pet 2:9)

It is our Christian vocation to live and walk as children of light – to seek and pursue that which is real and authentic and genuine in all of life. It does not matter whether it is in the classroom as professor or student, in the research lab, or a job in the public sector, ours is the high calling of seeking truth and excellence. In all of life's relationships – in our families, in our professions, or in our churches, it is our challenge to live as the "the light of the world" (Mtt 5:14), reflecting the glory of our Father in heaven until such a time that heaven (where God dwells) and earth (where we dwell) merge into the new heaven and new earth. Then –

> **"…there will be no need of the light of a lamp or the light of the sun, for the Lord God himself will give them light." (Rev 22:5)**

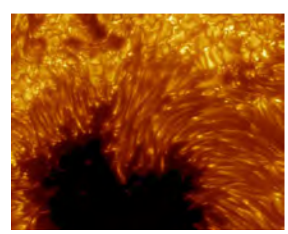


The Northern Lights observed at zenith.

Photo: apod.nasa.gov

"Even more important than the intellectual pursuit towards an understanding of light is its essential nature for human existence."

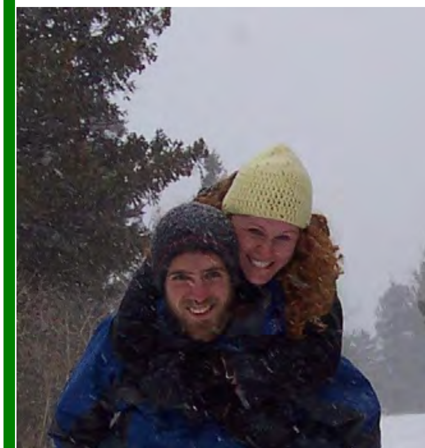
- Ed Schaub

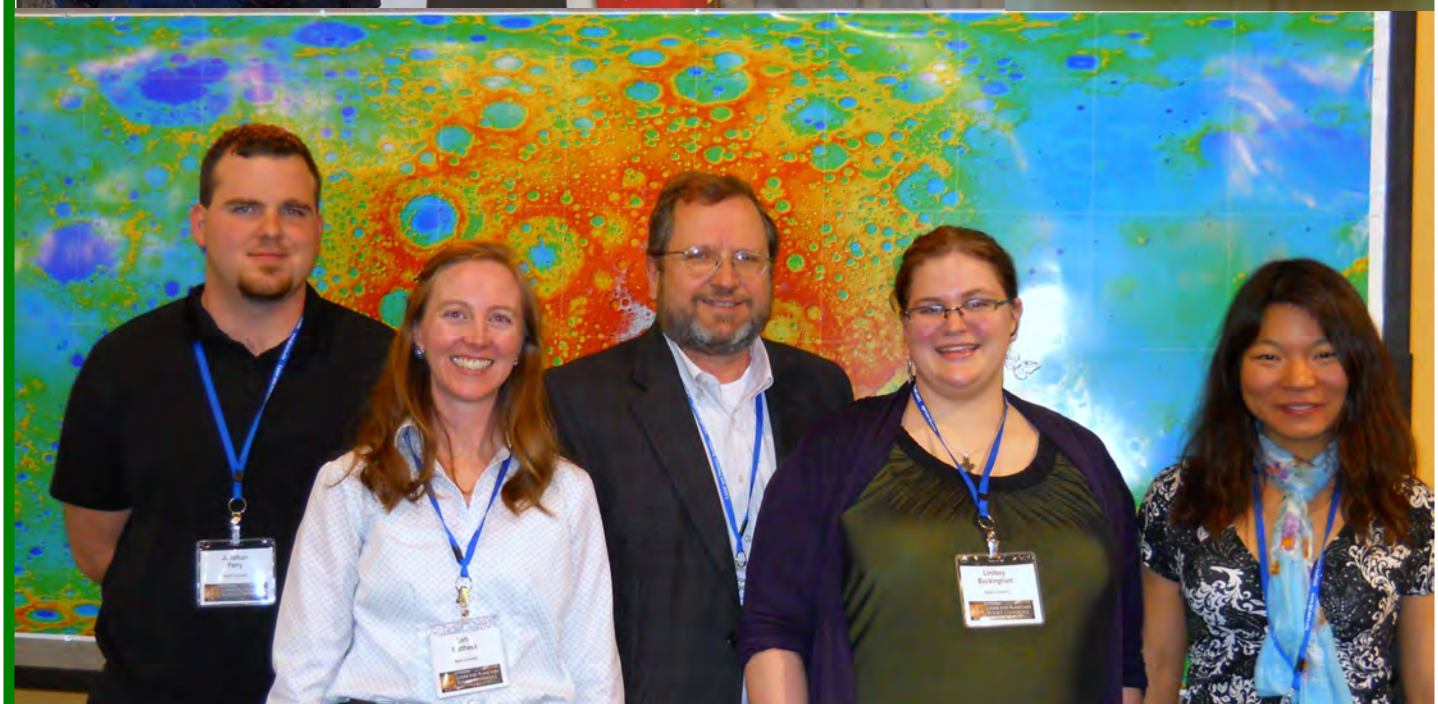


A sunspot moving along the surface of the sun.

Photo: apod.nasa.gov

The Department in Pictures





Doctoral Programs Student Publications per Capita	
Physics	5.23
EEES	1.80
Educational Psychology	0.79
Religion	0.75
ENPH	0.71
Psychology	0.53
Biology	0.50
Math	0.50

Alumni! 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 our current and potential Physics Majors and graduates.

Name: ____

Graduating Class: ____

Address: ____

____

E-mail address: ____

Phone Number(s): ____

Present Position: ____

Family News:

Career News:

Suggestions for the Department (how can we better communicate with you?):

(please give a short answer here, or email Physics_Newsletter@baylor.edu)

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Place

Stamp

Here

Dr. Gregory A. Benesh, Professor and Chair

Department of Physics

Baylor University

One Bear Place #97316

Waco, TX 76798-7316

We'll make it easy for you — just fold along this line!

We really want to hear from you - so this is how easy we're going to make it. Detach this last page of the newsletter, give us your most up to date contact information and news, fold along the solid line above, tape closed so the address above shows on the outside, affix a stamp in the box above and drop it in the mail.

The Constellation *Ursa Baylor*