PHYSICS *at SMU*

An occasional newsletter for alumni and friends. **Spring 2014**

Chairman's Report

This has been busy and exciting year for our department. As we begin the Spring semester, we have much to report.

The 2013 Nobel Prize in Physics was awarded for the Higgs Boson, and the official announcement made special mention of the Large Hadron Collider (LHC) experiments. SMU Physics faculty members on LHC ATLAS include **Professors Stroynowski**, **Kehoe**, **Sekula**, & **Ye**.

The Higgs Boson was also the topic of our 2013 Lightner Sams **Symposium.** The 2014 topic is **Symmetries in Science & Symphonies**, and will be held on 13 April 2014; we invite you to join us. *(Detailed information on page 2.)*

The SMU Physics Department successfully renewed our US DoE and NSF grants, and continues to bring in over $2M of external funding annually. **Prof. Pavel Nadolsky** was a DIS2013 convener in Marseille, France. **Prof. Ryszard Stroynowski** traveled to the University of Paris XI at Orsay, France to advise on the ATLAS physics program.

Dr. Simon Dalley received the 2014 Provost Teaching Recognition Award for his dedication to teaching and learning. He also received the 2013 Rotunda Outstanding Professor Award, and published a new textbook: *Ideas of Modern Physics.*

Physics hosted our annual NSF-funded QuarkNet program. 18 science teachers from DFW participated in the one-week summer institute. This is organized by **Dalley** with help from **Randy Scalise** and **Olness.**

Eight high school students performed summer research projects in the opto-electronics lab of **Andy Liu** and **Datao Gong**.

The **Master Physics Teacher Certificate** (MPTC) program continues in 2013-14 with new support from the **Hoglund Foundation** and the **Fluor Foundation**. This program is joint between Dedman College and the Simmons School. Organized by **Dalley** with instruction by **Scalise**, **Farley Ferrante** and **Dara Williams-Rossi,** and guest lecturers.

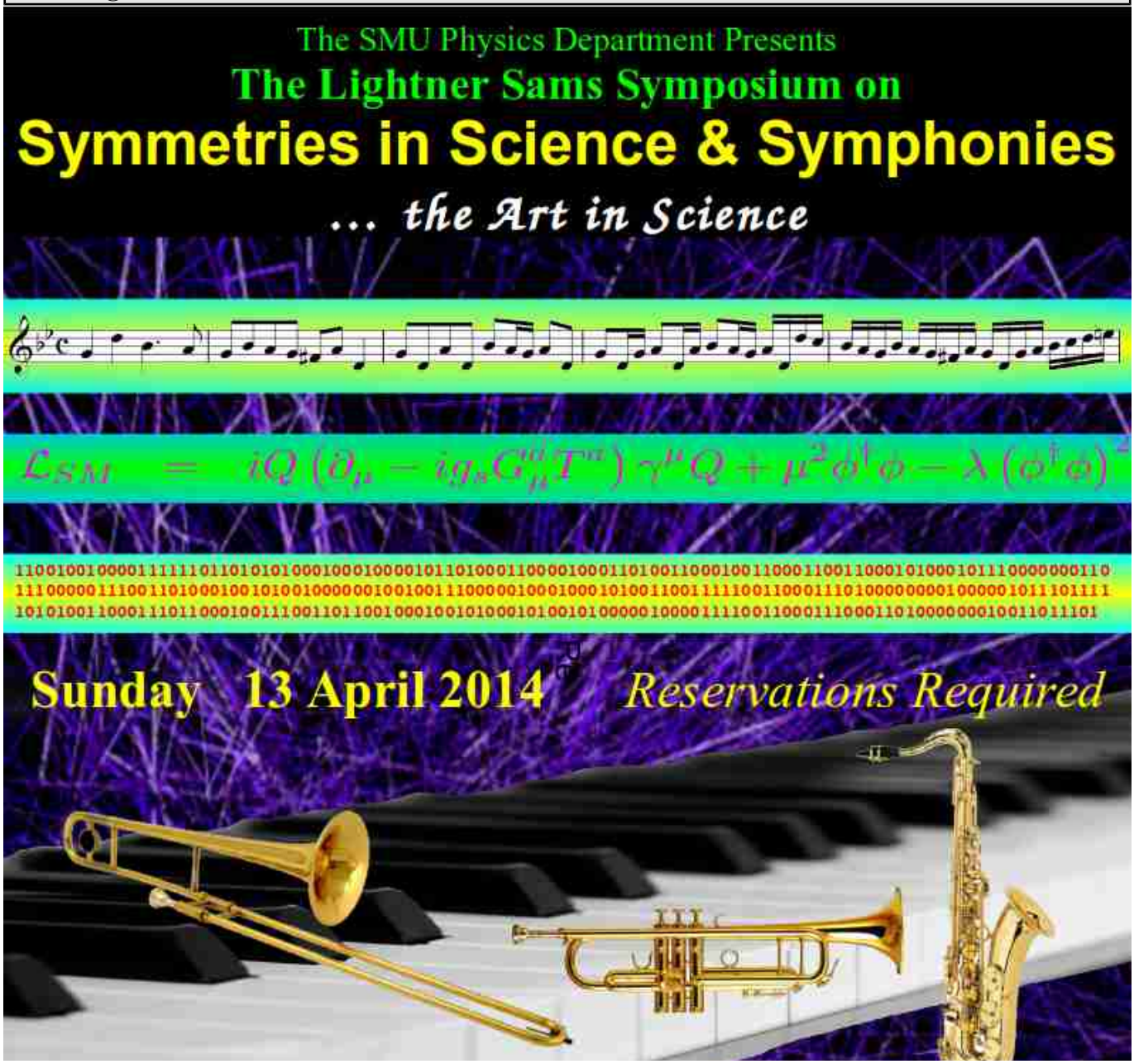
The Physics Department and SMU volunteers organized the **2014 Beal Bank Dallas Regional Science & Engineering Fair** together with several campus satellite events. Approximately 1,000 students were interviewed by 400 judges as they competed for more than $100,000 of prizes. The fair is led by President **Dalley** with support from Vice-Presidents **Scalise** and **Olness** and other faculty.

The Department is pleased to announce that graduate students **Ben Clark**, **Xiandong Zhao**, and **Li Zhou** have received the Lightner Sams Fellowship Award. Additionally, **Bowen Wang** received the Tittle Award to support conference travel this past year. **Dan Jardin** and **Jeff Hetherly** have received the **Physics Department Outstanding TA Award**.

To honor our undergraduate majors, Physics awarded the **Wiley Scholarship** to **Nicole Hartman**, the **Chalk Scholarship** to **Mayisha Nakib**, the **McDonald Award** to **Daniel Gum**, and the **Hyer Award** to **Ben Wise**.

Finally, many activities in the Department would not be possible without the generous support of our friends and alumni. On behalf of our faculty, staff and students, we express our thanks.

Fredrick Olness
Professor & Chair,
Dedman Family Distinguished Professor



This year's symposium features an eclectic mix of art and science with speakers that bridge these disciplines. There's no need for complex calculations to appreciate Bach, Beethoven, or the blues as we highlight the natural synergy between musical patterns and mathematical relations describing scientific phenomena. Cross-fertilization of disparate disciplines can provide new insights, and thus new solutions, to real-world problems.

Join us for an intriguing evening.

Lightner Sams Symposium
Sunday, 13 April 2014
Time: 6:00pm Reception
6:30pm Banquet
Reservations Required

Contact the Physics Department for details
`www.physics.smu.edu`
(214) 768-2495

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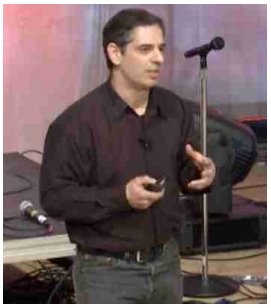
Symmetries in Science & Symphonies: Guest Lecturers

Scott Douglas is a professor, researcher, educator and entrepreneur with a lifelong passion and interest in sound and music. He is a Professor with the SMU Department of Electrical Engineering, and is also the Associate Director for the Institute for Engineering Education at SMU. He developed one of the first successful procedures for the active cancellation of sound in a room. He regularly consults with companies all over the world on topics related to his research interests, which focus on the processing of acoustic signals for sound and vibration control, speech enhancement, and spatial understanding. He has given lectures on digital music and sound engineering to audiences young and old across the US, and has been featured in live and recorded radio and television shows including NPR and WFAA-TV. An avid singer and musician, Scott's preferred instrument is the saxophone, and while he loves all forms of music, his favorite is jazz.

Ira Greenberg is the Director for the Center of Creative Computing, and holds a joint appointment in SMU's Meadows School of the Arts and the Lyle School of Engineering. With an eclectic background combining elements of painting and programming, Professor Greenberg has been a painter, 2D and 3D animator, print designer, web and interactive designer/developer, programmer, art director, creative director, managing director, art professor, and author. Professor Greenberg's research and teaching interests include aesthetics and computation, expressive programming, emergent forms, net-based art, artificial intelligence (and stupidity), physical computing, and computer art pedagogy (and anything else that tickles his fancy).



Fredrick Olness is a Professor in SMU's Physics Department, and his research is in theoretical elementary particle physics. He is an ardent music fan, and enjoys playing the trumpet. For the last 10+ years he has enjoyed mixing his vocation with his avocation combining Physics and Music in an introductory course that he team-teaches with Professor **Tom Tunks**.

Martin Sweidel is an Associate Professor of Composition and the Director of Electronic Music in SMU's Meadows School of the Arts. Professor Sweidel's music has been heard in performances throughout the country. Commissions have included Listen/Voices/Wind/Change for Voices of Change, A Stereo Fanfare for Polished Brass, and IX (nine) for Joseph Celli. Six of his video art collaborations with Donald Pasquella are included in the TV series Frame of Mind. His Split Shot Study No. 1 is recorded on CCG/CAGE Records, and Listen/Voices/Wind/Change is included in Main Street USA, a radio series on musical life in America produced for the Australian Broadcasting Corporation. Commercial music by Professor Sweidel includes electronic scores for the film The Last Witness and the documentary Adventures on the Planet Earth.

Thomas Tunks is a Professor of Music in SMU's Meadows School of the Arts, where he also served as Associate Dean for Academic Affairs. He also served SMU as Associate Provost for Educational Programs. His specialty is psychoacoustics and psychomusicology which integrates research on music perception, cognition, and neuroscience. This involves the scientific study of sound perception and the psychological and physiological responses associated with sound. Professor Tunks has been an editorial board member of The Quarterly Journal of Music Teaching and Learning and The Journal of Research in Music Education and was associate editor of Psychomusicology. In addition, he has held several offices with the Texas Council of the Arts in Education, including president in 2000.

SMU scientists celebrate Nobel Prize for Higgs discovery

Stroynowski explains the God Particle & the Big Bang.

Posted on October 8, 2013 by Kathleen Tibbetts

SMU's experimental physics group played a pivotal role in discovering the Higgs boson — the particle that proves the theory for which two scientists have received the 2013 Nobel Prize in Physics.

The Royal Swedish Academy of Sciences today awarded the Nobel Prize to theorists Peter W. Higgs and François Englert to recognize their work developing the theory of what is now known as the Higgs field, which gives elementary particles mass. U.S. scientists played a significant role in advancing the theory and in discovering the particle that proves the existence of the Higgs field, the Higgs boson.

The Nobel citation recognizes Higgs and Englert "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider."

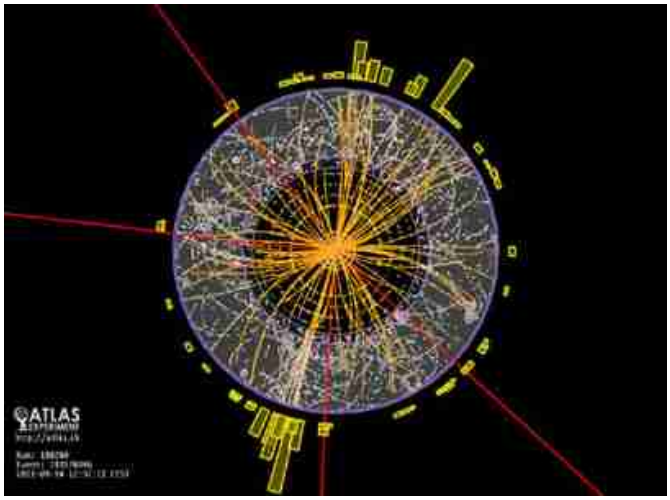
In the 1960s, Higgs and Englert, along with other theorists, including Robert Brout, Tom Kibble and Americans Carl Hagen and Gerald Guralnik, published papers introducing key concepts in the theory of the Higgs field. In 2012, scientists on the international ATLAS and CMS experiments, performed at the Large Hadron Collider at CERN laboratory in Europe, confirmed this theory when they announced the discovery of the Higgs boson.

"A scientist may test out a thousand different ideas over the course of a career. If you're fortunate, you get to experiment with one that works," says SMU physicist **Ryszard Stroynowski,** a principal investigator in the search for the Higgs boson. As the leader of an SMU Department of Physics team working on the experiment, Stroynowski served as U.S. coordinator for the ATLAS Experiment's Liquid Argon Calorimeter, which measures energy from the particles created by proton collisions.

The University's experimental physics group has been involved since 1994 and is a major contributor to the research, the heart of which is the Large Hadron Collider particle accelerator on the border with Switzerland and France.

SMU joins nearly 2,000 physicists from U.S. institutions — including 89 U.S. universities and seven U.S. Department of Energy laboratories — that participate in the ATLAS and CMS experiments, making up about 23 percent of the ATLAS collaboration and 33 percent of CMS at the time of the Higgs discovery. Brookhaven National Laboratory serves as the U.S. hub for the ATLAS experiment, and Fermi National Accelerator Laboratory serves as the U.S. hub for the CMS experiment. U.S. scientists provided a significant portion of the intellectual leadership on Higgs analysis teams for both experiments.

Preliminary discovery results were announced July 4, 2012 at CERN, the European Organization for Nuclear Research, near Geneva, Switzerland, and at the International Conference of High Energy Physics in Melbourne, Australia.



"It is an honor that the Nobel Committee recognizes these theorists for their role in predicting what is one of the biggest discoveries in particle physics in the last few decades," said Fermilab Director Nigel Lockyer. "I congratulate the whole particle physics community for this achievement."

The majority of U.S. scientists participating in LHC experiments work primarily from their home institutions, remotely accessing and analyzing data through high-capacity networks and grid computing. The United States plays an important role in this distributed computing system, providing 23 percent of the computing power for ATLAS and 40 percent for CMS. The United States also supplied or played a leading role in several main components of the two detectors and the LHC accelerator, amounting to a value of $164 million for the ATLAS detector, $167 million for the CMS detector, and $200 million for the LHC. Support for the U.S. effort comes from the U.S. Department of Energy Office of Science and the National Science Foundation.

"It's wonderful to see a 50-year-old theory confirmed after decades of hard work and remarkable ingenuity," said Brookhaven National Laboratory Director Doon Gibbs. "The U.S. has played a key role, contributing scientific and technical expertise along with essential computing and data analysis capabilities — all of which were necessary to bring the Higgs out of hiding. It's a privilege to share in the success of an experiment that has changed the face of science."

The discovery of the Higgs boson at CERN was the culmination of decades of effort by physicists and engineers around the world, at the LHC but also at other accelerators such as the Tevatron accelerator, located at Fermilab, and the Large Electron Positron accelerator, which once inhabited the tunnel where the LHC resides. Work by scientists at the Tevatron and LEP developed search techniques and eliminated a significant fraction of the space in which the Higgs boson could hide.

Several contributors from SMU have made their mark on the project at various stages, including current Department of Physics faculty members **Ryszard Stroynowski, Jingbo Ye, Robert Kehoe** and **Stephen Sekula**. Faculty members **Pavel Nadolsky** and **Fred Olness** performed theoretical calculations used in various aspects of data analysis. University postdoctoral fellows on the ATLAS Experiment have included **Julia Hoffmann, David Joffe, Ana Firan, Haleh Hadavand, Peter Renkel, Aidan Randle-Conde** and **Daniel Goldin**.

SMU has awarded eight Ph.D. and seven M.Sc. degrees to students who performed advanced work on ATLAS, including **Ryan Rios, Rozmin Daya, Renat Ishmukhametov, Tingting Cao, Kamile Dindar, Pavel Zarzhitsky** and **Azzedine Kasmi.**

Significant contributions to ATLAS have also been made by SMU faculty members in the Department of Physics' Optoelectronics Lab, including **Tiankuan Liu, Annie Xiang** and **Datao Gong**.

"The discovery of the Higgs is a great achievement, confirming an idea that will require rewriting of the textbooks," Stroynowski says. "But there is much more to be learned from the LHC and from ATLAS data in the next few years. We look forward to continuing this work." Higgs and Englert published their papers independently and did not meet in person until the July 4, 2012, announcement of the discovery of the Higgs boson at CERN. Higgs, 84, is a professor emeritus at the University of Edinburgh in Scotland. Englert, 80, is a professor emeritus at Universite Libre de Bruxelles in Belgium. The prize was announced at 5:45 a.m. CDT on Tuesday, Oct. 8, 2013.

Physics Research in the Mountains of Italy

*During April 2013, undergraduate physics students **Keith** and **Mayisha** traveled to L'Aquila and Gran Sasso, Italy, for the 2013 Low Radioactivity Techniques conference.*

Physicists walking back to the hotel from the conference with an inspiring view of the Apennine Mountains.

The 2013 Low Radioactivity Techniques conference was held at the Laboratori Nazionali del Gran Sasso, which is about an hour and a half northeast of Rome. The conference center is an above-ground facility in the middle of the beautiful snow-capped Apennine Mountains, where the air is fresh and our allergies start behaving. Eighty-five physicists from 13 countries around the world gathered at this conference to discuss experiments that require low radioactivity environments. Examples of such experiments include those dedicated to neutrino studies and dark matter searches.

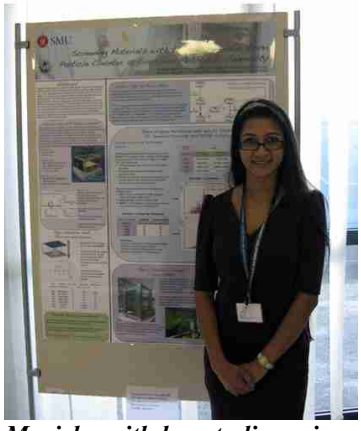
At the conference, we were able to learn more about the physics behind various experiments, including our own. We were pushed to understand components of experiments we were not familiar with: the designs of different detectors for neutrino studies and dark matter searches, scintillators, and distinguishing background noise from the decay of uranium and radon. We were also able to meet with researchers from different universities, some of whom we have been working with all along, but never met in person. The conference gave us a view of physics research around the world and various experiments including SuperCDMS.

A typical day of the conference would begin with a warm cup of Italian espresso and freshly baked chocolate croissants at the hotel. Physicists from three different hotels would then load onto the bus, which took us to the conference center. We watched **Professor Cooley** and Professor Loach (our collaborator on the Community Assays Database from Shanghai Jiao Tong University, China) give talks during the plenary sessions about background considerations for the SuperCDMS dark matter experiment and the Community Assay Database, and we absorbed as much of the information from the other talks as we could.

During coffee breaks, Professor Cooley would introduce us to various physicists and we got to participate in discussions and ask questions about low radioactivity physics. After the talks and poster sessions, we would head back to the hotel and meet for six-course dinners as one large family of physicists. At night, the stars would shine brightly over the mountains, making it a perfect time to sit outside and finish Dr. Scalise's Classical Mechanics homework.

The Poster Session: For the poster session, Keith presented the development of the Community Material Assays Database by Professors Cooley and Loach, and SMU undergraduates Ben, Matthew and himself. The database contains information on measurements of the radioactivity of various materials and will be used as a repository for future measurements and a reference for physicists around the world.

Mayisha presented initial studies using the XIA alpha particle counter housed in a clean room at SMU. The instrument is one of five such existing instruments in the world. It counts alpha particle emissions from various samples that are given off by radioactive decay, and can be used to screen materials for purity before they are used in the construction of dark matter detectors. The counter is also used to study various techniques for removing radon daughter particles from the surfaces of materials that scientists are considering for use in the next generation of dark matter experiments.



Mayisha with her studies using the XIA alpha particle counter.

We talked to several conference attendees one-on-one and answered several questions. We felt honored

to be working on research work that was significant enough to bring us to share our work and ideas.

On day three, we journeyed inside a mountain through tunnels 1,400 meters underground, and saw numerous experiments that are currently active in the largest underground laboratory in the world. These

Touring the world's largest underground laboratory

experiments are housed underground in order to shield them from cosmic rays that would be a source of background noise, which could interfere with the study. The goal for these low experiments is to detect particles that rarely interact with ordinary matter such as neutrinos, and dark matter candidates.

One of these experiments is the OPERA experiment. This experiment consists of layers of lead and emulsion that are used to identify tau neutrinos that have transformed from a beam of muon neutrinos sent all the way from CERN in Switzerland. The OPERA experiment made the news two years ago for finding neutrinos that appeared to travel faster than the speed of light, but the actual cause was a loose optical fiber cable. It was exhilarating to see these cables in person, since Professor Cooley explained the phenomenon in her introductory mechanics class.

Another experiment, ICARUS, has the same goal of studying neutrinos changing from one type of neutrino to another. However, ICARUS uses liquid argon instead of lead and emulsion and works similarly to a bubble chamber. As an undergraduate, it was amazing to see the colossal experiments we've learned about in class and during the conference.

After the conference, we had one last dinner with our newly expanded family of physicists Professor Schnee (Syracuse University) and Professor Cushman (University of Minnesota) whom we met at the conference.

We also had one day to discover Rome by foot ourselves. We managed to cover old Rome, the Roman Coliseum, and the Pantheon on a slow "pilgrimage" toward the Vatican to visit St. Peter's Basilica, the Vatican museum, and the Sistine Chapel. Apart from the works of Michelangelo and Raphael, there was a solid marble woman sculpted so that its texture made it appear that she was sweating and her clothes were sticking to her. It was such delicate detail in such a lifeless material, it made us wonder how the artist managed to achieve such an effect.

On the way back to the city center, we went by the Spanish Steps and the Trevi Fountain. We discovered the divine pleasure that is pistachio gelato and Italian green olives. One of our favorite things to do is probably walk into churches while people are singing and listening to the Italian music.

One Day to Roam Around Rome with Romans

Grateful for the opportunity: This conference was by far the most significant event of our undergraduate careers. It is unlikely we will come across such an opportunity like the LRT conference again. Preparing for the conference challenged us to really master and question what we know about our research. Professor Cooley, Dr. Silvia Scorza, Hang Qiu, and Bedile Kara drilled us on questions we may be asked so that once we were in Italy we could speak with confidence and accuracy. Overall, we believe we made a good impression at the conference and left as better scientists with more knowledge than when we came. In return, we left our own small contributions to the vast physics world.

We are extremely grateful to the Hamilton Undergraduate Research Program and the Assays and Acquisition of Radiopure Materials (AARM) Collaboration for providing funds to make this trip possible.

Fiber-optic data link, is critical in the hunt for Big Bang's "God" particle

Posted on June 29, 2012: — Margaret Allen

A tiny optoelectronic module designed in part by SMU physicists plays a big role in the world's largest physics experiment at CERN in Switzerland, where scientists are searching for the "God" particle.

The module, a fiber-optic transmitter, sends the Large Hadron Collider's critical raw data from its ATLAS experiment to offsite computer farms. From there, thousands of physicists around the world access the data and analyze it for the long-sought-after particle, the Higgs boson.

Dr. Annie Xiang

Now as a result of SMU's role on the LHC data link, SMU Physics Research Professor **Annie Xiang** has won a three-year research and development grant with $67,500 in support annually from the U.S. Department of Energy to advance the design of the optoelectronic module.

The grant calls for a customized multi-channel optical transmitter that can be deployed on many of the world's high-energy particle detectors.

Xiang is principal investigator for SMU's Data Links Group in SMU's Physics Department, working in the Optoelectronics Lab of Physics Professor **Jingbo Ye**. She coordinates the lab's development of optical data transmission systems for particle physics experiments.

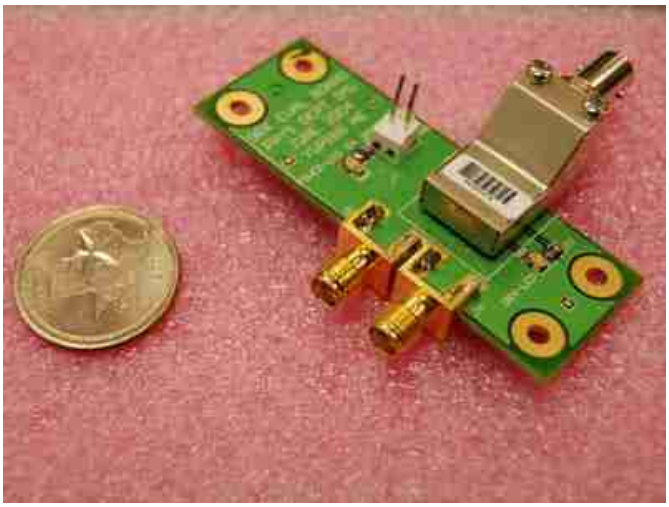
More than 1,500 data link modules are installed on ATLAS. "We made the first-generation fiber-optic data link specifically for ATLAS and its extremely harsh low-temperature, high-radiation environment," Xiang said.

More than 1,500 of the first-generation data link modules are installed on the calorimeter detectors of ATLAS. The link's job is to reliably offload a continuous flood of raw data without failure or error. Scientists scour the data for signs of the Higgs boson, which has been theorized for decades but never actually observed. It is believed the Higgs gives mass to the matter that we observe.

A second-generation data link, which SMU also helped design, is slated for deployment in the next upgrade of the LHC in coming years. The current data link installed in ATLAS can transmit up to 1.6 gigabits a second in a single channel, which equates to writing an HD DVD in one minute, Xiang said. The second-generation link, a 5 gigabit transceiver, has a smaller footprint than the current link, but can transmit three times faster and is qualified for even higher radiation. "Many thousands of the second-generation link can be expected across the LHC detectors," Xiang said.

The data link being supported by DOE will be even faster. A transmitter only, it will have a transmission capacity of 120 gigabits a second, or 75 times faster than the data link currently installed on ATLAS, Xiang said.

DOE project will customize off-the-shelf commercial components for on-detector installation



The SMU fiber-optic data link was made specifically for ATLAS and its extremely harsh low-temperature, high-radiation environment. (Credit: smuresearch.com)

To design the links, SMU's team and its collaborators start with qualified commercial transmitters and receivers, then customize them for the LHC detectors, Xiang said. They will repeat that process to develop the data link being supported by DOE.

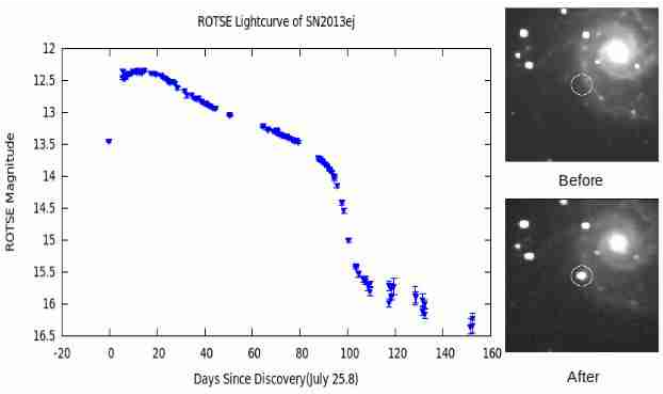
Called a "generic" module, the link supported by DOE isn't specified for any particular detector, but rather will be available to deploy on detectors at the LHC, at Fermi National Accelerator Laboratory (Fermilab) and others.

The module — a 12-channel transmitter — must be high speed and low footprint, and able to withstand an extremely cold and high-radiation environment, while at the same time maintaining low mass and low power consumption, Xiang said.

Ye and Xiang are members of SMU's ATLAS team, which is led by SMU Physics Professor R**yszard Stroynowski.**

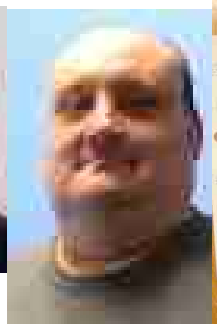
SMU Discovers More Supernovas with Robotic Telescope

In 2013, SMU officially assumed the ownership of the ROTSE-IIIb telescope located at McDonald Observatory near Ft. Davis, TX and 2013 proved to be a good year for the ROTSE (Robotic Optical Transient Search Experiment) project at SMU as we discovered five supernovae, observed two cataclysmic variable stars within the Milky Way, and also observed several optical counterparts of gamma-ray bursts (GRBs). Among the supernovae observations, ROTSE-IIIb was credited with the pre-discovery detection of the bright supernova SN 2013ej in the relatively nearby galaxy M74 (about 30 million light-years distant). Graduate student **Govinda Dhungana** and **Dr. Robert Kehoe** have been collaborating with several universities in the U.S. and internationally on photometric and spectroscopic analysis of SN2013ej. SN 2013ej was classified as a Type IIP core collapse supernova and was observed to maintain nearly uniform brightness for about 100 days before transitioning to a dimmer nebular phase.



ROTSE light curve of SN 2013ej, and ROTSE images of M74 before and after the eruption of SN2013ej.

Govinda Dhungana



Farley Ferrante

Prof. Robert Kehoe

Another interesting supernova discovery was SN 2013dz, a type IIn core collapse supernova, which Dhungana suspects to be a superluminous event. Detailed analysis of both photometric and spectroscopic data continues. Other supernovae observed by ROTSE-IIIb include SN 2013bu (another Type II core collapse event), SN 2013ag (a high velocity Type Ia), and SN 2013X (a Type Ia-91T possibly resulting from the merger of two white dwarf stars).

Also in 2013, we observed the outburst of a cataclysmic variable star and probable dwarf nova, ROTSE3 J203225+602837, previously discovered by ROTSE in July 2009. Additionally, we observed a super-outburst of the dwarf nova AL Com in the constellation Coma Berenices. Several outbursts and super-outbursts of AL Com have been reported over the years, the last of which occurred in 2007.

Two supernova detections in January 2014 got the new year off to a promising start. ROTSE-IIIb recorded the earliest observation of SN 2014J. This event, which occurred in the nearby galaxy M82 (about 11 million light-years distant), generated much attention among both amateur and professional astronomers as it was the closest supernova to Earth observed since SN 1993J at a similar distance in M81, a companion galaxy to M82. Prior to that the nearest supernova observed in recent history was SN 1987A in the Large Magellanic Cloud. Though we were not credited with the discovery of SN 2014J, the pre-discovery detection that we reported will be crucial in constraining the time of explosion. Then just five days later, ROTSE-IIIb imaged a supernova candidate, PSN J11544229+4401181, which has yet to be confirmed and classified.

We also observed several gamma-ray bursts (GRBs) during the past year. GRBs are flashes of gamma radiation associated with highly energetic explosions observed in distant galaxies. GRBs are the brightest electromagnetic events known to occur in the universe and are the most energetic events since the Big Bang. Bursts can last from a few milliseconds to several minutes and the initial burst is usually followed by a longer-lived afterglow emitted at longer wavelengths including optical. ROTSE-IIIb responded to multiple triggers from orbiting satellites such as Swift and observed the optical afterglow for three GRBs (GRB 130215A, GRB 130420A, and GRB 140129A). Graduate student and ROTSE-IIIb operations coordinator **Farley Ferrante** prepared and submitted GCN (Gamma-ray Burst Coordinates Network) observation report circulars for these events.

Ghostly Particles That Constantly Bombard Us Can Offer Clues To Early Moments Of Universe

NOvA Experiment Glimpses Neutrinos

One Of Nature's Most Abundant, And Elusive Particles

By Margaret Allen; Feb. 17, 2014. DALLAS (SMU)

Scientists hunting one of nature's most elusive, yet abundant, elementary particles announced today they've succeeded in their first efforts to glimpse neutrinos using a detector in Minnesota.

Neutrino path from Fermilab to Minnesota.

Neutrinos are generated in nature through the decay of radioactive elements and from high-energy collisions between fundamental particles, such as in the Big Bang that ignited the universe. Light and ghostly, however, they are unaffected by magnetic fields and travel at the speed of light. The neutrinos that currently bombard Earth from space are mostly produced by the nuclear reactions that power our sun.

More than 200 physicists from around the world collaborate on the massive neutrino experiment called NOvA, which has taken a decade to design and build. Their goal is to discover more details about neutrinos, which were theorized in 1930 and first observed in 1956.

"These first few neutrino events are a confirmation that NOvA's basic detector design and construction that dozens of people have worked on for a good fraction of a decade are sound," said **Thomas E. Coan**, an associate professor in the SMU Department of Physics, who is a researcher in the NOvA collaboration.

Studying neutrinos could yield crucial information about the early moments of the universe, Coan said.

"Neutrinos are fascinating. They are, besides light, the most numerous particle in the universe yet are notoriously difficult to study since they interact with the rest of matter so feebly," he said. "Produced in many venues, from laboratories to stars and even bones, they may be their own anti-particles and perhaps play a key role in explaining why any matter at all exists today and survived annihilation with its sister anti-matter produced all the way back in the Big Bang, many billions of years ago."

Prof. Thomas Coan

NOvA is the world's longest-distance neutrino experiment: The NUMI Off-Axis electron neutrino Appearance, or NOvA, is the world's longest-distance neutrino experiment. It consists of two huge particle detectors placed 500 miles apart, and its job is to explore the properties of an intense beam of neutrinos.

"NOvA represents a new generation of neutrino experiments," said Fermilab Director Nigel Lockyer. "We are proud to reach this important milestone on our way to learning more about these fundamental particles."

Scientists generate a beam of the particles for the NOvA experiment using one of the world's largest accelerators, located at the Department of Energy's Fermi National Accelerator Laboratory near Chicago. They aim this beam in the direction of the two particle detectors, one near the source at Fermilab and the other in Ash River, Minn., near the Canadian border. The detector in Ash River is operated by the University of Minnesota under a cooperative agreement with the Department of Energy's Office of Science.

Billions of those particles are sent through the earth every two seconds, aimed at the massive detectors. Once the experiment is fully operational, scientists will catch a precious few each day.

"It is both intellectually and emotionally satisfying," said SMU's Coan, "akin to a great

adventure, to be detecting neutrinos in Northern Minnesota that are produced some 500 miles to the south at Fermi National Laboratory near Chicago, after making thousands of engineering and scientific decisions that had to be spot-on to see these events."

Scientists will use NOvA to understand three changing flavors of neutrinos: Neutrinos are curious particles. They come in three types, called flavors, and change between them as they travel. The two detectors of the NOvA experiment are placed so far apart to give the neutrinos the time to

The NOvA detector stands about 50 feet tall and 50 feet wide. (Credit: Fermilab)

oscillate from one flavor to another while traveling at nearly the speed of light. Even though only a fraction of the experiment's larger detector, called the far detector, is fully built, filled with scintillator and wired with electronics at this point, the experiment has already used it to record signals from its first neutrinos.

"That the first neutrinos have been detected even before the NOvA far detector installation is complete is a real tribute to everyone involved," said University of Minnesota physicist Marvin Marshak, Ash River Laboratory director. "This early result suggests that the NOvA collaboration will make important contributions to our knowledge of these particles in the not so distant future."

Once completed, NOvA's near and far detectors will weigh 300 and 14,000 tons, respectively. Crews will put into place the last module of the far detector early this spring and will finish outfitting both detectors with electronics in the summer.

The NOvA collaboration is made up of 208 scientists from 38 institutions in the United States, Brazil, the Czech Republic, Greece, India, Russia and the United Kingdom. The experiment receives funding from the U.S. Department of Energy, the National Science Foundation and other funding agencies.

The NOvA experiment is scheduled to run for six years. Because neutrinos interact with matter so rarely, scientists expect to catch just about 5,000 neutrinos or anti-neutrinos during that time. Scientists can study the timing, direction and energy of the particles that interact in their detectors to determine whether they came from Fermilab or elsewhere.

"Seeing neutrinos in the first modules of the detector in Minnesota is a major milestone"

Fermilab creates a beam of neutrinos by smashing protons into a graphite target, which releases a variety of particles. Scientists use magnets to steer the charged particles that emerge from the energy of the collision into a beam. Some of those particles decay into neutrinos, and the scientists filter the non-neutrinos from the beam.

Fermilab started sending a beam of neutrinos through the detectors in September, after 16 months of work by about 300 people to upgrade the lab's accelerator complex.

Different types of neutrinos have different masses, but scientists do not know how these masses compare to one another. A goal of the NOvA experiment is to determine the order of the neutrino masses, known as the mass hierarchy, which will help scientists narrow their list of possible theories about how neutrinos work.

"Seeing neutrinos in the first modules of the detector in Minnesota is a major milestone," said Fermilab physicist Rick Tesarek, deputy project leader for NOvA. "Now we can start doing physics."

Women in Physics Conference

Acacea and Nicole at the conference in Austin

Two undergraduate students majoring in physics in Dedman College of Humanities and Sciences attended the Undergraduate Women in Physics Conference in January in Austin. This trip was funded by the SMU Physics Department, and the conference was funded by the National Science Foundation.

Meeting women in physics:
Posted on January 29, 2013
by Women in Physics Conference, Austin
An update from Acacea, a sophomore physics major:

When I first heard about the South Central Conference for Undergraduate Women in Physics, I was rather unsure about attending. I felt I was unworthy to attend as a sophomore without an extensive knowledge of physics and a research background. Additionally, the round-trip flight I took from Dallas to Austin was the first time I have flown and the only time I have traveled to another city alone, which was very exciting.

However, when I arrived, I soon realized that the conference was for any woman in physics – from the freshman to graduate level – and it was meant to motivate women in physics, rather than "lecture at them" about topics over their heads.

When I arrived at the check-in dinner for SCUWiP, I met several young physics majors from many different walks of life, physics professors and industry leaders who all seemed excited to meet me and rather interested in my research. Later that night, Nicole, my SMU roommate for SCUWiP, arrived and joined us to listen and participate in the Cutting Edge Science lecture.

When one of the CES lecturers, Dr. Risa Wechsler, gave a talk on galaxy formation, a few undergraduates were given the opportunity to speak with her later at the networking dinner and were able to ask her questions and discuss astrophysics in depth, which was a real treat.

Of course, the schedule throughout the conference was quite rigorous, and if I hadn't made a habit of waking up early, then the next morning around 7 a.m. I might not have been ready.

During the early breakfast at UT, Nicole and I met other physics majors from Baylor and UTSA, whom we would stick with throughout the conference.

After breakfast on the second day of the conference, several Cutting Edge Science lectures were given. I most enjoyed Dr. Ann Nelson's "Topics in High Energy Physics," considering the fact that I enjoy the notion of studying particle physics equally as much as astrophysics.

The conference's undergrad student talks gave me an inside look at what other physics majors are doing in research and gave me some ideas of my own to explore. For example, before a presentation on noise abatement inventions for Shell, I would have never thought about using physics to help marine life by regulating noise on drilling ships with specialized bubbles/balloons to dampen sound.

Ultimately, my favorite part of the conference was visiting the Texas Petawatt Laser and learning about atomic and optical physics from Dr. Todd Ditmire. Not only did I learn that the laser itself can produce light brighter than Gamma Ray bursts, but that it can reach temperatures hotter than the center of the Sun.

In addition to being an exciting conference, it was very useful. I feel like the career panel and Dr. Crystal Bailey's talk on physics careers was by far the most helpful part of the conference. Personally, I was surprised that until I had attended the conference, I had no idea that grad school was virtually "free" and that business and industry jobs in physics have a higher starting salary than many jobs in academia.

After attending the conference, I think that Nicole and I can both agree that every woman in physics should attend at least one of these conferences because without them, we would fail to see that there are people out there struggling just like us, and that we can learn from their mistakes in order to better ourselves as female physicists and students.

2013 Beal Bank Dallas Regional Science & Engineering Fair

2013 Grand prize winning students. Those in senior division are offered a scholarship to attend SMU.

Faculty, staff, and students of the SMU Physics Department organized the 2013 Beal Bank Dallas Regional Science & Engineering Fair (DRSEF). Nearly 1,000 middle and high school students who won through from their school fairs, together with 400 judges, registered from the Dallas area. They gathered at Fair Park on February 23 to exhibit and compete for $100,000 in prizes.

Competition winners, together with their parents and teachers, were later hosted on SMU campus at an awards banquet. Over 400 people attended in Hughes-Trigg student center, where they were addressed by Dean of Lyle Engineering School, Marc Christensen, and SMU physicist Jodi Cooley.

Over 100 students who placed in their science category at the DRSEF went on to the Texas state science fair, winning both best in fair titles and accounting for 29% of all placements (double that of other large urban regions in Texas). 7 out of 9 projects from DRSEF that went on to the International Science Fair also placed there.

Beal Bank
Dallas Regional Science and Engineering Fair
DRSEF

The DRSEF is governed by fair President **Simon Dalley**, assisted by Vice-Presidents **Fred Olness** and **Randy Scalise**, and is sponsored by Beal Bank, SMU, Fluor, Maxim Integrated and about 50 other organizations.

Website: www.drsef.org

SMU Hosts Master Physics Teacher Certificate Program

Simon Dalley illustrates a concept.

The Master Physics Teacher Certificate (MPTC) continues in 2013 and beyond with new support from the **Hoglund Foundation** and the **Fluor Foundation**. The program is organized by Prof. **Simon Dalley** with instruction provided by Dalley, **Randy Scalise**, **Farley Ferrante** and **Dara Williams-Rossi** (Simmons School) as well as guest lectures from other physics department faculty.

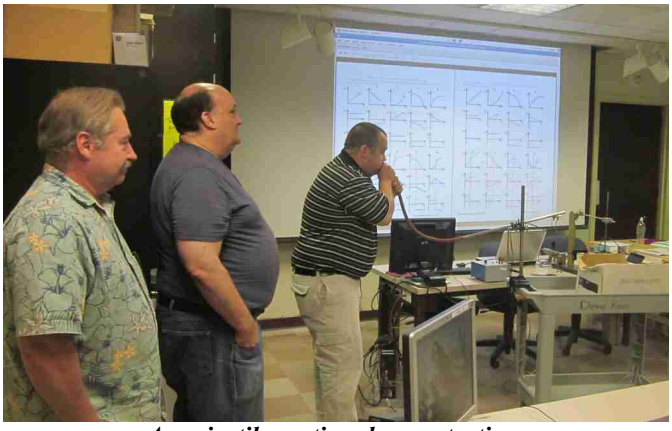
This SMU Physics MPTC initiative seeks to systematically strengthen the physics content of existing career science teachers who are teaching out of subject. They are brought into contact with experienced physicists who strengthen their physics background, giving them ideas, sources and materials that they can use in their classrooms.

Participants in the MPTC Program

The MPTC program differs from traditional professional development offerings. It is much more physics-content-focused, sustained, systematic, and modern in content. Given that the participants are currently career teachers, the efficiency of the program for producing better teachers who will serve in our schools is a guaranteed 100%.

Simon Dalley with the MPTC participants.

This is done via team-taught courses in the SMU Physics Department. The program began in 2012, and is jointly supported by **Dedman College** and the **Simmons School of Education & Human Development**. The curriculum draws from successful elements of introductory physics courses and from the existing SMU Physics QuarkNet summer workshop program for physics teachers.



A projectile motion demonstration.

SMU Lead Faculty:

Simon Dalley
Farley Ferrante
Randall Scalise
Dara Williams-Rossi

SMU Physics Summer QuarkNet Program

August 2013 – The SMU Particle Physics Group in Dedman College sponsored its annual QuarkNet activities this summer for local high school physics teachers and students. The week of August 5-9, 2013 held the workshop, an event organized annually since 2001, and new this year was a summer-long research project carried out by the students. This year there were 18 teachers and 10 students from Dallas area public and private schools.

Cosmic Ray Detector

During the workshop, teachers heard talks from SMU and UT Arlington professors on particle accelerators and detectors. Prof. **Joe Izen** presented by video-link from his CERN lab where his group is updating the pixel detector of the LHC. Prof. **Ryszard Stroynowski** gave a particle physics introduction during the CMS e-lab mini-workshop, during which QuarkNet LHC Fellow Shane Wood spend 2 days familiarizing the teachers with this source of real LHC data for use in the classroom.

Teachers also constructed and tested with cosmic rays and radioactive sources their own simple cloud chamber using an upturned fish tank. They also went on a half-day field trip to the crystallography lab and radiology lab at UT Southwestern to see the medical applications of particle physics.

Teachers **Darren Carollo, Bruce Boehne, Valerie Thomas,** and **Evelyn Restivo** presented on their summer research activities, and teacher **Janee Hall** presented on the Dark Matter research work she did with SMU Professor **Jodi Cooley** during the summer.

Summer High School Students

Eight high school students supervised by teacher **Trina Cannon** spent the summer doing research in the SMU Physics Department's Opto-Electronics lab. Working with physicists **Datao Gong, Tiankuan Liu,** and **Chu Xiang,** the students tested commercial and customized photonic components for potential use in the optical data link updates in the ATLAS LAr Calorimeter. Every week, the students participated in the lab group meeting to report on their learning and test findings. Each gave a short talk to the SMU faculty and to the QuarkNet teachers during the workshop. We expect their project results to be publishable.

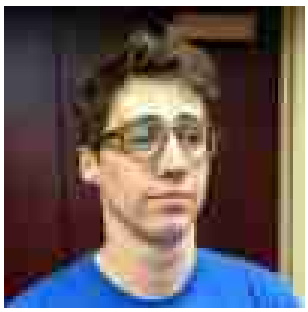
At work in the lab.

The QuarkNet program is organized by Dr. **Simon Dalley** and funded by the National Science Foundation. Other faculty mentors include Drs. **Fred Olness** and **Randy Scalise** (SMU Physics).

http://www.physics.smu.edu/sdalley/quarknet

Lightner Sams Graduate Fellowship Awards

The Lightner Sams Foundation has provided funds for Fellowships for outstanding graduate students in Physics. The 2013-14 recipients are **Benjamin Clark, Li Zhou,** and **Xiandong Zhao.**



Benjamin Clark

Fellow Benjamin Clark is studying Deep Inelastic Scattering (DIS) of leptons from heavy targets, which are used extensively to constrain Standard Model (SM) parameters and determine the nucleon structure functions. More specifically, he is making predictions for electroweak boson production via Pb-Pb collisions at the LHC. Additionally, he is also developing a Mathematica interface to the Parton Distribution Functions (PDFs) to facilitate calculations, comparisons and data analysis.

Li Zhou

Fellow Li Zhou is currently working on the ATLAS experiment Liquid Argon front-end signal process simulation with Xiandong Zhao and Datao Gong. He is also working on the measurement of the Z boson and W boson backgrounds in the study of the Higgs particle at ATLAS.

Xiandong Zhao

Fellow Xiandong Zhao is working with Professor Jingbo on the ATLAS Experiment to search for resonant W and Z bosons production in the leptons decay channel using LHC collision data collected by the ATLAS detector, which is one of the seven particle detectors constructed at the Large Hadron Collider in Switzerland. He also works with Li Zhou and Datao Gong to improve the algorithms for energy calibration of signals from the Liquid Argon calorimeter. Separately, in the SMU Opto-Electronics laboratory, he designed a 3D model adapted to the special requirements of the electronic components.

William (Bill) Tittle Graduate Awards

This award is named in honor of former Physics Professor & Chair, William (Bill) Tittle, and it provides support for graduate students for travel to conferences and workshops. The 2013 Tittle Awards included support for graduate students **Benjamin Clark, Eric Godat,** and **Bowen Wang** to attend the CTEQ School on QCD and Electroweak Phenomenology which was held at the University of Pittsburgh, Pennsylvania, 7 – 17 July 2013. These students are working with Professors Nadolsky and Olness on phenomenology of parton interactions to characterize the data from the LHC and Tevatron experiments.

The Wiley Scholarship

Nicole Hartman

We are pleased to announce that **Nicole Hartman** is the 2013-14 recipient of the Wiley Scholarship. Nicole is a sophomore at majoring in physics, math, and electrical engineering. She conducts research with Prof. **Stephen Sekula** investigating the decay of two Z bosons to two muons and two jets for insights that it may lead to the decay of two Higgs boson particles. After graduation Nicole hopes to attend physics graduate school to become a particle physicist.

The Chalk Scholarship

Mayisha Nakib

We are pleased to announce that **Mayisha Nakib** is the 2013-14 recipient of the Chalk Scholarship. Mayisha is working on research with **Prof. Jodi Cooley** to improve our understanding of the universe by deciphering the nature of dark matter. Prof. Cooley and her colleagues operate sophisticated detectors in the Soudan Underground Laboratory, MN. The scholarship will provide support for a conference trip to present her work.

The Hyer Award

We are pleased to announce that **Ben Wise** is the 2013-14 recipient of the Physics Department Hyer Award. Ben is a 3rd year majoring in Physics, Mathematics, and Mechanical Engineering, and a member of the University Honors Program. This award was established in honor of SMU's first president Robert Stewart Hyer.

The McDonald Award

We are pleased to announce that **Daniel Gum** is the 2013-14 recipient of the Physics Department McDonald Award. Daniel is a 2nd year Physics major. This award was established in honor of Frank C. McDonald, Chair of the Physics Department 1941-1962.

SMU Physics Outstanding TA Award

We are pleased to announce that **Jeffrey Hetherly and Daniel Jardin** are the 2013-14 recipients of the SMU Physics Department Outstanding TA Award.

Jeff is studying the b-jet trigger algorithm timing with Professor Stephen Sekula for the ATLAS experiment. This is a critical aspect to the performance of the trigger systems for the LHC. Currently he is examining how the jet and tracking online software components perform relative to the

b-jet tagging algorithms. He is also investigating the Higgs boson's self-coupling by looking at four jet final states; this work is in collaboration with Profs. Sekula and Stroynowski.

Dan is a first-year graduate student from Hebron, Connecticut, and he received his undergraduate degree from Syracuse University. He was the TA for our Physics 1301 *Ideas of Modern Physics* with Professor Simon Dalley. He was responsible for supervising the labs as well as grading the weekly homework and lab reports.

He is planning to start his research with with Professor Jodi Cooley as as part of CDMS experiment; one of many collaborations searching for dark matter.

The Amazing SMU Physics Circus

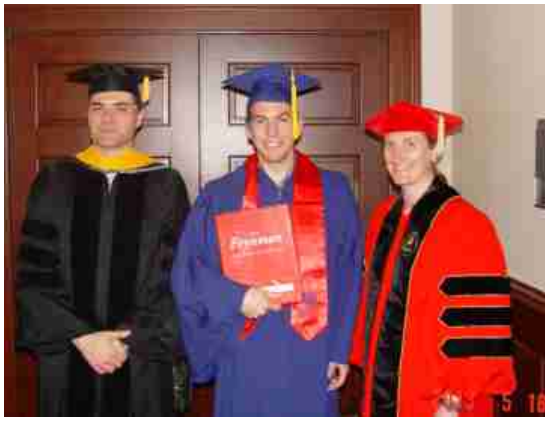
Check us out on YouTube.com

Dr. Randy Scalise blows off some steam.

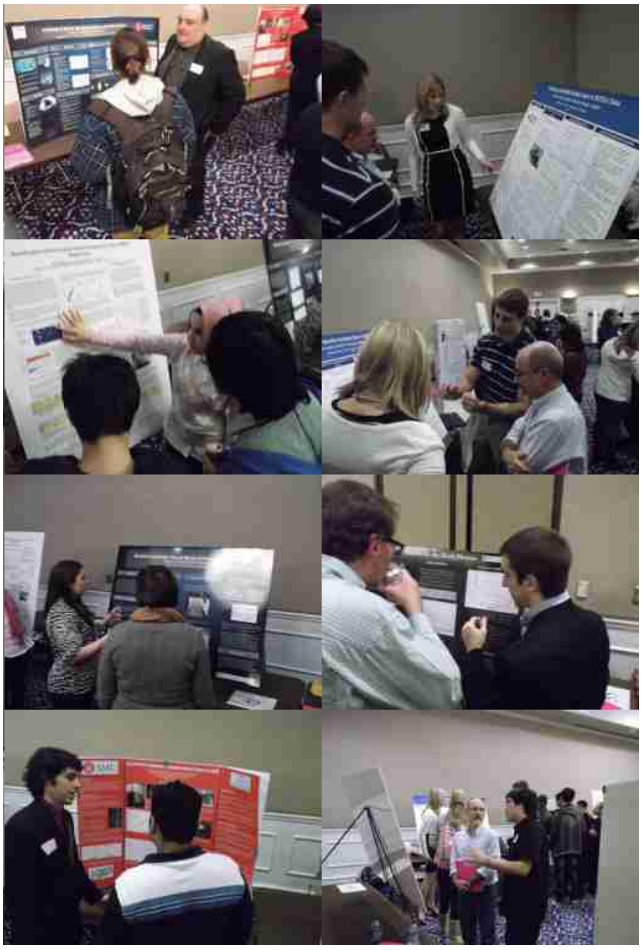
Dr. Fred Olness on the rocket cart.

SMU Physics Photo Gallery

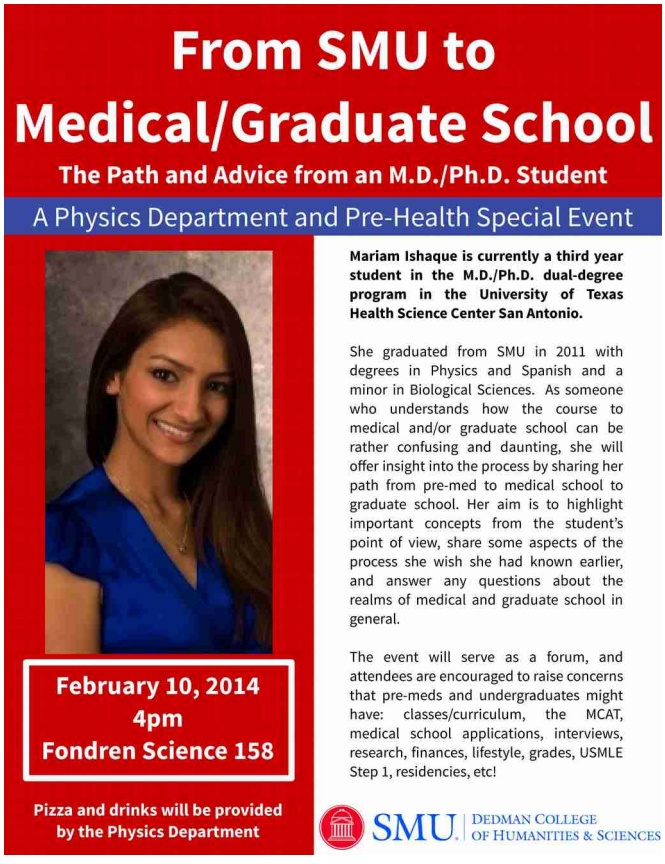
Dr. Simon Dalley received the
2014 Provost Teaching Recognition Award.
Pictured here with President Turner and Provost Ludden.



Garrett Bockman with
Profs. Nadolsky (L) and Cooley(R)



Research Day Collage



Many thanks to SMU alum Mariam Ishaque (2011), who discussed her path to medical school and advice to current pre-health students on finding their path to medical school.

Members of The SMU Department of Physics faculty gathered to watch the web-cast of the Higgs Boson presentations. *[From left to right in photo: Ryan Rios, Prof. Sekula, Prof. Stroynowski, Prof. Kehoe, Prof. Olness, Prof. Nadolsky, Marco Guzzi, Aleksander Kusina, Benjamin Clark, Jun Gao..]*

Thank You For Keeping In Touch:

The physics department now has a regular, "*Mustang Physics"* audio podcast:
http://blog.smu.edu/mustangphysics

We are looking for alumni contributions to the program. If you are interested, please contact Professor Stephen Sekula at **ssekula@smu.edu** or (214)-768-7832

Thanks to all of you who updated your contact information for our records. You can find recent news at our web page**.** We request that you:

- Inform us of any address changes in the future so we can stay in touch.
- Put us in touch with others who would like to receive the Physics Newsletter.
- Help us recruit both undergraduate and graduate students by putting us in touch with any prospective candidates.

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