

March 25, 2009

Dear Alumni and Friends:

Greetings! I hope this summer finds you all well and, once again, eagerly awaiting news from the physics program. The past academic year was an exciting one for physics at The U.

DUSEL Update

As hoped for in last year's letter, this section will become a regular feature of the newsletter for many years in the future. Last July, July 11, 2007 to be exact, the National Science Foundation announced that the Homestake Mine in South Dakota was chosen as the preferred site for Deep Underground Science and Engineering Laboratory with an additional \$15 million provided to the Homestake Collaboration to develop detailed plans for the facility. The full cost of constructing DUSEL at Homestake will be several hundreds of millions of dollars and will require the approval of the National Science Foundation, the National Science Board, the White House and Congress, which could take many years. However, South Dakota has a bit of a head start thanks to the donation of T. Denny Sanford, and the commitment by the state to proceed with early entry to the 4850-ft level.

A great deal of progress has already been made toward early entry into the mine. In October, Dr. Jose Alonso was hired as the director for Sanford Lab. As the new lab director, he will be responsible for the startup and overall operation of the interim laboratory at the 4850-foot level, known as Sanford Lab. Pumping of water began in March, and optimistic estimates suggest that experiments may begin to move underground in early 2009.

South Dakota Public Broadcasting featured Homestake on an episode of South Dakota Focus this June. I was fortunate to participate in a panel, which included Governor Rounds, Dr. Bill Roggenthen (SDSM&T), Bill Harlan (Sanford Lab – Public information Officer), and Tom Nelson (mayor of Lead, SD). We had a great time discussing the implications of a Deep Underground Lab for economic development, physics research, and science education in South Dakota. A few days earlier, the Particle Physics Project Prioritization Panel (P5) released their report in which several recommendations focused on experiments planned for Homestake.

Research Activities

The Nuclear and Particle Physics group continues to be productive. During the past year, the group submitted several major proposals including two DOE-EPSCoR proposals connected to activities at Sanford Lab. Dr. Mei received notification that his DUSEL R&D proposal, which was submitted to NSF, has been recommended for funding. The project will measure external sources of background at Homestake, and is an essential component for any Double Beta Decay or Dark Matter Experiments located underground. Both Dr. Mei and Dr. Sun were awarded Applied Research & Commercialization Grants from our Office of Research, which were matched by funds from Los Alamos National Lab to explore fundamental questions related to Dark Matter Detection. Dr. Mei also received a Competitive Seed Grant from the Board of Regents to study argon depletion techniques for dark matter experiments.

Dr. Mei published two papers this past year, one in *Astroparticle Physics* entitled "A Model of Nuclear Recoil Scintillation Efficiency in Noble Liquids" and another in *Physical Review C* entitled "Nuclear Inelastic Scattering Processes as a Background for Double Beta Decay Experiments."

Dr. Sun published a paper entitled "Magnetic g tensors for the $^4I_{5/2}$ and $^4I_{3/2}$ states of $\text{Er}^{3+}:\text{Y}_2\text{SiO}_5$ in *Physical Review B*. He was also invited to spend a month in the research lab of Dr. Lorgere of the Université de Paris and was asked to deliver the keynote address at the 15th International Conference on Luminescence and Optical Spectroscopy of Condensed Matter (ICL08) in Lyon, France in July.

MNS Program

As the former Homestake gold mine in Lead, S.D. continues its transition into a Deep Underground Science and Engineering Laboratory (DUSEL), we also want to give K-12 teachers and students the opportunity to understand and participate in the exciting science occurring at DUSEL. As a first step in the process, we delivered a weeklong workshop for area K-12 teachers. The workshop, "Physics of Atomic Nuclei (PAN) – Underground," was presented by Dr. Peggy McMahan Norris, senior research scientist at Lawrence Berkeley National Laboratory. Along with Dr. Mei and me, Dr. Koppang of Chemistry and Dr. Ezrailson of the School of Education also contributed to the workshop, which satisfied an interdisciplinary science requirement for the Masters of Natural Science (MNS) program. We had Science teachers from South Dakota, Iowa and Nebraska spend the week learning the fundamentals of nuclear and particle physics, as well as the technical and engineering issues associated with constructing experiments in a deep underground environment.

During the workshop, teachers performed several experiments on nuclear radiation, including shielding and half-life measurements, and each teacher received a Geiger counter for their classrooms. They also built cloud chambers, which are used for detecting particles of ionizing radiation, to be used in their classrooms for demonstrations. The culminating workshop project included the construction of a cosmic ray detector, which will be housed at USD but available – by request – to science teachers in South Dakota for use in their classrooms. Funding for the workshop was provided by the South Dakota Board of Regents, The University of South Dakota, Black Hills State University, the U.S. Department of Energy, Lawrence Berkeley National Lab, the American Physical Society Forum on Education and the Contemporary Physics Education Project. The partially assembled cosmic ray detector is visible on the table in the picture below.



Participants and instructors in the PAN – Underground Workshop.

Lawrence Dedication

You may remember our first newsletter in the spring of 2002, in which we mentioned the wonderful celebration we had on campus to honor E.O. and John Lawrence, two of the U.'s most illustrious graduates. During the celebration, we renamed the Akeley Science Center to the Akeley-Lawrence Science Center, and restored the plaque of E.O. Lawrence to its spot next to Lewis Akeley in the foyer of the building. Unfortunately, a plaque of John Lawrence was not available at the time. We finally corrected the omission this fall when we added a plaque for John Lawrence to the foyer of Akeley-Lawrence Science Center.



Jim Lawrence with the plaques honoring his father, John and his uncle, E.O. Lawrence outside the lecture hall in Akeley-Lawrence Science Center.

As I reread the 2002 newsletter, I was reminded of a couple of interesting tidbits. Ken Lande presented one of the keynote speeches at the Lawrence Symposium in December of 2001 in which he discussed his work on solar neutrinos under Ray Davis at the Homestake Lab. In the fall of 2002, Ray Davis was awarded the Nobel Prize for his work on solar neutrinos. Ken was also an early champion for converting Homestake to a national underground lab once Barrick abandoned its gold mining enterprise at the lab. One of the enduring legacies of the 2001 Lawrence Symposium is the Lawrence Brothers Science Camp at USD. Every summer, we bring middle school students to campus and introduce them to the wonders of science. The summer of 2008 marked the seventh year, and the enthusiasm for the camp remains high among faculty and students alike.

Astronomy Day

Our Astronomy Day speaker for 2008 was Dr. Dan Hooper of Fermi National Laboratory. Dr. Hooper's talk was entitled "In search of our universe's missing mass and energy", and discussed the 95% of the Universe about which we know next to nothing. In addition to his public lecture, he also presented a technical talk to students and faculty entitled "Dark matter annihilations in the WMAP sky", which explored the premise that excess of microwave emission from the region around the center of our Galaxy, known as the WMAP Haze, could be synchrotron emission from relativistic electrons and positrons generated in dark matter annihilations. Dr. Hooper is the author of one book on dark matter entitled "Dark Cosmos" and will have a second book released this fall entitled "Nature's Blueprint: Supersymmetry and the Search for a Unified Theory of Matter and Force."



Visiting Speakers

In addition to our astronomy day speaker, we had a number of other prominent speakers visit our campus. In September, Andrew Hime of Los Alamos National Lab returned to our campus to discuss continued participation in DEAP/CLEAN through pursuit of new techniques for depleting Argon to be used in Dark Matter detectors and the submission of a DOE-EPSCoR Implementation Proposal. While at USD, he presented a talk entitled “Beyond the Neutrino Matrix” to students and faculty. The talk focused on new questions that have emerged at the forefront of modern science and at the intersection of nuclear and particle physics, astrophysics, and cosmology from the discovery of neutrino oscillations. Dr. Hime also discussed the development of a novel detector technology operating deep beneath the earth's surface to detect the mysterious dark matter of the universe and the low energy neutrinos from the sun.

In July, we brought three more distinguished scientists to our campus to explore additional collaboration opportunities related to Homestake. Dr. Richard Gaitskell, a professor of physics at Brown University and project spokesperson for the Large Underground Xenon (LUX) collaboration, spoke about Dark Matter in a well-attended public lecture on the evening of July 1st. The LUX collaboration is a project that involves scientists and students from more than a half dozen colleges and universities in the United States. The scheduled project calls for the construction and deployment of a large two-phase liquid/gas xenon dark matter detector and water shield to be installed this year at the Sanford Underground Laboratory in the former Homestake Mine at Lead, S.D., to establish a clear leadership role for the United States in the field of direct dark matter detection. The University of South Dakota has accepted an invitation to be a part of this groundbreaking Deep Underground Science and Engineering Laboratory (DUSEL) experiment and we look forward to being part of this exciting experiment.

Joining Gaitskell for the meeting were Dr. Xing-Zhong Li, professor of physics at Tsinghua University in Beijing, China, and Dr. Thomas J. Dolan, adjunct professor of nuclear engineering at the University of Illinois. Dr. Li holds doctorates in physics from both Tsinghua University and the University of Wisconsin, and he is an internationally renowned scholar in the areas of plasma physics and controlled nuclear fusion. His visit to the United States and South Dakota was for the purpose of building a collaboration to study neutrino emissions, with a possibility for locating this new experiment at the Sanford Underground Laboratory. Dr. Dolan's areas of expertise include innovative plasma confinement concepts for nuclear fusion; fusion power plant design, safety, environmental aspects, and economics; molten salt fission reactors; nuclear training programs for developing countries; and coordination of international activities in nuclear energy. He is also interested in participating in potential underground experiments at Homestake.

Changes in the Department

After twenty-five years at USD, Wayne James retired at the end of the 2007-2008 academic year. Wayne had been affiliated with the physics program for more than twenty years. He began by teaching the algebra-based physics courses, and later became a full-time instructor in the department. As part of this move, he assumed full responsibility for all of our introductory labs during a time when the number of students taking labs each semester more than doubled. Wayne not only taught almost all of those lab sections, but also procured and repaired equipment, wrote the lab manual, and made it available to students online at no cost to them. Wayne's wife, Billie, also retired, and I am sure they will enjoy their retirement with plans to travel and spend time with grandchildren.

As Wayne's replacement, we hired Vernon McBride, a former graduate of our program, and a current instructor in the Department of Mathematics. Vern will have big shoes to fill, but we are confident that he will continue to make the labs a positive learning experience for our students. We also doubled the number of tenured professors in the department as Dr. Sun was awarded tenure this past spring.

After a successful year at USD, Zhongbao Yin (our first post-doc) returned to China and Zhang Chao took his place. Chao comes to us from Three Gorges University, where he was an instructor of Physics. He received his Ph.D. from the Institute Of High Energy Physics in Beijing, specializing in Particle and Nuclear Physics.

Students

Keenan Thomas and Jason Spaans both received competitive travel awards from the American Physical Society – Division of Nuclear Physics to attend the April meeting and present their research results. Jason (*Depleted Argon as a Dark Matter Detector at DUSEL*) and Keenan (*Pulse Shape Discrimination Study of Low Energy Recoils for DUSEL Projects*) also presented at IdeaFest on our campus, as did Frank Leibfarth (*New Molecular Architectures Toward Highly Efficient Platinum Doped Titanium Dioxide Photocatalysts*).

We have six students working on DUSEL related research activities this summer. Two of our students, Brian Woltman and Patrick Davis are funded through the Northern Plains Undergraduate Research Center (NPURC) through the Department of Chemistry. Keenan Thomas is funded by a Research Experiences for Undergraduates grant, also through USD's chemistry department, and Jimmie Broomfield is funded through an internal grant from our Office of Research. And although Jason Spaans has graduated, he continues to work with the research group through funding from grants from the Office of Research and the South Dakota Board of Regents.

The Joseph and Margaret Nelson Scholarship is being used as a research award this year and has been awarded to Amber Onken. Brian Woltman received the G.I. Moller Scholarship.

The Society of Physics students continued their tradition of freezing and exploding objects for local school children with performances at the Science Olympiad on campus and at the Vermillion Middle School.

Graduating Seniors

Three students graduated from our program this spring. Frank Leibfarth graduated with a double major in physics and chemistry. Frank will enter the Ph.D. program in chemistry at the University of California – Santa Barbara. Frank received a prestigious National Science Foundation Graduate Fellowship, which means \$30,000 a year for three years of graduate school and \$10,500 a year for tuition and fees. You may remember that Frank received many other awards as an undergraduate at USD, including a Goldwater Scholarship and a 2007 USD Today Academic All-Star Award. Jason Spaans graduated with a physics major, and will enter the Master's Program in Physics at South Dakota State University next fall. Jason has been an extraordinarily productive member of the research group, and we hope that although Jason will be taking courses at SDSU next year, he will be able to pursue research activities for the masters at USD. Our third "new" graduate is actually a student who had been with us several years ago. Bret Jones graduated in 2005 with a degree in computer science. Bret had been pursuing a double major in computer science and physics while at USD, but circumstances forced him to graduate with the computer science degree while still being one course short of the requirements for the physics major. He came back this spring to complete that one course, and we are happy to add Bret to our list of alums.

Alums

Katrina Jacobs (B.S. 2005) received her M.S. in Geophysics from the University of Alaska-Fairbanks. She will enter the Ph.D. program at Victoria University in Wellington, New Zealand and will be studying probabilistic models for earthquake swarms.

Nataly Jager (B.S. 2003) is a Ph.D. candidate at the University of Kansas and is studying Jovian Auroras.

Kortney Klinkel (B.S. 2003) graduated in May 2007 with a Ph.D. in Inorganic Chemistry from the University of Colorado at Boulder. She is now working as a patent examiner at the US Patent and Trademark Office.

Changes at the U.

Construction activities are occurring all over campus. The Medical School has completed construction (it is a beautiful building), construction on the new student center continues, and ground has been broken for the new business school. The science buildings on campus will also be undergoing some major renovation during the upcoming year. The South Dakota Legislature approved over \$70 million in funding to renovate science buildings on the six Regental campuses. Pardee, Churchill-Haines, and Akeley-Lawrence are all scheduled to have major infrastructure improvements made.

Once again, we enjoy hearing from all of you. Please keep the information coming. Send the information to phys@usd.edu or you may send the information to me via regular mail in care of the physics program at USD. You may also wish to explore our web site at www.usd.edu/phys.

As always, I will end by asking for your help. All of the activities, scholarships, and visiting speakers mentioned above require financial support. As costs increase from year to year, while operating budgets remain static, we depend more and more on friends of the program to help accomplish our goals and support our activities. Our undergraduate majors are some of the very best students at this institution. While they remain successful competing for general scholarship dollars available at our institutions, we think rewarding them with dollars designated specifically for physics majors would help us retain and recruit undergraduate students.

Thank you for all of your support and I look forward to hearing from you.

Best Wishes,

A handwritten signature in black ink that reads "Tina Keller". The signature is written in a cursive, flowing style.

Tina Keller, Director