

UMSL *Physicist*

Department of Physics & Astronomy <http://www.umsl.edu/~physics> November 2007

Note From Chair

As I write this, I am representing the newly formed UMSL Chapter of Sigma Xi at the 107th annual meeting in Orlando. Sigma Xi is a scientific research society that emphasizes interdisciplinary research and also strives to raise public awareness of science issues such as global warming and the energy crisis. The goals of Sigma Xi fit nicely with the focus of the Department with recent hires in biophysics, astrochemistry, and materials science. This year we are happy to have Dr. Eric Majzoub join our faculty from Sandia National Labs. Eric conducts research on energy storage and conversion, and in particular hydrogen fuel cells, using computational and experimental techniques (see The Faculty section). Eric is also a member of the Center for Nanoscience and is spearheading an inter-disciplinary research proposal on theoretical and computational nanoscience.

You may be wondering: what is the Center for Nanoscience (CNS)? Built in 1997, it was until this year called the Center for Molecular Electronics. The name change followed the hiring of the first permanent director (Dr. Jimmy Liu) and associate director (Dr. George Gokel) in 2006, and better reflects the scientific expertise and goals of the Center. The Director, Dr. Jimmy Liu, is also a faculty member of Physics & Astronomy (see The Faculty). CNS held an Open House on October 30 that was attended by over 250 scientists from academia and industry as well as community leaders (and many physics alumni!) to inform people about the Center's capabilities and new research focus. More than 80% of the attendees were from off-campus. The Department's faculty and students will continue working closely with the CNS. We recently appointed Dr. Dan Zhou, the lab manager for CNS, as an Associate Research Professor of Physics. Both Jimmy and Dan will be teaching a course next semester on Advanced Scanning Electron Microscopy that should attract students as well as researchers in industry.

After 34 years of service to the University, Dr. Ta-Pei Cheng elected to "retire". Dr. Cheng has had a long and distinguished career with fundamental contributions to the field of particle physics. He has been a Fellow of the American Physical Society since 1982. He has written the advanced physics texts *Gauge Theory of Elementary Particle Physics* and an accompanying book *Problems and Solutions* (both with Ling-Fong Li) and *Relativity, Cosmology, and*

Gravitation: A Basic Introduction. Dr. Cheng is highly regarded for his teaching and is responsible for starting the Physics Learning Center. Dr. Cheng always provided exemplary service to the Department including his role as the Department Chair (1978-79), Graduate Coordinator (1988-91), and, on-and-off for several occasions including the past 5 years, Undergraduate Advisor. Even though retired, Dr. Cheng plans to update his books and teach an occasional course while assuming the title of Professor Emeritus.

Please note the questionnaire attached to this Newsletter. Feedback from our alumni is essential as we undergo our five-year self-study in spring of 2008 and plan for the future. And please join us for Department activities such as the Alumni Awards Luncheon in May.

Bruce A. Wilking, Chairperson

Dr. Sonya Bahar receives PECASE

Following the awarding of an NSF CAREER grant in 2006, Dr. Sonya Bahar has been selected to receive the prestigious Presidential Early Career Award for Scientist and Engineers (PECASE) by the President's Office of Science and Technology Policy. Dr. Bahar is an Assistant Professor of Biophysics and Director for the Center for Neurodynamics. She is one of 20 young scientists nationwide with NSF funding selected to receive this award. Her selection was based upon "the combination of innovative research at the frontiers of science and technology and community service...". Dr. Bahar received the award at a White House ceremony on November 1, 2007. Please read about Dr. Bahar's research and outreach programs in the section on The Faculty.



Dr. Sonya Bahar

Roxana: Free at Last!

Physics graduate student Roxana Contreras provided plenty of anxious moments for the Department when she was detained in Russia for 76 days for purchasing some Red Army medals and old ruble notes from a street vendor. The items were appraised at about \$20. Roxana was visiting friends in Voronezh after attending a neuroscience conference in Dresden. Unbeknownst to her, the buying and selling these items is illegal and, if convicted, she could have received a seven-year prison sentence. Fortunately, through the efforts of her advisor Dr. Sonya Bahar, the Chilean consulate, and many others, she was allowed to leave Russia after paying a hefty fine.

Marty G. Mlynczak Receives UMSL Distinguished Alumni Award

Dr. Marty G. Mlynczak became the 5th physics alumni to receive the UMSL Distinguished Alumni Award. He received the award at the Founders Day Dinner held at the Ritz-Carlton on September 25, 2007. Marty received his B.S. in Physics in 1981 from UMSL, an M.S. in Meteorology in 1984 from the University of Wisconsin, and a Ph.D. in Atmospheric Sciences in 1989 from the University of Michigan. Since receiving his Ph.D., Marty has been employed at NASA Langley Research Center in Hampton, VA where he is currently a Senior Scientist. He has been an Associate Principal Investigator on the SABRE space mission (1994-present) to study the infrared emission from the Earth's upper atmosphere. He is the Principal Investigator on the proposed FIRST mission (Far-Infrared Sensor for the Troposphere) and a mission to study the atmosphere of Mars. In addition, he has been the Principal Investigator for three major suborbital flight projects (sounding rockets or balloon-based). As a result of these studies, Dr. Mlynczak has published over 70 major papers in scientific journals and made over 40 presentations at technical conferences, many of which were invited. Because of his expertise in the relationship between the Sun and Earth's climate, he has become a key player in the current debate over global warming. He has been recognized for these contributions by receiving the NASA Medal for Exceptional Scientific Achievement (2003) and the World Meteorological Organization Norbert Gerbier-MUMM International Award (2005). A nice interview with Marty about the Award that appeared in the NASA Langley Researcher News can be found at

http://www.nasa.gov/centers/langley/news/researchernews/rn_mylnczak.html .

Attending the Dinner with Marty was his wife, Pam, Jake and Bette Leventhal, Bernard and Marjorie Feldman, and Bruce and Janet Wilking. Physics alumni who have previously received this recognition include Steven Rutledge, Lawrence Ramsey, Otto Sankey, and Gary Kamerman.



*Marty Mlynczak and Chancellor Tom George
(photo courtesy of August Jennewein)*

First Frank and Elaine Moss Distinguished Lecture

Professor Thomas F. George, Chancellor and Professor of Chemistry & Physics at the University of Missouri-St. Louis delivered the First Frank and Elaine Moss Distinguished Lecture on November 16, 2007. His lecture was entitled "Laser-Induced Electronic and Vibrational Excitation of Nanoparticles". Professor George conducts an active research program in theoretical chemical physics and has published over 670 articles and chapters as well as 5 textbooks on various aspects of quantum and classical mechanics and chemical/materials/optical/nanophysics. He has secured nearly \$5M in grants and contracts from various agencies including the American Chemical Society-Petroleum Research Fund, National Science Foundation, NASA, the Research Corporation, the Air Force Office of Scientific Research, the Office of Naval Research, and the Army Research Office. In recognition of his research excellence, Professor George has received numerous honors and awards including election as a Fellow in the American Physical Society, a Fellow in the American Association for the Advancement of Science, and a member of the Korean Academy of Science and Technology. The lecture is the first in a series sponsored by generous contributions to the endowed Frank and Elaine Moss Hospitality Fund.

Don C. Winter Honored at Alumni Luncheon

The annual Physics & Astronomy Alumni Awards luncheon was held on May 4, 2007 at the Alumni House. Don C. Winter (B.S. 1977, M.S. 1980) was the guest of honor. Don is the Vice President- Engineering and Information Technology. In addition to his physics degrees, Don obtained an MBA from Washington University in 1994. The luncheon was also attended by alumni Brian Rodenborn

(B.S. 1981, M.S. 1983), Rich Heuerman (M.S. 1983), and Charles Jones (B.S. 1974). Graduating senior Will Lowes received the Jeffrey Earl Award and a set of the Feynman Lectures. Zak Jost received the Senior Alumni Award (\$500). Keara Wright, Zak Jost, Michelle Brockschmidt, and Meredith Ordway are recipients of the Physics & Astronomy Alumni Scholarships that provides \$1000 for the academic year. Lauren Fallert received the Outstanding Graduate Teaching Assistant Award which is a \$100 prize and a one-year subscription to the American Journal of Physics. Following the luncheon, we were treated to an excellent two-part talk by Don entitled “Innovation at Boeing Phantom Works” and “Trends and Careers in Industrial R&D. It is thanks to your generosity that these awards and scholarships are possible.



Bruce Wilking presents Don Winter with the Department's Distinguished Alumni Award

Observatory Update

Plans are on hold for moving the Richard D. Schwartz Observatory from its present south campus site. A project to build a new baseball field on the south campus has been delayed so the Observatory will stay put at least until the summer of 2008. A new site has been selected, just off Florissant Road adjacent to the Fines Arts Building and Women's Softball Field.

Graduate Program Update

We had a very active year, awarding six M.S. in Physics degrees. Dan Blake (advisor: Dr. Gibb) wrote a Master's Thesis entitled “Carbon Monoxide in Disks Around Young Stellar Objects” and Holger Euchner (Advisor: Dr. Flores) a thesis entitled “Probing the Evolution of Galaxy Cluster Ellipticities with the Sunyaev-Zel'dovich Effect”. Chris Bognar, Doug Brumm, David Coss, and Isaac Smith also completed M.S. degrees without thesis.

David Coss (advisor: Dr. Flores) is receiving a graduate fellowship (\$15,000) from the NASA/Missouri Space Grant Consortium. Jinfeng Wang won the Sigma Xi Award for

Innovation at the Graduate School Research Fair held April 6, 2007 on the UMSL campus.

We welcomed several new students to our graduate program this year. Shuang Liu joins the Masters' program from Changchun University of Science and Technology in China. David Peaslee and Will Lowes both received their B.S. degrees from UMSL and are continuing in the Master's program. Kristen Erickson received her degree in astronomy and physics from the University of Arizona and is taking classes full time in our M.S. program after teaching high school math last year at McCluer North H.S.

Eric Mandell (advisor: Phil Fraundorf) has accepted an Instructor's position in the Department of Physics & Astronomy at Bowling Green State University in Ohio. In October 2007, he successfully defended his Ph.D. dissertation entitled “Characterization of Carbon Nanostructures in Electron Microscopy”.

Wayne Garver Goes Electric

If you swing by Benton Hall, you may notice a uniquely painted orange 1971 Volkswagen SuperBeetle in Lot Q. Or you may see the car in the parking garage near an electrical outlet. Wayne converted the car to run on electricity in 1982 and added a more powerful motor last year. The battery pack consists of fourteen 6-volt lead acid golf car batteries in series for total of 84volts. About 35% of the car weight is in batteries. The range is about 40 miles on a full charge which takes about 8 hours. Operating cost is about 3 ¢/mile for electricity and 7 ¢/mile for battery depreciation. This cost translates to an equivalent of \$2.50 /gal for gas with a 25 mpg car. Wayne also uses the principles of his electric car in teaching his Modern Electronics course.



Graduate student David Coss and Wayne Garver

Undergraduate Research Symposia

Ten high school, undergraduate and graduate students made presentations at the 16th annual meeting of the NASA/Missouri Space Grant Consortium hosted by Washington University in St. Louis on April 20-21, 2007. High school students Anamaria Baluyut and David Dotson

presented their analysis of astronomical data of young stars (advisors: Drs. Erika Gibb and Bruce Wilking). Nathan Hunton, Zak Jost, and Eric Mandell discussed the results of their study of presolar graphite grains in the Murchison meteorite (advisor: Phil Fraundorf). Ryan Cleaver described his JPL internship and research on Saturn and Titan data from the Cassini mission. David Peaslee described the UMSL Planetarium program he and Michelle Brockschmidt conducted for area 5th grade students and teachers. Melissa Pastorius (advisor: Dr. Erika Gibb) discussed her project "Ice in Interstellar Envelopes Surrounding Young Stellar Objects". Melissa was selected to present a poster of her project at the Great Midwestern Regional Space Grant Consortium meeting held at Purdue University on September 6-7, 2007.



Front: Amamaria Baluyut, Melissa Pastorius, David Dotson, Ryan Cleaver; Back: Dr. Wilking, Eric Mandell, Nathan Hunton, Zak Jost, and David Peaslee.

The Department of Physics & Astronomy was well represented at the annual Undergraduate Research Symposium held on the UM-St. Louis campus on April 27 and hosted by the Golden Key International Honour Society, the Pierre Laclède Honors College, Sigma Xi, and the College of Arts & Sciences. Poster presentations were made by physics majors Justin Braden, Ricardo Garcia, Melissa Pastorius, and Keara Wright (advisors Drs. Mary Leopold, Frank Moss, and Erika Gibb, respectively).

UMSL Hosts Third Annual Meeting with UMR Physics

Our third joint meeting with the Physics Department from UM-Rolla was held on Friday, March 2, 2007 on the UMSL campus. These joint meetings, which are becoming "sesquianual" events, promote cooperation between Departments and give the graduate students a chance to meet faculty before selecting their Ph.D. committees. There were both oral and poster presentations of research by undergraduate and graduate students. In the poster

competition, UMSL graduate students Daisuke Takeshita (advisor Dr. Bahar) won the \$500 first place prize and Kari Van Brunt (advisor: Dr. Gibb) won the \$200 third prize. A very enjoyable Vice Presidents' Distinguished Lecture, entitled "*Star Clusters, Binary Stars, and Stellar Collisions: Tracing the Interface Between Stellar Dynamics and Stellar Evolution*" was delivered by astrophysicist Dr. Robert Mathieu from the University of Wisconsin.

More Changes....

It seems strange not to have Drs. Dan and Mary Leopold on campus this semester. Dan has moved his lab in the Center for Nanoscience to his lab at Washington University. After teaching Modern Physics and serving as the Physics Club advisor for the past several years, Mary is teaching physics at Nerinx hall High School.

Benton-Stadler Renovation??

The Lewis and Clark Discovery Initiative recently passed by the Missouri Legislature is providing \$28.5M for the long-awaited renovation of Benton and Stadler Halls. The funds come from the sale of assets from MOHELA. It is not clear when renovations will begin, but new teaching labs for chemistry are a high priority.

Physics Club News

During 2007, the Physics Club held the second and third Chili Cook-off with great turnouts, and our recycling fundraiser is continuing strong. Also we've continued the tradition of the faculty and student potluck followed by a movie in the planetarium. For Mirthday in the spring, liquid nitrogen and superconductor demonstrations were used that drew good crowds. Several members participated in the Undergraduate Research Symposium in the spring. In October, the club held an observing open house on campus as a service project that drew many onlookers. Prospective events include more service projects in November, joint activities with Saint Louis University's Physics Club, and building a trebuchet to demonstrate at the next Mirthday in 2008.

If you have any questions, please contact us by email at umsl_physics@yahoo.com.

Contributors 2006-2007

Mrs. Patricia J. Amick
 Mr. James M. Baker
 Mr. Timothy J. Bancroft
 Dr. Joseph F. Baugh
 The Boeing Company
 Ms. Lynda E. Busse
 Dr. Ta-Pei and Ms. Leslie Cheng
 Mr. Daniel M. Doerer
 Mr. Deryl L. Earsom
 Dr. Lu Fei and Dr. Lucy He

Mr. Randall J. Ferber
Dr. James and Mrs. Maureen Guffey
Mr. William B. and Mrs. Mary Harms
Mr. David J. Harris
Mr. William P. Hartnett
Dr. Bo He
Hershey Foods Corporation
Mr. Gerard P. Hesper
Ms. Michelle L. Huson
Mrs. C. Ruthann Jones
Mr. Charles and Mrs. Ruthann Jones
Mr. Mark S. Jones
Mr. David A. Kalin
Dr. Michelle and Mr. Timothy Kirchoff
Mr. Mark E. Kushina
Mr. Harvey W. Leeds
Mr. Jeffrey L. Libbert
Mrs. Frances and Mr. Steven Lopata
Mr. James A. Malke
Maritz Inc.
Ms. Lebeé S. Meehan
Dr. Michael R. Meyer
Dr. Martin and Mrs. Pamela Mlynczak
Mr. Christopher M. Morris
Mr. Thomas J. Mroczkowski
Mr. Vincent G. Musielak
Mr. Donald L. Ortner
Mr. Kurt M. Pollack
The Progressive Insurance Foundation
Mr. Ronald R. Richter
Mr. James M. Roedder
Dr. Elenore A. Schewe
Dr. Chang and Mrs. Helen Shen
Mr. Duane A. Theilen
Mr. Howard and Mrs. LaDonna Thoele
Mr. Justin R. Trice
Dr. Michael J. Way
Mr. Michael J. White
Mr. Robert G. Wilking
Mr. Keith L. Wilkinson
Mr. Don C. and Mrs. Susan Winter
Dr. Zhongyu Zhang

Note: Please contact us if you made a contribution to the Department from July 1, 2006–October 15, 2007 and your name does not appear. Many thanks to all of you!

Check Out our Web Page!

You can always look at the Department Web page to find our schedule of colloquia, journal clubs, Observatory Open Houses, and up-to-date news. Check it out at and join us at Department events!

<http://www.umsl.edu/~physics/>

The Faculty:

Sonya Bahar

My research concerns neural synchronization in pathological processes and information processing, as well as general problems of collective dynamical behavior in biological systems.

A major current area of study involves synchronization of neural firing during epileptic seizures. The role of synchronization in seizure development can be studied with computational models of coupled neurons or oscillators, and also with experimental imaging of epileptic events. We image seizure onset in the rodent neocortex using a combination of various techniques, including the intrinsic optical signal (a drop in light reflectance that correlates with an increase in electrophysiological activity), calcium sensitive dyes, and voltage sensitive dyes. A central problem is to investigate changes in spatiotemporal synchronization, and other measures of spatial organization, during the course of seizure onset, development, and offset, and to try to understand the underlying dynamics driving this process.

Other projects involve magnetoencephalographic (MEG) imaging of the human brain, in collaboration with Dr. Richard Bucholtz and Dr. Jayant Acharya at Saint Louis University Hospital, comparison of EEG and fMRI methodologies (collaboration with Dr. Linda Larson-Prior and colleagues at Washington University), and the study of eye movement synchronization in traumatic brain injured patients (collaboration with Dr. Minah Suh and colleagues at the Brain Trauma Foundation and Weill-Cornell Medical College of Cornell University).

Finally, as part of an NSF CAREER grant, I am running an outreach program to introduce local high school students to interdisciplinary science.

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Bernard J. Feldman

During the last year I have continued to develop new materials for physic teachers. This year, The Physics Teacher accepted for publication “The Physics of Bird Flight: An Experiment,” coauthored with Chancellor Thomas George and STARS high school student, Michael Mihail. I am presently working on a paper on hybrid automobiles.

This summer I spent two weeks at the University of Western Cape in Cape Town, South Africa as part of an exchange program sponsored by the University of Missouri, where I gave three colloquia, taught one class and sat in on three classes.

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Michael Fix

My research deals with Missouri's only known dinosaur site – the Chronister Site about 30 miles west of Cape Girardeau. I have been working with a group affiliated with the Bollinger County Museum of Natural History, in Marble Hill, Missouri. This group, called the “Missouri Ozark Dinosaur Project (MODEP),” is conducting the first truly scientific excavation of the site, which was accidentally discovered in the early 1940's. The dig is enclosed within a 20 by 36 foot greenhouse in order to keep water out. Inside there is a 60 square meter hanging grid which is used in conjunction with a portable one meter mapping grid with an XY axis sliding cursor equipped with a laser pointer for precision mapping of fossils. Thus far we have found numerous bones of a hadrosaur (duck-bill dinosaur) called *Hypsibema missouriense* (our official state dinosaur), including a partial skull of a juvenile, which according to Dr. John Horner is probably the most complete dinosaur cranial material ever found in the eastern U.S. The site has also yielded fossils from a member of the tyrannosaur family, a possible tooth from a relative of velociraptor, as well as numerous fossils of turtle, crocodile, fishes, and amphibians. We are working on a paper about these finds with Dr. David Parris from the New Jersey State Museum and Dr. Barbara Grandstaff at the University of Pennsylvania, which is intended for publication in the “Journal of Vertebrate Paleontology.”

Ricardo A. Flores

My research interests are astrophysical cosmology and applications of quantum field theory to the physics of elementary particles. Cosmology is now a well established branch of science thanks in great part to the astounding diversification of Astronomy in the last three decades into observations covering a very broad range of the electromagnetic spectrum. It is also a very exciting field of research due to its inherent intellectual appeal, and the rapid progress allowed by a steady flow of observational data. I am currently working on using future observations of the Sunyaev–Zel'dovich effect (a distortion of the microwave background due to the hot electron gas present in clusters of galaxies) to constrain the shape evolution of DM halos; such observations will become possible with ALMA, a multinational observatory being built in Chile. Recent completed work has been on the systematics of the shape of DM halos (MNRAS 367(2006)1781), and comparisons to X-ray observations to test these predictions (MNRAS 377(2007)883). Other relatively recent work has been on clusters of galaxies (see ApJ 532(2000)206 and ApJ 538(2000)92) and gravitational lensing (see ApJ 533(2000)194 and ApJ 535(2000)555). My work has been funded in the past by the National Science Foundation, the University of Missouri System Research Board, and by Research Awards here at UM - St. Louis. Over the years, I have collaborated on a long-term basis with scientists from around the world to carry out my research. Most recently: Joel Primack @ UCSC (Santa Cruz, USA), and Hernan Quintana @ Universidad Catolica (Santiago, Chile).

Philip B. Fraundorf

My research involves materials, atomic resolution microscopes, computer simulations, and conceptual strategies for doing both nanoscale detective work and curriculum modernization. For over a decade we've been providing for the region tools not otherwise available in state to examine the nanostructure of a growing variety of specimen types, including for example aerosol catalysts, integrated circuit silicon, carbon nanotubes, extraterrestrial materials, and ferrofluids for drug delivery. We've also put graduates into applied physics internships and jobs with companies that include MEMC, Seagate, Martin-Marietta, Mitsubishi Silicon-America, and Motorola. Of three recent intellectual challenges, one lies at the intersection between single-walled carbon nanostructures in the history of our own atoms, and possible roles for carbon droplets in cool stellar atmospheres. Another involves the study of defects in and on gigascale integrated circuit silicon, a highly-ordered material tightly connected to future technology. A third involves the study of atomic-resolution images using wavelet-versions of long-established optical darkfield techniques. More on recent developments, information on the recently established MissOuri NanoAlliance, and a variety of web-based nanoworld adventures, may be accessed through:

<http://www.umsl.edu/~fraundorf/index.html>.
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Thomas George

I am involved in theoretical research in several areas of laser/materials physics. One area involves molecular clusters, where excitation processes in fullerenes by ultrafast laser pulses are being investigated theoretically by numerically solving the Liouville equation for electron density matrices. Comparisons are then carried out with experiments in regard to the control of vibrational excitations. Another area is nonlinear optical processes, where a theory of quantum control of short-wavelength sum-frequency generation, which employs continuum states, has been developed. Nonlinear interference processes in a multi-level ladder-type quantum system are being considered, along with the coupling of several strong laser fields with adjacent bound-bound (discrete) and bound-free (continuous) transitions in the continuous wave regime, accounting for relaxation of coherence. Also, quantum switching and amplification without inversion controlled by two optical fields are being examined in connection with (1) solids doped by rare earths and (2) atomic and molecular vapors. A third area involves ultrafast laser-driven materials processing, where femtosecond laser pulses are used in a theoretical analysis of microprocessing of metals, semiconductors and dielectrics. Here, a two-temperature model (energy coupling between electronic and phonon subsystems), the role of Dember effects, and ballistic transport are being considered. Step melting of crystalline and amorphous lead foils due to irradiation by ultraviolet laser pulses are being examined experimentally by optical microscopy-densitometry and atomic force microscopy methods. A fourth area deals with quantum 1/f noise effects.

A fifth very recent area of research deals with laser-induced explosion of gold nanoparticles and their potential role for nanophotothermolysis of cancer. Finally, as a side project just for fun, Newtonian mechanics is being applied to help resolve the controversy of two opposite theories explaining the origin of vertebrate flight: (1) running and leaping into flight ("ground-up theory") and (2) gliding to flight ("tree-down theory").

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Erika Gibb

I am an astrochemist, studying chemistry in star formation regions and comets. One of the most exciting areas of astrobiological research is the search for organic molecules of prebiotic importance in disks and envelopes of gas and dust around low mass young stars that are thought to be similar to the young solar system. I use infrared spectroscopy to detect molecules and infer the quantity, temperature, and location of each molecule. The observations are usually performed at major telescopes like the 10-meter Keck Observatory and the 3-meter Infrared Telescope Facility on Mauna Kea, HI or the 8-meter Gemini South Observatory in Chile. I also collaborate with a research group at NASA Goddard Space Flight center to measure abundances of those same molecules in comets, which are thought to have been a source of much of the early Earth's reserve of organics and water. We recently participated in the worldwide campaign to observe comet Tempel 1 from ground based telescopes during the Deep Impact mission (published in *Science*, volume 310). In this way, I hope to track the organic chemistry through the star and planet formation process and to be able to infer the role that comets may have played on delivery of organics and water necessary for life on Earth.

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Peter H. Handel

I have found the origin of the fundamental $1/f$ fluctuations present in most high-tech devices and systems ("Coherent and Conventional Quantum $1/f$ Effect", *Physica Status Solidi* b 194, 393 (1996)), including computer chips, infrared detectors, quartz resonators, atomic and laser clocks, submicron electronic devices, FET and HBT transistors, laser gyros, SQUID magnetometers, etc. ("Fundamental Quantum $1/f$ Noise in Small Semiconductor Devices", *IEEE Trans. on Electr. Devices*, 41, 2023 (1994)). I am using this new effect to optimize these devices ("Incoherence and Negative Entropy in the Quantum $1/f$ Effect of BAW and SAW Quartz Resonators", *Proc. Frequency Control Symp.*, Orlando, FL, May 1997, pp. 464-69) for the Department of Defense and for civilian applications, such as ultra-low power computers. This research is supported by the Office of Naval Research and by the Air Force Office of Scientific Research. Having also found the origin of Atmospheric Electricity ("Polarization Catastrophe Theory of Cloud Electricity", *J. of Geophys. Research* 90, 5857 (1985)), I use the new law for weather modification and protection against

lightning and ball lightning (Handel et al. "Development of the Maser-Caviton Ball Lightning Theory", *J. of Geophys. Research* 99, 10689 (1994)). In nonlinear Plasma Physics with solitonic MASER interactions, I am developing (Zhil'tsov et. al. "Spatially Localized Microwave Discharge in the Atmosphere", *Zh. Eksp. Teor. Fiz.* 108,1966 (1995) & *JETP* 81, 1072 (1995)) a new type of electric discharge and artificial ball lightning. Finally, I am applying my quantum $1/f$ formulas to optimize our chemical and bacteriological sensors. I was included into DoD's Ultra-Low Phase Noise MURI #17, together with the University of California, Caltech and Yale University in May 2001. The goal of this new 5-year grant is a new generation of electronic devices and radars. See my web site at www.umsl.edu/~handel/.

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Bob L. Henson

Currently, my activities in the Department are mostly in the areas of instruction at the graduate and undergraduate levels plus service in the curriculum area. This has been the typical case for me for several years now. However, I am still active in theoretical research, but at a very reduced level of activity. My main scholarly activity now is writing a text at the senior-graduate level on the topic of atmospheric physics. I am approaching this by writing up and expanding my class notes for Physics 4354 (Atmospheric Physics), which I have taught several times over the past thirty years.

Mary Jane Kernan

My primary activities in the Department are related to physics education. I supervise the undergraduate labs, and I've been teaching the undergraduate Quantum Mechanics course for the past two years. I'm also the webmaster for the department. We're currently making substantial revisions to the website, so I would welcome your input with comments or suggestions.

Wayne Garver and I are continuing our collaboration on an internet lab course for Electricity and Magnetism. We've completed the hardware devices and are awaiting word from the NSF on our grant proposal for implementing the course. Several of our undergraduate and graduate students as well as an REU student from SIU-E have contributed to the project, and we're hoping for funding so we can support additional students.

My research area is condensed matter-I use nuclear magnetic resonance (NMR) to characterize the structural, electronic, and optical properties of photovoltaic materials. The various types of hydrogen present in amorphous semiconductors have unique NMR signatures - the NMR signal gives us insight into the fundamental nature of the semiconductors. Thanks to the generosity of Professor Larsen in the Chemistry Department, I now have a 13MHz pulsed NMR spectrometer, which we hope to retrofit for our Advanced Lab course.

Jacob J. Leventhal

With Charlie Burkhardt, I have written a textbook *Topics in Atomic Physics*. The book has been published by Springer in October. *Topics in Atomic Physics* provides a foundation for students to begin research in modern atomic

physics. It can also serve as a reference because it contains material that is not easily located in other sources. A distinguishing feature is the thorough exposition of the quantum mechanical hydrogen atom using both the traditional formulation and an alternative treatment not usually found in textbooks. The book is intended for graduate students who have had introductory quantum mechanics, but undergraduates who have had such a course can also benefit from it. There are more than eighty problems at the ends of chapters with all answers given. A detailed solutions manual, in some cases giving more than one solution, is available to instructors.

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Jingyue “Jimmy” Liu

My research focuses on two platforms: 1) nanoparticles and nanoparticle systems and 2) advanced nanocharacterization techniques. Nanoparticles are defined very broadly here: metal and alloy clusters for catalysis, semiconductor quantum dots for bio-labeling or as biomarkers, oxide nanocrystals as sensor components, as well as proteins, viruses and other nanoscale components of biological systems. Nanoparticle systems include catalysts, displays, nanocomposites, nanosensors, etc. Advanced nanocharacterization techniques include high-resolution microscopy, novel X-ray scattering/diffraction techniques, as well as a variety of spectroscopy and in situ techniques for characterization of nanoscale materials and devices; the goal of this research platform is to develop quantitative and statistically meaningful nanostructural characterization techniques, which is one of the grand challenges in nanoscience and nanotechnology research. All the research activities will have strong component of industrial applications or industry involvement. Our research is conducted in the interdisciplinary Center for Nanoscience, which consists of physicists, chemists, materials scientists, biochemists and biologists.

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Eric Majzoub

The research focus in our group is on the study and design of new materials for energy storage and conversion, as well as sensing technologies. We perform our research using the tools of condensed matter physics for the characterization and modeling of bulk and nano-crystalline materials. We employ a combined experimental and computational approach, utilizing first-principles techniques to understand the electronic, mechanical, and thermodynamic properties of the materials we study.

Currently, our primary research area is hydrogen storage. Materials of current interest for hydrogen storage applications include complex anionic hydrides such as the class of materials known as alanates and borohydrides. Examples include NaAlH₄, LiAlH₄, Ca(BH₄)₂, and LiBH₄. These materials are generally wide gap insulators, and are very different in their material properties from interstitial metal hydrides. In a classic interstitial hydride, the metal alloy composition remains the same before and after hydrogenation. For example, the compound LaNi₅

reversibly absorbs hydrogen to become LaNi₅H₆. In contrast, the complex hydrides undergo decomposition reactions. NaAlH₄ ultimately decomposes into Na and Al. Important stoichiometric compounds in the system include Na₃AlH₆, and NaH. It is interesting to note that Na and Al are immiscible, even in the melt. The compound NaAlH₄ exists as an ionic molecular solid, with AlH₄⁻ anions bound with polar covalent Al-H bonds. Likewise, Na₃AlH₆ is composed of AlH₆³⁻ anions, charge balanced by three Na⁺ cations. *In-situ* single crystal Raman scattering studies have shown that the AlH₄⁻ anions are stable up to the melt in NaAlH₄ (see ref. 4 below), limiting the explanations of enhanced sorption kinetics through transition-metal "doping" procedures commonly used for this compound. Our group studies the structure, lattice dynamics, and thermodynamic properties of these materials to develop higher hydrogen capacities and better hydrogen sorption kinetics. We have also developed a Monte Carlo global optimization technique, using basin-hopping and potential energy smoothing, which can predict ground state crystal structures and structures close to the ground state in many of the complex anionic hydrides. This approach allows us to search the space of materials difficult to access experimentally, and to search for new potential hydrogen storage materials.

Selected Publications

1. *Crystal structure, Raman spectroscopy, and ab initio calculations of a new bialkali alanate K₂LiAlH₆*, E. Ronnebro, E.H. Majzoub, J. Phys. Chem. B, 110, 25686, 2006.
2. *Location and energy of interstitial hydrogen in the 1/1 approximant W-TiZrNi of the icosahedral TiZrNi quasicrystal: Rietveld refinement of x-ray and neutron diffraction data and density-functional calculations*, R.G. Hennig, E.H. Majzoub, K.F. Kelton, Phys. Rev. B, 73, 184205, 2006.
3. *²⁷Al and ¹H MAS NMR and ²⁷Al Multiple Quantum Studies of Ti-doped NaAlH₄*, J.L. Herberg, R.S. Maxwell, E.H. Majzoub, J. Al. Comp., 417, 39-44, 2006.
- 4.



Dr. Eric Majzoub

Frank E. Moss

Recently we have been developing a simulation based on Natural Selection in evolution. The simulation uses the simplest and fewest possible hypotheses. It makes predictions about certain distributions (hop lengths and turning angles) used by small aquatic animals during optimum foraging for food. With these results we connect with and criticize current interpretations of optimum foraging strategies using Levy statistics. Collaborating are Nathan Dees and Sonya Bahar.
mossf@umsl.edu

Wilfred H. Sorrell

Main research focus is theoretical astrophysics. Previous research work was focused on models for interstellar solid particles with a special emphasis on the physical and chemical properties of graphitic solid particles producing the interstellar ultraviolet absorption band at wavelength 2175 Angstroms. The research work was published and appears in a peer-review journal as Sorrell (1990, Monthly Notices Royal Astronomical Society, 243, 570). Other research works on the chemical properties of hydrogenated amorphous carbon solids in diffuse interstellar clouds appeared as Sorrell (1991, Monthly Notices Royal Astronomical Society, 248, 439), and on dust grain processing in the Orion Nebula as Sorrell (1992, Monthly Notices Royal Astronomical Society, 255, 594). Research work on the interstellar dust grain alignment problem appeared as Sorrell (1994, Monthly Notices Royal Astronomical Society, 268, 40 and 1995, Monthly Notices Royal Astronomical Society, 273, 169-200). Research work on the issue about a massive black hole at the center of the Milky-Way galaxy appears in the Bad-Honnef Conference on Cosmic Jets, July 3-7, 1995. Recent research focused on the Origin of Life problem appears in Sorrell (2001, Astrophysical Journal Letters, L129-L132). Recent research work on the nature of the T-Tauri binary system appears in Sorrell (2002, Monthly Notices Royal Astronomical Society, 334, 705-712). Current research is focused on cosmological models for the universe that have nothing to do with the Big Bang. The cosmological models I am now constructing are based upon my idea that says the Big Bang is a cosmic myth.

swsorre@jinx.umsl.edu

Vassiliy Tsytsarev

My research concerns interneural integration and information processing in the neocortex of mammals. We are observing neuronal activity in the neocortex using a combination of various techniques, including the intrinsic optical signal (a drop in light reflectance that correlates with an increase in electrophysiological activity), and voltage sensitive dyes. At the central of our project is a problem of spatiotemporal representation of the information in the brain. Actually we are working with whiskers system of the rat, one of the very common object for the neuroscience research. As is well known the layout of whiskers on a rat's face creates a topographic map, with one-to-one correspondence between a whisker and a "barrel" of few thousands densely packed

neurons. We are visualizing somatosensory-evoked neural activity using voltage-sensitive dye optical imaging methods in the barrel cortex at high temporal and spatial resolution. Obtained result indicates that the sensory neurons of the barrel have a directional preference and might have a fine anatomical structure.

tsytsarev@umsl.edu

Teaching activity:

4347 - Biophysics of Imaging

The course included introduction into the main modern methods of the brain imaging – functional magnetic resonance imaging, positron-emission tomography, intrinsic optical imaging, voltage- and calcium sensitive dye.

Selected papers:

Song and speech: brain regions involved with perception and covert production. Neuroimage. Callan DE, Tsytsarev V, Hanakawa T, Callan AM, Katsuhara M, Fukuyama H, Turner R. 2006 Jul 1;31(3):1327-42

A new planar multielectrode array: recording from a rat auditory cortex. Vassiliy Tsytsarev, Makoto Taketani, Frank Schottler, Shigeru Tanaka and Masahiko Hara. J. Neural Eng. 3 (2006) 293-298

Bruce A. Wilking

Low mass star formation and young brown dwarfs continue to be the focus of my research. In collaboration with graduate students Tina Fanetti and Julia Greissl (U. Arizona) and Dr. Michael Meyer (U. Arizona), we have used the Hubble Space Telescope to obtain infrared images and spectra for five fields in the NGC 1333 star-forming region. Our results, published in the April 2007 of *The Astronomical Journal*, report the discovery of new young brown dwarfs and low mass stars and suggest an absence of objects below 20 Jupiter masses. I am continuing to use optical spectroscopy to characterize the ages and masses of low mass stars that lie at the surface of the Rho Ophiuchi and Serpens star-forming regions (see 2005, *Astronomical Journal*, v130, p. 1733-1751 for first results). This summer was spent analyzing optical spectra from the WIYN 4 meter telescope and optical images from the 2.3 meter Bok Telescope of young stars in the Serpens star-forming region. I continue to work on a review chapter on star formation in the Ophiuchus cloud for a book entitled "Handbook of Low Mass Star-Forming Regions" in collaboration with Marc Gagné (West Chester University) and Lori Allen (Harvard-Smithsonian Center for Astrophysics). The book should be published in 2008. In June 2007, I attended the workshop *Transformational Science with ALMA: Through Disk to Stars and Planets* meeting in June held in Charlottesville, VA.

Alumni Information

1981

Terry Walker (B.S.) is a full professor of physics and a full professor of astronomy at Ohio State University. In May of 2005, he was named Director of the Center for Cosmology and Astro-Particle Physics, a multidisciplinary center funded at over \$1M per year by Ohio State.

1988

David J. Harris (B.S.) is a lawyer specializing in immigration law for Gallop, Johnson, and Neuman LC in St. Louis. David received his law degree from Washington University School of Law in 1991. He recently attended the Center for Nanoscience Open House.

1989

James Fedchak (B.S.) received his Ph.D. in physics from the College of William and Mary in 1994. After a postdoctoral position at Argonne National Lab, he has a position in the Process Measurements Division at the National Institute of Standards and Technology (NIST).

1991

Tim Giblin (B.S., M.S. 1993) has taken a tenure-track faculty position at the University of North Carolina Asheville but will still be involved with the Virgin Islands Robotic Telescope project as well as the Pisgah Astronomical Research Institute and the UNC System.

Michael Way (M.S., Ph.D. 1998) has switched coasts and moved from NASA-Ames to NASA Goddard Institute for Space Studies in New York City. He is also an Adjunct at Queen's College and is teaching Astronomy 1.

Michael R. Meyer (M.S.) is a tenured associate professor of astronomy at the University of Arizona and is on sabbatical leave at the Center for Astrophysics in Cambridge, MA. In March, he received the Professor Leon and Pauline Blitzer Award for Excellence in the Teaching of Physics and Related Sciences from the University of Arizona.

1994

Mark Kushina (B.S.) is a Senior Laser Engineer for Cutting Edge Optronics which is owned by Northrop-Grumman. For the second year in a row, Mark visited the Windows on Physics class this November to talk about careers for physicists in industry.

David O'Gorman (B.S.) completed his Ph.D. at the Harvard-MIT program in Speech and Hearing Bioscience and Technology in 2006. His dissertation was entitled

“Dynamical mechanisms of neural firing irregularity and modulation sensitivity with applications to cochlear implants”. Also in 2006, he received the Helen Carr Peake Research Prize awarded to an MIT student in bioengineering research. David is currently a postdoctoral fellow at Boston University.

1997

Thomas Fisher (B.S.) has founded Fisher Patent group in Hickory, North Carolina.

Fred Baugh (B.S., M.S. 1999, Ph.D. 2003) is an Assistant Professor of Physical Science at Chapman University in Orange, CA.

1999

Minh Q. Truong (B.S. 1999, M.S. 2001, Ph.D. 2006) is an assistant professor at Fontbonne University in St. Louis. He published his dissertation research (Advisor: Dr. Cheng) in a paper entitled "Superfield Calculation of Loop Contribution in Extra Dimensional Theories" in 2006 in *Physical Review D*.

2001

Jon Bailey (B.S.) recently completed his Ph.D. in physics at Washington University in St. Louis. His dissertation (Advisor: Dr. Claude Bernard) was entitled “Staggered Baryons” which consists of work on chiral perturbation theory and interpolating operators for lattice calculations involving baryons composed of up, down, and strange quarks. He recently attended the summer school on Lattice QCD at the University of Washington in Seattle and has begun a postdoctoral appointment at Fermilab.

2005

David Holy (B.S.) has a 6 month COOP position. He currently supports EDI (electronic data interchange) and develop software in java to handle that data at Monsanto. He is hopeful it develops into a permanent position.

2007

Eric Pulley (B.S.) is a graduate student in physics at the University of California-Davis.

Dan Hopper (M.S.) has accepted a position teaching physics at DeSmet Jesuit High School in Creve Coeur, MO.

Lauren Fallert (M.S.) is teaching science classes at Rosati-Kain High School in St. Louis.

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