Physics @ CU-Boulder

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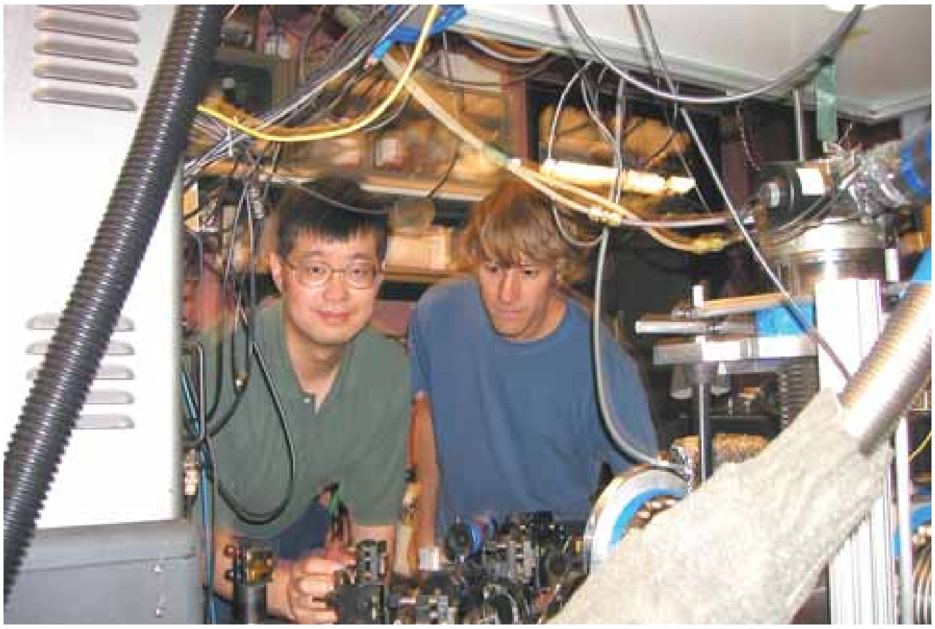
CU Physics' AMO Discoveries May Save Lives



Professor Jun Ye and graduate research assistant Michael Thorpe at work in the lab where they developed their ultra-precise optical frequency comb instrumentation.

"Hold still for a quick stick." How often have you heard this familiar refrain at the doctor's office right before you felt the sharp prick of the needle? If CU physics professor and JILA fellow Jun Ye and graduate research assistant Michael Thorpe continue their current progress, you may one day say goodbye to invasive diagnostic blood tests for common diseases such as asthma or cancer—and reduce your medical costs in the bargain.

Ye's atomic, molecular, and optical (AMO) physics laboratory has been engaged in research originally aimed at studying fundamental interactions between light and matter, with important applications such as improving the precision of the atomic clock at the National Institute of Standards and Technology (NIST). One of the tools used in laser-based spectroscopy is known as an optical-frequency comb. Using this tool, a multiple-colored laser light beam is directed at the substance of interest. The radio-wave-like output is carefully measured and the results are logged using specialized computer software.

The optical frequency comb permits measurement of the myriad frequencies that distinguish the colors within a beam of light. Each comb line or 'tooth' in the machine is tuned to a distinct frequency of molecular vibration. The extremely broad frequency range that can be captured by the comb can then be used to identify thousands of different molecules that comprise any substance that is placed within the purview of the beam.

In the future, by applying this method to a breath sample and comparing the output to a 'library' of the frequencies of known substances that participate in human diseases, scientists (or doctors) will be able to learn about disease processes – hopefully, long before they run a destructive course within the body of the person providing the sample.

Ye says the precision of this measurement is so advanced that it can even be linked to a new generation of atomic clock that is off by one second in 200 million years! What is more, it permits the simultaneous testing of a single sample for a virtually unlimited set of substances, making it also vastly more efficient – and thus eventually more economical – than existing blood or breath testing protocols.

We may not have to wait decades before medical practitioners can use this methodology to treat patients and save lives. Ye predicts that real-life applications may be just around the corner: "Very likely, we will see results within ten years. We might even see this approach in use in as few as five years from now."

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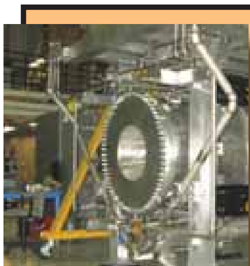

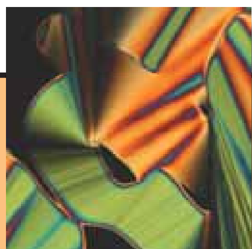

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This ground breaking work can benefit the CU-Boulder campus in many ways. It will undoubtedly serve to attract highly qualified undergraduate, graduate, and post doc researchers as it paves the way for fruitful collaboration with CU Health Sciences Center and beyond.

After further testing and refinement, the optical frequency comb may some day make your trips to the doctor easier, less invasive, and less expensive while being more informative about your health. We await the real-life application of this exciting project that Ye thoughtfully asserts is "at the frontier of the most novel applications based on interactions of light and matter."

CU's T2K Team Searches for Neutrino Mass

In 2008, a research group of CU-Boulder Physics designed and fabricated a key component of the international experiment to pin down the mass of the neutrino. The neutrino was first postulated in the 1930s, and it was assumed to be massless. However, in 1998 the 'oscillation' of one neutrino flavor into another implied that neutrinos must have a nonzero mass. This opened an area of study in high-energy physics with implications for cosmology and astrophysics.

One of the three focusing 'horns' now operating on T2K that was designed and built by the CU research team.

To measure neutrino oscillations, the T2K (Tokai to Kamioka) experiment was designed as a collaboration of more than 300 physicists on three continents, including members from national laboratories and 10 U. S. universities. To be successful, the experiment needs to observe a new, rare mode of oscillation: the oscillation of muon neutrinos into electron neutrinos over long distances. T2K will produce a nearly-pure muon neutrino beam and detect it twice: once near the production point at the new J-PARC accelerator in eastern Japan and again 295 kilometers away in the Super-Kamiokande neutrino detector.

At J-PARC, a beam of high-energy protons collides with a solid target (a graphite cylinder about the size of a baseball bat) and many subatomic particles are produced, including charged pions. These pions can then decay to the muon neutrinos the detector is looking for. A series of 'magnetic horns' – large aluminum coaxial conductors – is used to focus the pions progressively until they are mostly collinear. The pions then enter a 90-m-long region where they are allowed to decay in flight; at the end of the decay region a large beam absorber stops everything except the neutrinos, which can travel through the earth. One of the three horns now operating on T2K was designed and built at CU's Nuclear Physics Laboratory building by the CU research team. The focusing horn must withstand very-high-current, continuous water spray for cooling, and intense radiation from the beam. It must be made of thin conductors that allow pions to pass through. This adds up to major design and engineering challenges. To overcome these challenges, the CU team developed a frame cooling design to keep the radiation heating of the support frame low, and they applied friction stir welding on a conical surface (the horn's inner conductor) for the first time. Funded by the U.S. Department of Energy's Office of High Energy Physics, the CU team includes Associate Professor Eric D. Zimmerman; postdoc Martin Tzanov; department technician Eric Erdos; undergraduates, Joshua Spitz, Zhon Butcher, and Eric Hansen; and a consulting engineer Larry Bartoszek.

ARPES Replaces Synchrotron in Many Studies

One of the most powerful and direct methods for probing the electronic structure of solids is angle resolved photoemission spectroscopy (ARPES). This technique hails from Hertz's 1887 experiment and Einstein's Nobel-winning explanation in 1905. Using advanced versions of this technique, Dan Dessau's research group at CU-Boulder Physics works to understand the electronic structure and phase transitions of high temperature superconducting materials and unusual magnetic materials.

The technique fires photons into a material and analyzes the energy and momentum of the electrons that are knocked out. Typically the photons for these experiments are obtained at synchrotron radiation facilities – large 100-million-dollar-plus facilities where users can perhaps get a few weeks of beam time per year. The ARPES technique replaces the photons from the synchrotron with those from a laser. An ultraviolet laser which produces photons with energy of about 6 eV or more (wavelength of about 200 nm) is needed to overcome the work function of the sample, which is typically about 4.5 eV. This gives electrons of maximum energy 1.5 eV, which is much lower than what is typically used at the synchrotrons (20-50 eV). Electrons with this low a kinetic energy

Editors: Debra Biasca, John Cumalat, and Pat Weis-Taylor   Design: Rick Hinrichs

had not previously been used successfully for ARPES because the construction of the electron spectrometer to work at these low energies is much more difficult.

The laser-based ARPES system built by Dessau and grad students not only replaces the synchrotron for many of their studies, but actually performs better for some problems. Compared to the synchrotron, Dessau says they can now get far superior momentum resolution, energy resolution, and count rates. They experience less sensitivity to the surfaces of the samples, which has been the scourge of all prior studies, and they are working to make use of the femtosecond nature of their lasers to directly access the electron dynamics. Their system is currently unique, though many groups around the world are working to duplicate it. As Dessau sums it up, "What is exciting is that we can now directly obtain the most intimate quantum mechanical details of the electrons in the superconductor."

Physics Research That Reaches from the Beginnings of Life to Your Laptop—Liquid Crystals

What does your laptop computer's display have in common with DNA, life's molecular carrier of genetic information? According to recent discoveries in physics, they may share a state of matter known as liquid crystal (LC). LCs exhibit exotic, partially-ordered phases lying between, and sharing properties of, the liquid and crystalline states of matter. An area of continued interest to researchers at CU-Physics and beyond, liquid crystal research is gaining attention as it amasses a growing body of positive epistemological and practical results.

Among those are discoveries made in CU's multi-disciplinary Liquid Crystal Materials Research Center (LCMRC) under the direction of CU-Physics professor Noel Clark, a pioneer in the field. Keynoting the prestigious 2008 International Liquid Crystal Conference in Jeju, Korea, Clark delivered a talk entitled "Liquid Crystals and the Origin of Life: End-to-End Stacking and Condensation of Complementary Nanoscale DNA" describing his team's ground-breaking work that places an LC phase at the biological beginnings of life.

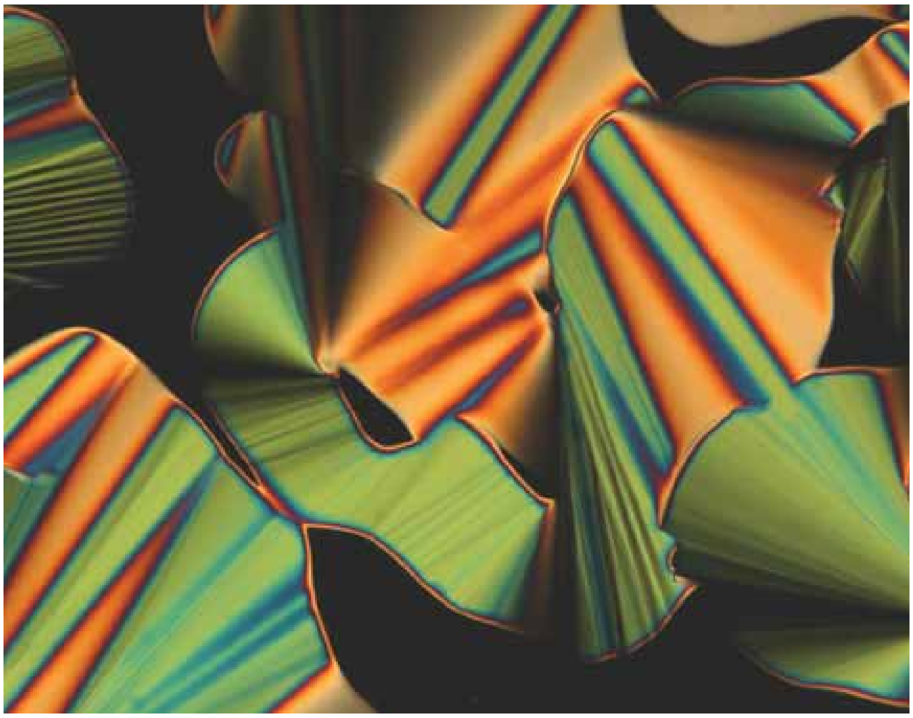
Funded by a $6 million National Science Foundation grant, the LCMRC brings together faculty, graduate, and undergraduate students from physics, chemistry, and engineering to develop novel LC science and applications. A team headed by Clark's group has discovered some unexpected occurrences of LCs in DNA molecules dispersed in water, providing a new scenario for a key step in the emergence of life on Earth. Their findings were published in the November 23, 2007, issue of *Science* in an article authored by Clark, post doc Michi Nakata [deceased, September 2006], and graduate student Chris Jones from CU-Boulder, together with scientists from the University of Milan and the Brookhaven and Argonne national laboratories.

It has been known for many years that long DNA can form orientationally- and positionally-ordered liquid crystalline phases in water, in accord with established theoretical predictions for the self-assembly of long rods. Clark's team has now discovered that nano-segments of DNA can assemble into several distinct LC phases that orient parallel to one another and stack into columns when placed in a water solution. Life is widely believed to have emerged as segments of DNA- or RNA-like molecules in a prebiotic 'soup' of prehistoric organic molecules, and this new work suggests that LC ordering may have served to catalyze the early development of longer, more complex forms of DNA.

While aqueous liquid crystalline phases have been identified in many biological systems to date, and the themes of LC ordering and self-assembly are useful in understanding such seemingly unrelated systems as thin magnetic films, soap bubbles, and Bose-Einstein condensates, we are most familiar with the liquid crystals used in displays, or 'LCDs.' LCDs contain no water but are completely filled with a slimy, transparent goo formed by mixtures of rod-shaped molecules chemically synthesized to optimize certain physical properties. These molecules self-assemble into ordered fluid phases whose orientation can be controlled using applied magnetic and electric fields to change their optical appearance.

The recent discoveries relating liquid crystals phases to the origins of life are definitely surprising and unexpected. For physics research, LCs have represented a series of new beginnings – with more surprises undoubtedly just over the horizon.

More information on research in the liquid crystal physics group is available at http://bly.colorado.edu. Visit the LCMRC website at http://lcmrc.colorado.edu.



This polarized light microscope image shows a solution of DNA molecules that has formed a liquid crystal phase. Image by Michi Nakata, University of Colorado.

New Faculty Corner

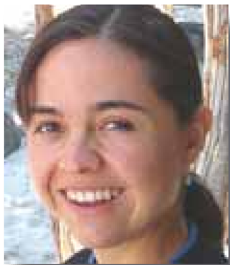
Michael Hermele

After growing up in the Denver suburbs, I studied at Harvard, where I received my BA, and then at the University of California Santa Barbara, where I received my PhD. I held a postdoc position at MIT before returning to Colorado in August 2007 to join the CU-Boulder Physics Department. I am a theorist interested in a wide range of problems in condensed matter physics, particularly those where both quantum mechanics and inter-particle interactions play a crucial role. Recently, my work has focused on 'exotic' states of matter, where interactions are so strong that the collective behavior of, say, a many-electron system bears no resemblance to weakly interacting electrons. This area is particularly exciting with the discovery of a few materials that are beginning to allow a more detailed comparison between theory and experiment. In the past, I developed a theory of the Josephson effect in superconducting thin films. I have growing interest in the nonequilibrium dynamics of quantum systems and in a variety of topics in strongly correlated materials.

Ivan Smalyuk

I received my BS and MS degrees from Lviv Polytechnic National University and the Candidate of Sciences degree from the Institute for Physical Optics in Lviv, Ukraine. I earned my PhD in 2003. My dissertation on three-dimensional imaging of director fields in liquid crystals was based upon my research at the Liquid Crystal Institute of Kent State University, for which I received the Glenn H. Brown Prize of the International Liquid Crystal Society. After receiving my degree, I was a visiting scientist at the State University of New York at Buffalo and the University of Pennsylvania as well as a researcher at the Liquid Crystal Institute in Kent, Ohio. Following that experience, I held a postdoctoral research associate position supported by a fellowship of the Institute for Complex Adaptive Matter at the University of Illinois at Urbana-Champaign. I joined the CU Physics faculty in 2007. I plan to study soft condensed matter and biological systems from the fundamental science standpoint as well as for technological and biomedical applications. My research interests encompass molecular and colloidal self-assembly, electro-optics and photonics of liquid crystals and nano-structured metamaterials, as well as physics phenomena involving nanoparticles, biological molecules, and living cells. In the study of these systems, I expect to use and develop laser trapping and imaging techniques, such as coherent anti-Stokes Raman scattering (CARS) polarizing microscopy, confocal and multi-photon fluorescence imaging, laser tweezers, and optical patterning of structures.

Ana Maria Rey



Born and raised in Bogotá, Colombia. I pursued undergraduate studies in Bogotá at the Universidad de los Andes and graduate studies at the University of Maryland at College Park and the National Institute of Standards and Technology under the advice of Dr. Charles Clark. My doctoral thesis, entitled "Ultracold bosonic atoms loaded in optical lattices," received the best doctoral AMO thesis award in 2005. Continuing my research on cold atomic systems, I completed a three-year ITAMP postdoctoral fellowship at the Harvard-Smithsonian Center for Astrophysics. I am pleased to join JILA and the CU faculty in the fall of 2008. My main research goal is to study how to control and manipulate cold atomic and molecular lattice systems with the aim of using them as quantum simulators, as quantum information processors, and to perform high precision spectroscopy.

Faculty Awards and Transitions

Selected Honors and Awards to Faculty & Staff

John Bohn – Awarded faculty title *Research Professor* (2008)

Oliver DeWolfe – Junior Faculty Development Award (2007)

Michael Dubson – CU Parents Association Marinus Smith Award (2007)

William T. Ford – Faculty Research Fellowship (2008-2009)

Matthew Glaser – CU Innovation Seed Grant Award (2007)

Martin Goldman – Magnetospheric Multi-scale (MMS) mission independent science investigation, $3.325M over a ten-year period for the study of "Simulations of Magnetic Reconnections"

John L. Hall – Nobel Prize in Physics (2005)

Nils Halverson – Alfred P. Sloan Research Fellowship (2008)

Michael Hermele – Council on Research and Creative Work Junior Faculty Development Award (2008)

Mihaly Horanyi – Fellow of American Geophysical Union (2008)

Deborah S. Jin – Benjamin Franklin Medal (2008)

Henry Kapteyn – Fellow, American Association for the Advancement of Science (2007)

At the close of Spring Semester 2008, the Department welcomed Paul Beale as its new Chair and Mike Dubson as incoming Associate Chair.

Outgoing Chair John Cumalat and Associate Chair Allan Franklin received praise and gratitude for their outstanding contributions to the Department during the 12 years of their able stewardship.

Ed Kinney – Fellow, American Physical Society (2007)

Judah Levine – Department of Commerce Gold Medal (2007)

Heather Lewandowski – Air Force Young Investigator Award (2007), NSF Career Award (2007-2010), Junior Faculty Grant from the Petroleum Research Fund from the American Chemical Society (2008-2009)

Kyle McElroy – Alfred P. Sloan Research Fellowship (2008)

Tobin Munsat – DOE Plasma Junior Faculty Development Award (2005-2008)

Margaret Murnane – University of Colorado Distinguished Professor (2008)

Jerry Peterson – Jefferson Fellow (2008)

Steven Pollock – CU Presidential Teaching Scholar (2008)

Leo Radzihovsky – Faculty Research Fellowship (2008-2009)

Patricia Rankin – Best Should Teach Award (2007); Chancellor's Committee for Women Award (2008); Dorothy Martin Award (2008)

Ivan Smalyukh – Junior Faculty Development Award (2008), CU Innovation Seed Grant Award (2008)

Jun Ye – Friedrich Wilhelm Bessel Award (2007)

Shijie Zhong – Faculty Research Fellowship (2007-2008)

Eric Zimmerman – JSPS (Japan Society for the Promotion of Science) Invitation Fellowship (2008-2009)

Staff News

Long-time undergraduate secretary, **Linda (Frueh) Wellmann**, is back in the office part time assisting with Carl Wieman's Physics Education Technology (PhET) Group and the Science Education Initiative (SEI) program and as back-up receptionist for the Physics Department.

Ellen Frohsinn retired in 2007 after 12 years as building manager of Duane Physical Sciences. She is enjoying sleeping in, building her new home in Berthoud, Colorado, volunteering at the humane society, and being retired!

Memorial

Professor Emeritus William A. Rense of Physics at CU-Boulder, a founder of the Laboratory for Atmospheric and Space Physics (LASP), passed away in Estes Park on March 28. He was 94. Rense grew up in Cleveland and earned a bachelor's degree in physics and astronomy at Case Western Reserve University in Cleveland. He earned master's and PhD degrees in physics from the Ohio State University.

Early in his career, Rense taught at Rutgers University, the University of Miami, Texas A&M University, and Louisiana State University. In 1949, he accepted a permanent position in the CU-Boulder Physics Department, where he remained until his retirement in 1980. He began working in CU-Boulder's Upper Air Laboratory, which he helped develop into LASP. Rense was LASP's first director.

Among Rense's many scientific contributions was the discovery of the lyman alpha spectral hydrogen signature, which led to better understanding of the properties and chemical composition of the sun. He published numerous research articles, authored a textbook on physical science, and was the recipient of several million dollars in research funding from NASA and other federal agencies. His true pride and legacy, however, were the students he taught and inspired, many continuing on to major careers in academics, the sciences, medicine, and business.

Professor Emeritus Raul A. Stern an expert in plasma physics at CU-Boulder, passed away on June 22, 2008, following a long illness. He was 79. Born in Bucharest, Romania, Stern received a BS degree in 1952 and an MS degree in 1953 from the University of Wisconsin-Madison. He earned his PhD in 1959 from the University of California, Berkeley and completed postdoctoral studies in aeronautical sciences there in 1960. At UC Berkeley, from 1955 to 1960, he was an instructor and research associate. From 1960 to 1981 he worked in the scattering and low-energy physics research department at Bell Telephone Laboratories' research laboratory in Murray Hill, N.J.

Stern came to CU-Boulder in 1978 where he was rostered in the department of astrophysical, planetary and atmospheric physics from 1978 to 1996 and served as a physics professor. While at CU, he received several appointments as a visiting professor or research physicist, including posts at New York University; University of California, Los Angeles; the Center for Research in Plasma Physics at the École Polytechnique Fédérale in Lausanne, Switzerland; University of California, Irvine; Université de Provence in Aix-Marseille, France; École Polytechnique in Palaiseau, France; and California Institute of Technology (CIT). He was a Sherman Fairchild Fellow at CIT in 1986. He was a fellow of the Center for Integrated Plasma Studies at CU-Boulder and a member of the Institute of Plasma and Fusion Research at UCLA. Stern also served on the Boulder Faculty Assembly and several of its committees.

Stern was a leading expert in the use of tunable dye lasers for making measurements on plasmas by induced ion fluorescence. When he served as a visiting scientist at other labs, he helped to install laser scattering tools and to start vigorous research programs. He enjoyed mentoring young scientists and helped launch several into successful careers.

Theodore Maiman, renowned physicist who earned his bachelor's and master's degrees in engineering physics at CU (PhD, Stanford, 1955), passed away in May 2007, in Vancouver, B.C. at the age of 79. On July 7, 1960, Maiman demonstrated the world's first laser on a device that was small enough to fit in his hand. Since that time, lasers have been used to solve an incredibly diverse set of problems—from reading bar codes to guiding missiles.

Abrasive Jet Machining Comes to CU

CU-Boulder instrument maker Charles Bowen still uses the 1956-vintage tool room lathe (left) and will soon use the Omax abrasive jet machining center (right) to make precision instruments for CU researchers.

The CU-Boulder Physics Instrument Shop bridges the worlds of precision machining for instrument making and cutting-edge research for the physical sciences. The shop's seasoned instrument makers can use researchers' designs supplied as CAD program outputs or sketches on napkins to create the precision devices needed for experiments. In fact, the availability of the Physics Instrument Shop is often mentioned in research proposals as a distinguishing qualification of CU-Boulder. The shop works in glass, plastic, and metal to meet the needs of graduate student researchers, research professors, and anyone in the CU system. Once, the shop even fabricated a part needed to repair the campus power plant.

Set up in the 1960s, the Physics Instrument Shop purchased quality equipment that has stood the test of time. That tradition continues with the purchase this year of a state-of-the-art Omax abrasive jet machining center. This new tool can cut every material, from paper to titanium, using a very fine, garnet abrasive water jet that operates at 50,000 psi. The cut width on the Omax is about .015 inch, with a positional tolerance of only .0005 in or .0127 mm. In addition to extreme precision where needed, the new machine allows faster turnaround to rework precision components for research experiments. This quick response to experimental needs increases the productivity of CU's researchers.

The staff level of the shop has expanded and contracted, depending on research activity. Today, the supervisor, Tracy Buxkemper, and two additional instrument makers serve the needs of the physical sciences departments and engineering college. Over the years, Herman Stump, Norm Baer, Bill Foote, Karl Gebert, Tom Foote, Jim Kastengren, and Todd Asnicar have been supervisors of the precision shop. Nearly all of these instrument makers have come from careers at the National Bureau of Standards, now known as NIST.

Undergraduates

CU-Boulder student Ben Safdi, who graduated in May with dual degrees in engineering physics and applied mathematics, has possibly won the most honors of any recent graduate. Safdi maintained a 4.0 grade-point average and was named one of 13 Churchill Scholars in the United States for 2008, an award carrying a $25,000 academic scholarship for a year at Cambridge University in England. Safdi was also awarded a $120,000 National Science Foundation Graduate Research Fellowship for doctoral studies at Princeton to begin in fall 2009. During his undergraduate studies, Safdi conducted world-class research in two scientific fields, played the Japanese flute, appeared in a rock-climbing movies, and practiced martial arts.

Honors Graduates Spring 2008

Ellery Ames	Summa Cum Laude	Galan Moody	Summa Cum Laude
Zhon Butcher	Magna Cum Laude	Benjamin Safdi	Summa Cum Laude
Ashley Ellington	Magna Cum Laude	Darren Tarshis	Summa Cum Laude
Nathan Kirchhofer	Magna Cum Laude		

News from the Oliver C. Lester Library of Mathematics and Physics

By Suzanne T. Larsen, Faculty Director

Where did all the journals go? Lester Library, and the University Libraries on a larger scale, have made the commitment to provide online access to scholarly journals. Because it costs more to receive a journal both online and in print, we are ceasing to subscribe to print. Interestingly, one of the major scientific societies, the American Geophysical Union (AGU), has already declared that 2010 will be the last year for the publication of any of their journals in print.

Online journals are available to faculty, students, and researchers in their offices, at home, or even while away from CU. Access is determined by IP address for computers on campus and through VPN (Virtual Private Network) certification when off campus. The VPN software can be downloaded free from ITS. Anyone can use the online resources while on campus, but only CU-Boulder affiliates can access them remotely. In addition, through library funding and a generous gift, we subscribe to the archives of most of the important journals in the field of physics back to their first volumes.

Why does the library look so different? We've done some sprucing up! With fewer current journals in print, we were able to remove shelving near the entrance, move outdated reference books to the stacks, move the reference collection to the shelving across from the windows, and remove the former reference shelving. This resulted in a large open space with a view of the Flatirons beyond the JILA Tower.

Department News

The CU-Boulder Physics Department currently has more than 70 faculty members, and they participate in many interdisciplinary partnerships, including close connections with JILA, LASP (which was originally formed from Physics faculty), CIRES, CIPS and CIEI. The Physics faculty also have important ties to Chemistry, Engineering, Electrical Engineering, Biochemical Engineering, Applied Math, and MCDB. In 2008, the department had 214 graduate students and 375 Physics undergraduate majors, including Engineering Physics.

The Physics Department took first place for outstanding academic leadership in graduate and professional student success in the first annual President's Award for Outstanding Academic Leadership in Student Success in 2008. The awards were based on student achievement, including awards earned at national or international competitions, students' scores on standardized national exams, licensure or professional examination results, recognized scientific or creative achievements, and academic scholarships or fellowships such as the Rhodes, Marshall, Goldwater, Fulbright, and H. Truman scholarships. CU President Bruce D. Benson will present first-place winners with a cash award of $15,000, a plaque, and the President's Cup. The department's graduate program has grown significantly over the past decade to compete with Harvard, Stanford, MIT, and the University of California-Berkeley. Over the past three years, graduate students in the Physics Department have authored more than 400 reports in major professional journals such as *Nature, Science,* and *Physical Review Letters.*

Alumni News and Notes

Spencer Weart (PhD, 1968)

Spencer Weart is director of the Center for History of Physics of the American Institute of Physics. After graduation from CU, Weart taught at the California Institute of Technology and researched the sun's atmosphere using ground-based and space-based telescopes. In 1971, he entered graduate study in History at the University of California at Berkeley. He assumed his current position in 1974. The Center for the History of Physics preserves and publishes the history of the scientific discipline. As director, Weart has conducted and supervised tape-recorded oral history interviews of prominent scientists. He has helped preserve documentation in archives to help other scholars in their work. He has been closely involved with major projects preserving the history of modern astronomy, high-energy physics, lasers, geophysics, and solid-state physics, among other fields.

Christopher M. Sorensen (PhD, 1976)

This year, CU presented Chris Sorensen the George Norlin Award for his distinguished scientific career and devotion to education. Since graduating from CU with a doctorate in physics, Sorensen has become a University Distinguished Professor at Kansas State University. His research in the optics and dynamics of aerosols combines physics, chemistry, and engineering. He has won

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more than $10 million in research funding to study the properties of aerosols that increase understanding of the creation and control of pollution. He was awarded the David Sinclair Award by the American Association for Aerosol Science. He was named Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education. In addition to university teaching, Sorensen visits local high schools to encourage interest in science and engineering and has received the Making a Difference Award from KSU Women in Science and Engineering.

Roger G. Johnston (PhD, 1983)

In a 2006 article for *American Scientist,* Roger Johnston described his work on tamper-indicating seals. Johnston has been head of the Vulnerability Assessment Team at Los Alamos National Laboratory since 1992. He has authored more than 90 technical papers and 45 invited talks, and he holds 10 U.S. patents. He has won many awards including the Los Alamos Fellows Prize for Outstanding Research.

Joseph E. Pesce (BA, 1988)

After graduating from CU-Boulder, Joseph Pesce completed his PhD at Cambridge University and worked as a postdoctoral research fellow at the Space Telescope Science Institute in Baltimore, Maryland, from 1993 through 1997. He was a research fellow at the Pennsylvania State University and then a Senior Science and Technology Analyst for the U.S. Government until 2005. In 2005, he founded Omnis, Inc., a science and technology consulting and training firm. His scientific research involves the large-scale environments of the subtype of quasi-stellar objects (quasars) classified as BL Lacertae objects (BL Lacs). He teaches university courses in astronomy and astrophysics.

Kyle Dedrick (BA, 1990)

Through 2000, Kyle Dedrick served on active duty in the Navy. As a Navy Meteorology and Oceanography ("METOC") officer, his tours of duty included: working aboard a hydrographic survey ship during Operation Desert Storm; writing weather and ocean forecasts for ships of the Atlantic Fleet; teaching applied remote sensing and geographic information systems (GIS) to members of the armed forces; digitizing and publishing a 30-year compilation of northern hemisphere sea ice records originally maintained by the Navy throughout the Cold War; serving as Operations Officer at the Naval Ice Center in Suitland, MD; serving as Executive Officer of the Navy Reserve weather detachment at NAS Patuxent River, MD; teaching atmospheric transport and dispersion modeling to members of the armed forces; and supporting ensemble weather prediction research at the Naval Research Laboratory. In June 2007, the Navy Reserve selected him for promotion to the rank of Commander. As a DoD contractor, he manages meteorological data servers and numerical weather prediction 'clusters' in support of atmospheric transport and dispersion analyses conducted by the Defense Threat Reduction Agency (DTRA). In May 2003, he completed an MS in physics through a part-time graduate program at Virginia Polytechnic Institute and State University (i.e., Virginia Tech). He, his wife, and daughter live in Springfield, VA. Dedrick still enjoys ice skating and pick-up hockey games.

David Newell (PhD, 1994)

After graduating, David Newell worked as a post doc for one year with the JILA gravity group. Then he won an NRC postdoctoral fellowship and worked with the NIST Watt Balance/Electronic Kilogram Project in Gaithersburg, Maryland. He became a full-time NIST staff member in 1996. While continuing work on the next-generation NIST Watt Balance, he joined the NIST Microforce Realization and Measurement Project in 2000. This work looked at nano-scale forces traceable to the SI system of units. In 2004, he became a leader of the Fundamental Electrical Measurements group within the Quantum Electrical Metrology Division of NIST. He is a member of the American Physical Society and secretary for the CODATA Task Group on Fundamental Constants.

Heather Patrick (PhD, 1995)

After receiving her PhD, Heather Patrick worked for several years with the Optical Sciences division of the Naval Research Laboratory in Washington, D.C., developing fiber optic sensors for structural sensing and guidance systems. In 2000, she joined start-up Optinel Systems Inc. in Elkridge, Maryland, where she designed and tested amplified fiber optic links for digital cable TV subsystems. Since 2005, she has been working under contract to the Optical Technology Division at NIST in Gaithersburg, Maryland. She is establishing accuracy and traceability for scatterometry — a non-imaging, diffraction-based optical measurement technique that provides a fast, non-destructive alternative to scanning electron microscopy and atomic force microscopy for determining the dimensions of nanometer-scale lines on semiconductor wafers. She and her husband, David Newell, (see above) have two children, ages five and three.