Expecting the Extraordinary
Carnegie Mellon High-Energy Particle Physicists Seek Nature’s Subtle Secrets

Also in this issue:
New and Retiring Faculty • Science Van on the Road • Alumni News • Student Honors • Online Science Learning • Joint Computational Biology Ph.D. • NMR Center
Rarely in the life of our college do we get a moment to celebrate the remarkable talent that underpins our reputation with other universities, funding agencies and the public. This issue of the MCS Newsletter acknowledges some of that talent and showcases just a few highlights of our exceptional interdisciplinary science and pedagogy. Activities over the last year, from prestigious awards to scientific discoveries, continue to attest to our unique character and leadership in research and education.

I am especially pleased to report news that reflects the strength of our junior faculty. For example, this year, Roy Briere became co-spokesperson for CLEO, a large, international collaboration of high-energy physicists. Briere’s work with CLEO and the activities of several other collaborations are profiled in our cover story on the key role MCS faculty are playing in the exciting future of high-energy physics (see pages 10–13). I’m also impressed by individuals like biologist Russell Schwartz, who was one of a select group nationwide to receive a prestigious Presidential Early Career Award for Scientists and Engineers. These are just two examples of the talented leaders MCS has attracted (see pages 5 and 15–16). “News Briefs” contains many examples of impressive research findings and awards by junior faculty (see pages 1–2). Some very exciting findings are directly linked to unique facilities such as the NMR Center, which plays a vital role in pre-clinical biomedical research (see back inside cover).

This year, MCS also continued to benefit from steadily increased research funding at a time when securing such funding has become highly competitive. Our educational programs are also growing. Together with the University of Pittsburgh, we are launching a Ph.D. program in computational biology (see page 14). We also are partnering with investigators across the university in an ambitious project, the Open Learning Initiative (OLI), to evaluate online interactive tools that help students learn principles of chemistry and biology (see pages 4–5). And we continue our enthusiastic commitment to inspiring young scientists in western Pennsylvania (see pages 8–9) at a time when pre-college laboratory experiences are often limited.

I’m especially pleased to report that alumni, foundations and friends are helping us to expand and improve graduate and undergraduate student support (see page 6 and 14). Such generosity is critical for MCS to continue producing student leaders and alumni who are shaping their disciplines and educating future scientists at other institutions (see pages 3, 6 and 7).

As you read through this issue, I hope you will appreciate—as I do—how MCS continues to grow as a dynamic, innovative institution. Please continue to visit us at www.cmu.edu/mcs to see the impact we’re making in your world.

Richard D. McCullough
Dean, Mellon College of Science
Alumnus John Hall Receives Nobel Prize in Physics

John Hall, who received his bachelor of science (1956) and doctoral degree (1961) in physics from the Carnegie Institute of Technology, is a 2005 recipient of the Nobel Prize in Physics for “contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique.”

Co-recipients of the $1.3 million prize include collaborator Theodor Hänsch of the Ludwig-Maximilians-Universität in Munich, Germany, and Roy Glauber of Harvard University. A senior scientist at the National Institute of Standards and Technology in Boulder, Colorado, Hall together with Hänsch developed the optical frequency comb technique. This method provides an extremely precise way to measure the frequency of light emitted from molecules and atoms. “This technique makes it possible to carry out studies of the stability of the constants of nature over time and to develop extremely accurate clocks and improved GPS technology,” stated a press release issued about the Prize by the Royal Swedish Academy. At Carnegie Mellon, Hall was a graduate student of Robert Schumacher, emeritus professor of physics.

Astrophysicist’s Article Honored

An article by Jeff Peterson, professor of physics, was recognized by ISI® as one of the most highly cited papers in space sciences in 2004. Published in Astrophysical Journal/600, the article, “High-Resolution Observations of the Cosmic Microwave Background Power Spectrum with ACBAR,” features the most descriptive, sensitive images to date of cosmic microwave background radiation. This data provides information about the earliest moments of the universe after the Big Bang.

Black Holes at the Heart of Galaxy Formation

Using a new computer model of galaxy formation, Tiziana Di Matteo, associate professor of physics, and collaborators at the Max Planck Institut fur Astrophysik in Germany and Harvard University showed that growing galactic-central black holes release a blast of energy that fundamentally regulates galaxy evolution and black hole growth itself. The report on this simulation and associated findings appeared in the February 10 issue of Nature and received international press coverage.

Zoë Finds Life in Atacama Desert

In a first, Zoë, a rover with automated technology developed at Carnegie Mellon, has identified life in Chile’s Atacama Desert. During the second field season of the NASA-sponsored Life in the Atacama project, Zoë was equipped with a highly sensitive fluorescence-imaging life-detection system designed by Alan Waggoner, director of the Molecular Biosensor and Imaging Center. The results of field expeditions ultimately may enable future robots to seek life on Mars. The New York Times and other major media outlets covered Zoë’s successes.

Making Gene “Archaeology” Easier

Using Notung—a powerful new software program—scientists can use evolutionary clues to understand what genes do in modern organisms. Developed by Associate Professor of Biological Sciences Dannie Durand and her team of investigators, Notung considers thousands of evolutionary scenarios to arrive at an informed, probable estimate of when a given gene arose. Such information could be used to plan additional gene studies or suggest strategies for circumventing drug and pesticide resistance in parasites.

Neurons Glow Green

Alison Barth, assistant professor of biological sciences, has developed the first tool to identify and study individual neurons activated in a living animal. This advance, described in The Journal of Neuroscience, should help scientists see which neurons are active in different neurological diseases and should facilitate rational drug design.

Delivering a Genetic Tool into Living Cells

An MCS research group, led by Assistant Professor of Chemistry Danith Ly and graduate student Anca Dragulescu-Andrasi, has developed a new way to introduce a genetic tool called a peptide nucleic acid directly into live mammalian cells. The work, published online in Chemical Communications, holds considerable promise in genetic engineering, diagnostics and therapeutics.
News Briefs
(Continued from page 1)

New Form of Fe-TAML® Synthesized
A team of chemists led by professors Terry Collins and Eckard Münch has successfully synthesized an Fe-TAML® activator that reacts avidly with oxygen. This novel chemistry opens new ways to harness oxygen for efficient, cost-effective green industrial oxidation processes, including remediating environmental problems and modifying industrial processes to make them more efficient and productive.

Speeding Metallic Glass Design
Professor of Physics Michael Widom has created a computational approach to speed the discovery of recipes for amorphous metals, also called metallic glass. Compared to materials like stainless steel, metallic glass is highly elastic and slow to break or corrode. Widom’s method, detailed in Physical Review B, has already been used to generate recipes for more than 1,700 structures. It should reduce considerably the trial-and-error time in the laboratory normally required to make metallic glass.

Studying, Resolving PCB Contamination in Rivers
A research team led by William Brown, professor of biological sciences, has conducted the first-ever side-by-side comparison of sediments taken from two rivers in upstate New York contaminated with polychlorinated biphenyls (PCBs). Using DNA fingerprinting to analyze the sediments, the team discovered distinct bacterial populations that digest PCBs at different rates. Their work provides convincing evidence that how quickly a PCB breaks down and what it becomes depends on where it settles. The research team ultimately hopes to coax bacteria with a preference for PCBs into becoming more dominant life-forms in sediments.

Strange Quark Plays Role in Proton Structure
The G-Zero collaboration, including a group of Carnegie Mellon physicists, has found that the strange quark contributes to properties of the proton. While previous experiments have hinted at this connection, this G-Zero research provides evidence that the strange quark influences the proton’s charge and magnetization. The G-Zero collaboration performs research at the Department of Energy’s Jefferson Lab in Newport News, Va.

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PSC Unveils Powerful Computing System
The Pittsburgh Supercomputing Center has unveiled its newest and most powerful system, the Cray XT3, also known as “Big Ben.” The latest stage in the evolution of high-performance computing technology and a major boost for computational science in the United States, Big Ben comprises 2,090 processors with an overall peak performance of 10 trillion calculations per second.

Mentored, Cutting-Edge Research Experiences in Molecular Biosciences
The Department of Biological Sciences has re-established a Research Experiences for Undergraduates (REU) site with support from the National Science Foundation. The competitive program brings students from small colleges and universities that lack extensive research programs to Carnegie Mellon for 10 weeks to conduct intensive, mentored research projects. In recent years, nearly 70 percent of REU alumni have entered Ph.D. programs in the sciences while the rest have gone to medical school or directly into scientific employment.

Tribute: Philip Morrison
Philip Morrison (S’36), Manhattan Project scientist and consequent campaigner against nuclear proliferation, died on April 22 at age 89. After earning his undergraduate degree at the Carnegie Institute of Technology, Morrison completed a doctorate in physics at the University of California, Berkeley. He chaired NASA’s early study groups on the search for extraterrestrial intelligence and helped establish an organized program in 1992. In 1964, he joined the Massachusetts Institute of Technology’s Department of Physics, where, in the next four decades, he conducted research in high-energy astrophysics and cosmology, co-authored two books and educated the public about science.
Catherine Hofer, a 2005 biological sciences graduate, has received an Honorable Mention for a Graduate Research Fellowship from the National Science Foundation. She will attend graduate school at Yale University in the Molecular Cell Biology, Genetics and Development track of the Combined Program in Biological and Biomedical Sciences. Hofer also received a Teagle Foundation Scholarship.

Claire Tomesch is the recipient of a Department of Homeland Security Scholarship, which is designed to educate and inspire university tuition and fees, a monthly stipend for nine months and a summer internship at a Department of Homeland Security-designated facility between her junior and senior years.

Pfizer has awarded Jasper Weinberg a 2005 Undergraduate Summer Research Fellowship for Molecular Biology. This $5,000 award allowed Weinberg, a senior biological sciences major, to spend his summer working in the laboratory of Brooke McCartney, assistant professor of biological sciences at Carnegie Mellon. His research focuses on the role the adenomatous polyposis coli 2 protein plays in the organization of a cell’s inner scaffolding during fruit fly development.

Sophomore Jennifer Anttonen was awarded the Barry M. Goldwater Scholarship, which was established to foster and encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences and engineering. Anttonen, a physics and creative writing major, was one of 320 students nationwide receiving the $15,000 scholarship this year. She conducts research with Carnegie Mellon’s Experimental Medium Energy Group.

Deboshri Banerjee, a doctoral candidate in chemistry, has been selected as a Teresa Heinz Scholars for Environmental Research for innovative green chemistry research to rid water of biohazards and persistent toxic chemicals. Banerjee, one of only eight doctoral students to receive this $10,000 award this year, has optimized catalysts known as Fe-TAML® activators to kill spores of a cultured, benign anthrax simulant.

During the 2004–2005 academic year, two MCS students received stipends and research support from the Arnold and Mabel Beckman Foundation to conduct research and pursue their undergraduate studies. Jamie Conklin, a senior biological sciences major, is conducting a proteomic analysis of cell shape changes during gastrulation in Drosophila. Ashley B. Krankowski, a senior chemistry major, is working on synthesizing new conductive elastomers with potential applications in electronics. The 2005–2006 Beckman Scholars are William Eimer, a sophomore biological major, and Ryan Malecky, a sophomore chemistry sciences major. Eimer is using Difference Gel Electrophoresis to improve blood serum proteome analysis. Malecky is using tartrazine and its derivatives to understand how Fe-TAMLs oxidize Azo dyes.

Carnegie Mellon’s prestigious Dickson Prize in Science. Whitesides, the Woodford L. and Ann A. Flowers University Professor at Harvard University, is one of the pioneers in molecular self-assembly and in using enzymes in large-scale organic syntheses.

Chien Ho Honored

Scientists from around the world gathered at the Mellon Institute in November to participate in a symposium honoring Chien Ho, director of the Pittsburgh NMR Center for Biomedical Research and Alumni Professor of Biological Sciences. Ho is well known for conducting groundbreaking research in the application of nuclear magnetic resonance to living systems.

WaterMellon Workshop

Mathematicians from the University of Waterloo (Ontario, Canada) and Carnegie Mellon gathered on Carnegie Mellon’s campus in May to participate in the WaterMellon Workshop on Extremal Graph Theory. Research groups from both universities shared ideas on extremal graph theory, including random graphs, algorithmic aspects and applications in economics and computer science.

Buhl Lecture

The Department of Physics sponsored the 2005 Buhl Lecture, “E=mc²,” featuring Hitoshi Murayama, a theoretical physicist and professor at the University of California. During his lecture, Murayama discussed the impact of Einstein’s famous equation, part of the theory of relativity that changed our understanding of nature at the most fundamental level.

Dickson Prize Awarded to Pioneering Chemist

George M. Whitesides, considered one of the world’s most creative chemists, received

MCS Events

Homecoming 2005

Homecoming 2005 is October 27–30.

MCS Alumni Reception

Friday, October 28, 4–6 p.m.

Victor M. Bearg Physics Museum

A300 Hallway, Doherty Hall

See www.cmu.edu/alumni for information. Hope to see you there!
Enter a Chemistry Lab—Online

The video starts with a polluted river in Bangladesh, while the voiceover explains that the United Nations helped the Bangladeshi people install tubewells to access clear water underground. The camera pans across photos of Bangladeshis drawing water from the wells. “In 1993, chemists discovered that a hidden killer was concentrated in the groundwater—arsenic, a poisonous element.” Now we see that some of the wells have been painted red to indicate danger. Still, people draw water from them because they have no alternative. The health costs are evident in the photos of people with gangrene, skin cancer and conjunctivitis. “Clearly, something must be done very soon to remove arsenic from Bangladesh’s water supply,” the voiceover says. “But what?”

Is this a recent Frontline segment? No. It’s a scenario in Carnegie Mellon’s Open Learning Initiative (OLI) Chemistry course on stoichiometry, designed by Associate Professor of Chemistry David Yaron, cognitive scientist Gaea Leinhardt of the Learning Research and Development Center at the University of Pittsburgh, and OLI Director Candace Thille. The multimedia production engages students using a virtual laboratory, real-world scenarios, videos, voiceovers and problem-solving assistants called pseudotutors.

“Scenarios help students see why the chemistry they are learning is useful,” Yaron says. “A story helps them remember.”

Multimedia Stoichiometry

The arsenic scenario was designed to help students learn stoichiometry—the chemist’s method of handling quantitative relationships in reactions—to address a real-world problem. In Introduction to Modern Chemistry at the Mellon College of Science, stoichiometry is not covered in first-year chemistry lectures because it represents review for most students. Instead, entering students review the subject themselves and pass a test in stoichiometry to demonstrate mastery of this key skill as part of their first chemistry course.

The OLI Stoichiometry Module, launched in August 2005 and to be evaluated this fall, was designed to help students study for and pass this test and may also be useful for those in high school who are learning the material for the first time.

Because it is intended for independent study, the module contains a variety of features. To substitute for and enhance those available in traditional classrooms, some of the videos advance the arsenic story line and others demonstrate how to perform the mathematical manipulations needed for stoichiometric calculations, as a professor would in a lecture.

Following each video, students reflect on what they have learned, answer multiple-choice or short-answer questions on the material and receive instant feedback to reinforce concepts or correct errors, similar to the assistance provided by a tutor.

For more complex calculations, the course uses a structured problem-solving template called a “pseudotutor,” which offers hints and feedback for that specific problem.

Virtual Lab

At the most intellectually challenging and rewarding level of the course, students enter the Virtual Laboratory to solve problems. The Virtual Lab has previously been used by more than 20,000 students in classes at Carnegie Mellon and other universities.

“A scenario like arsenic contamination in ground water links real-world problems to the world of chemistry,” Yaron explains. “The Virtual Lab is an equally important component to bridge between the world of chemistry and mathematical manipulations.”

Developed by Yaron and his team that included many undergraduate researchers, this award-winning Virtual Lab simulates all of the chemical processes and apparatus (e.g. glassware, pH meters, balances, spectrometers, etc.) needed to solve problems with titles like “Determine whether this sample of water from Bangladesh is safe to drink,” and “Can density be used as a sensitive measure of arsenic content?” Everything from the overall story line, structure and length of the course materials to the order and phrasing of questions and hints is driven by this understanding of students’ learning and problem solving. Leinhardt and Thille have provided guidance in structuring the course according to the latest understanding of how students learn.

Science of Learning

As part of its design, the online course has a feature to further investigate the learning process. A logging function records every entry a student makes—with the student’s approval—and provides insight into problem-solving strategies and patterns of misunderstanding. This data will funnel into research at the recently established Pittsburgh Science of Learning Center, a joint initiative between Carnegie Mellon and the University of Pittsburgh supported by a $25 million, five-year grant from the National Science Foundation.

Plans for more chemistry modules to supplement this first one are already under way. Yaron wants to find even more ways to make chemistry more relevant to students.

The free online version of the OLI Chemistry Course is available to anyone with Web access at www.cmu.edu/oli. A for-credit version of the complete chemistry course, subject to tuition fees, will eventually be available to students at other institutions. The OLI is funded by a grant from the Hewlett Foundation.
New & Retiring Faculty

Retiring Faculty

Three MCS professors are retiring in 2005: William R. McClure, professor of biological sciences; Robert F. Stewart, professor of chemistry; and Charles H. Van Dyke, associate professor of chemistry.

William R. McClure
William R. McClure joined the Department of Biological Sciences in 1981 as an assistant professor and became a professor in 1982. In his research in polynucleotide enzymology, McClure has elucidated operation and regulation mechanisms of RNA polymerase in Escherichia coli. From 1987 to 1992, McClure served as executive editor of the journal Nucleic Acids Research. He has also served on the National Science Foundation (NSF) biochemistry study section from 1982 to 1985 and the National Institutes of Health (NIH) microbial physiology and genetics study section from 1986 to 1990, a section he chaired from 1988 to 1990. From 1989 to 1996, he served on the advisory panel of the NIH Office of Scientific Integrity. McClure also has played a key role in developing Molecular Models for Biochemistry, a Web site that includes 3-D animated images of important biochemical molecules.

Molecules in Motion
Just as students in an origami class fold and manipulate their own pieces of paper to create beautiful birds, students in biology classes at Carnegie Mellon can manipulate 3-D models of important biological structures to understand complicated processes like protein synthesis and DNA replication, which often are difficult to conceptualize. Chime and RasMol images of many molecules and macromolecules found in biochemistry are available on Carnegie Mellon’s Molecular Models for Biochemistry Web site, which was first developed in 1995 by biology professors Will McClure and Gordon Rule. Now, the models and animations have been integrated into an online modern biology course, which is part of the OLI.

For more information, visit: http://telstar.ote.cmu.edu/biology/

Robert F. Stewart
Robert F. Stewart joined the Mellon Institute in 1964 and the Department of Chemistry in 1967, where he became a professor in 1975. Stewart conducted research in charge density studies, the study of nuclear and electronic charge distribution in crystals. Well known for his research, Stewart provided much of the foundation for modern X-ray crystallography, a highly effective technique for deducing the molecular and atomic structure of a substance. His extensive contributions were recognized at the 62nd Annual Pittsburgh Diffraction Conference held October 2004 in his honor.

Charles H. Van Dyke
In 1964, Charles H. Van Dyke joined the Department of Chemistry, where he conducted research in inorganic chemistry, organometallic chemistry of the Group IV elements, and the study of hydrogen compounds of this same group of elements. From 1986–2001, he served as the department’s director of undergraduate studies. Van Dyke pioneered innovative computer molecular modeling techniques for introductory chemistry students. From 1985 to his retirement, he was academic coordinator of Carnegie Mellon’s Advanced Placement/Early Admission program. In 1977, he won Carnegie Mellon’s William H. and Frances S. Ryan Award for Meritorious Teaching and the NSF Science Faculty Professional Development Award.

New Faculty

Mathias Lösche
Biological physicist Mathias Lösche joined the Department of Physics as a professor in September 2005. He completed his doctorate at the Technical University of Munich and postdoctoral research at the University of California, San Diego. In 1994, Lösche became a Leipzig University physics professor. In 2003, he became a Johns Hopkins University research professor and director of the Cold Neutrons for Biology and Technology Initiative, located at the National Institute of Standards and Technology’s Center for Neutron Research.

Robert Pego
Robert Pego joined the Department of Mathematical Sciences as a professor in fall 2004. After completing his doctorate in applied mathematics from the University of California, Berkeley and holding a postdoctoral research position at the University of Wisconsin, Pego was on the faculty at the University of Michigan and the University of Maryland. For the past 20 years, his work on dynamic scaling and the study of non-linear waves has been supported continuously by the NSF.

New Positions

William Alba
In August 2005, William Alba became the director of Carnegie Mellon’s Science and Humanities Scholars Program, run jointly by MCS and the College of Humanities and Social Sciences. In 1992, Alba earned his Ph.D. in chemistry from the University of California, Berkeley. Alba has held research, teaching and administrative leadership positions at Bard College, the School of the Art Institute of Chicago, St. John’s College in Santa Fe and New York City’s Bard High School Early College.

Christopher Borysenko
Christopher Borysenko, a physical biochemist, joined MCS in fall 2004 as director of its interdisciplinary undergraduate science laboratories. Borysenko earned a doctorate in bioorganic chemistry at Brandeis University in 1998. From 1996 to 1999, he designed and managed a Harvard University Extension School laboratory course in organic chemistry. From 1998 to 2000, he worked as a research scientist at Biogen, Inc. After a postdoctoral research position from 2000 to 2002 at the University of Pittsburgh School of Medicine, Borysenko worked as a research chemist at the Veterans Affairs Pittsburgh Healthcare System.
Robert Bowser (S’87), associate professor of pathology at the University of Pittsburgh School of Medicine, has founded a biotechnology firm, Knopp NeuroSciences, Inc., to commercialize a panel of protein biomarkers he has discovered for amyotrophic lateral sclerosis, or Lou Gehrig’s disease.

Anindya Ghosh (S’04) has received the prestigious 2005 Kenneth G. Hancock Memorial Student Award in Green Chemistry from the American Chemical Society (ACS).

Mark S. Gordon (S’68), Distinguished Professor of Chemistry at Iowa State University and director of the applied mathematics and computational sciences division of the Ames Lab, was elected in 2004 to the International Academy of Quantum Molecular Science.

Alan Colburn (S’83) received a 2003–04 Distinguished Faculty Teaching Award from California State University, Long Beach. Alan is an associate professor of science education at Cal State Long Beach and a recognized expert in inquiry-based teaching.

Robert Gilbert (S’55) received the Alexander von Humboldt Senior Scientist Award for his research on homogenization of bone and for models of ultrasound measurements on bones.

Randy Headrick (S’82), assistant professor of physics at the University of Vermont, was awarded a five-year, $610,000 grant from the National Science Foundation through its Faculty Early Career Development program.


Joseph R. Staniszewski (S’50) of Haddon Township, New Jersey, donated memorabilia from the Ranger project to Carnegie Mellon’s Victor M. Bearer Physics Museum.

Mark Aldon Weiss (S’81) of Germantown, Maryland, received the BEProud Award for Exceptional Performance from the United States Department of the Treasury’s Bureau of Engraving and Printing.

Gifts Benefit Education and Research in Physics

The Department of Physics will sustain and enhance its leading programs in research and education thanks to gifts totaling close to $1 million this year from the families and estates of two late alumni—Xerox PARC founder George E. Pake and former physics department head Raymond A. Sorensen. The estate of George Pake (S’45) and his wife, Marjorie S. Pake, gave more than $550,000 for doctoral fellowships in physics. Raymond Sorensen (S’58) and his family gave close to $400,000 for undergraduate scholarships and support for other programs and initiatives in the department.

“The top priority for our graduate program is endowed fellowships. The wonderful gift from the Pake family will be tremendously beneficial to our program, and it is particularly appropriate for it to be associated with a world-renowned physicist, George Pake,” said Fred Gilman, head of the Department of Physics and Buhl Professor of Theoretical Physics.

Pake earned B.S. and M.S. degrees in physics in 1945 from the Carnegie Institute of Technology and his Ph.D. in physics from Harvard University in 1948. Pake held positions at Harvard University, Stanford University and Washington University, where he served as executive vice chancellor and provost. He conducted research that proved foundational to the development of modern magnetic resonance imaging. In 1970, Pake founded and led the Xerox Corporation’s Palo Alto Research Center. In 1987, he was honored with the National Medal of Science.

“Ray Sorensen was an outstanding physicist and valued colleague,” said Gilman. “His bequest, split between undergraduate scholarship funds and an unrestricted gift, will make possible support of both the educational and research goals of the department.”

Sorensen earned degrees in physics—a bachelor’s in 1953 and a doctorate in 1958—from the Carnegie Institute of Technology. After a year at the Niels Bohr Institute in Copenhagen and two years at Columbia University, Sorensen returned to Carnegie Mellon’s Department of Physics, where he was head from 1980 to 1989. He retired in 1997. At Carnegie Mellon, Sorensen conducted research in theoretical nuclear physics and taught classes at undergraduate and graduate levels. In the mid-1960s, he and colleague Lincoln Wolfenstein played key roles in launching medium-energy physics.

The department currently has 75 graduate students who pursue research in a range of fields and assist in undergraduate teaching. The 132 undergraduate majors conduct research in the department or in other Carnegie Mellon departments. Past physics undergraduates have co-authored journal articles and patents and, after graduation, they have joined leading graduate programs in physics or become employed with innovative corporations.

We welcome further news of alumni honors, as well as suggestions for future faculty and alumni profiles. Please send clippings, URLs or ideas to Rea Freeland, associate dean for special projects, at rf51@andrew.cmu.edu.
Alumni in Action
MCS Alumnus Steve Joachim Provides Leadership for Securities Industry

Most of us follow the stock and other securities markets through newspapers and Web sites and with the help of brokers. Steve Joachim has experienced the dynamics of these markets from the inside.

Throughout his career, Joachim has witnessed technology transform the financial sector. Computational modeling grew to be a critical part of the securities industry. Dealers and investors switched from telephones to computers and the Internet for communication and information-sharing. And available information about securities expanded exponentially. Joachim used his unique training to help his companies weather the financial market falls of 1987 and 2000. Then, just several years later, he launched a database that is now dramatically changing the securities industry.

And it all started with his undergraduate work at Carnegie Mellon, the beginning of an education that he describes as the foundation of his current success at the National Association of Securities Dealers (NASD) and in other posts he has held along the way.

A Unique Education
Joachim earned his undergraduate degree in mathematical sciences (S’71) and a master’s degree in public management (HNZ’75) from Carnegie Mellon and a master’s degree in political science from Duquesne University. He has spent more than 20 years in finance, first with Bankers Trust and then with Merrill Lynch. At Merrill Lynch he served as business manager equity trading and director of floor broker services, first vice president, business architect for capital markets, and chief technology officer for equity markets.

He went on to become the Chief Operating Officer and Chief Strategy Officer of Plural, a custom interactive software development and strategy firm. He guided the firm during the dot-com boom, when Plural experienced a more than fourfold expansion until 2000. Then the dot-com bubble burst. The company shrank back to near to its original size by 2002.

Preventing Financial Disasters
Not long after this experience, a recruiter asked Joachim if he would be interested in joining NASD, the private sector self-regulatory arm of the securities industry whose mission is to bring integrity to the markets and to protect investors. NASD members include all broker dealers doing business with the United States public—about 5,200 firms, more than 104,000 branch offices and more than 660,000 registered securities representatives. Joachim saw the position as an opportunity to use his skills and experience to serve the public interest and to prevent disasters like the dot-com speculative bubble.

“I joined because I thought that regulation was going to be critical to the industry in the aftermath of the late ’90s,” Joachim said, “and because my specific role offered an opportunity to play a major part in revolutionizing the way bonds are traded.”

Of his industry, Joachim added, “There’s no question that we’re starting a new stage of evolution. And we’re more interested than ever before in building stronger financial, analytical, problem solving and technology skills that will allow us to get ahead of the curve, so that we can anticipate rather than simply react to change in the marketplace.”

As executive vice president of transparency services for NASD, Joachim directed the launch of TRACE, a real-time database of market transaction reports. Prior to TRACE, each dealer set its prices independently. Investors could not see comparable prices and had no way of judging if they received a fair price. TRACE provides investors with reliable and up-to-date information so they can check comparable prices and ensure that they are getting competitive rates. Joachim and others in his field describe TRACE as a major victory for investors.

Looking Ahead
Getting reliable information to the public is a large part of regulating the securities industry, one that is both enabled and challenged by the latest technology. Prior to the 1990s and the Internet, investors needed to go to a broker or dealer for information. Now, information is everywhere. The securities industry, however, still faces the problem of how to make sure that people receive reliable, consistent and accurate information on which to base their investment decisions. Joachim points to this problem as a major new focus in the field of securities regulation.

The volume and speed of transactions also are increasing as technology becomes more advanced and information becomes more accessible.

“In the 1960s, the New York Stock Exchange had to close on Wednesdays because they couldn’t handle the flow of paper,” said Joachim. “In 1968, they were doing 6 million shares a day. Now we’re doing 6 million shares in the first second of the market. We trade 1.5 billion shares a day.”

With technology and the securities marketplace constantly changing and growing, regulatory groups like the NASD require a new brand of professional able to anticipate market changes, leverage technology and stay one step ahead.

“The set of skills you need to be a successful regulator today are analytics, technology, business skills, all the basic core skills that Carnegie Mellon draws people toward,” said Joachim, who values mathematics as the root of these core skills. “Mathematics provides a terrific foundation. It is the basis for all the sciences, engineering, technology and the business world. I think it gives you the flexibility to do almost anything.”
Taking Science on the Road

The middle school years are a crucial time for maintaining and cultivating interest in science and mathematics. Carnegie Mellon’s Science Van program brings science to life for middle school students through hands-on demonstrations and auditorium performances. The “Science Van Guys” also work with science teachers, showing them engaging, thought-provoking and fun activities for students that they can use in their own classrooms. Since 1998, the Science Van has interacted with more than 600 teachers and approximately 12,000 students.

One of the greatest scientific concepts introduced in middle school is the existence of atoms. The Science Van Guys — Garry Warnock and John Ziegler — set out to convince a group of middle school students that atoms do exist, even if they are smaller than the human eye can see. Here, Warnock and Ziegler show how many molecules of oxygen fill a balloon the size of a basketball.

Warnock demonstrates that carbon dioxide (which fills fire extinguishers) is no match for a fire created using magnesium metal, an energy-rich fuel. The metal continues to burn even inside cold blocks of CO₂ and only can be put out with magnesium oxide or everyday sand.

Warnock and Ziegler demonstrate easy lab lessons for middle school teachers. Here, Warnock shows the paramagnetic properties of liquid oxygen by pouring the blue liquid between the poles of strong neodymium magnets.

The Van Program is supported by the Eden Hall Foundation, the Howard Hughes Medical Institute, the Spectroscopic Society of Pittsburgh, the Society for Analytical Chemists of Pittsburgh, and Mark Gelfand (S’73). For further information about the Van Program, please visit www.cmu.edu/mcs/van-outreach.

All photos this page by Ken Andreys.
Atoms may be smaller than the eye can see, but they sure do make a big fireball. A student volunteer brings the propane torch near the propane-filled balloon held by David D’Emilio, chemistry demonstrator from the University of Pittsburgh. The size of a fireball produced by igniting propane reflects the stoichiometry of combustion.

The Science Van Guys’ repertoire consists of more than the glitz and glamour of big science shows. The team also is committed to bringing equipment for hands-on science activities to the classroom so that teachers can use it in their lessons.

From the kitchen to the classroom, undergraduate students working in Warnock’s laboratory are growing crystals using inexpensive ingredients teachers can buy at their local grocery store. They are incorporating their recipes into a new unit on the structure and properties of crystals that will be presented to audiences of various levels during 2005–2006.
Expecting the Extraordinary

Carnegie Mellon High-Energy Particle Physicists Seek Nature’s Subtle Secrets

Beneath an Illinois pastureland where bison graze, beams of protons and antiprotons zoom around inside 4 miles of circular pipe, accelerating until they hurtle along at nearly the speed of light. The particle beams smash into each other, resulting in collisions that scatter debris in every direction. This demolition derby of the tiniest proportions at Fermilab is one way high-energy particle physicists look for clues to solve a cosmic mystery: What happened to antimatter?

Antimatter has existed in the minds of science fiction writers for decades. The Starship Enterprise is powered by antimatter, and Isaac Asimov gave his fictional robots brains made out of antimatter particles called positrons. But antimatter is not just the stuff of science fiction.

Most physicists believe that matter and antimatter were created in equal amounts during the Big Bang, a fiery explosion that formed the universe more than 13 billion years ago. At that time, in theory, every particle of matter should have had a counterpart—an antimatter particle of opposite charge. If that were the case, they would have annihilated each other and released bursts of energy. But for some reason, all antimatter apparently disappeared nanoseconds after the Big Bang, while some matter remained and formed planets, stars and galaxies. The big question is: Why?

The ‘why’ behind the matter-antimatter imbalance in the universe is one of nine big questions in a report compiled by the High Energy Physics Advisory Panel (HEPAP) to the Department of Energy and the National Science Foundation. Fred Gilman, head of the Department of Physics at Carnegie Mellon and chair of HEPAP, has been instrumental in HEPAP’s quest to address these questions that lie at the heart of particle physics today.

High-energy particle physicists at Carnegie Mellon have a long history of using theory and experiment to reconstruct pieces of the matter-antimatter puzzle. Their experiments, conducted at particle accelerators around the world, may shed light on this cosmic conundrum and uncover new principles of physics. “At accelerators, we can produce conditions like those in a time-slice of the universe right after the Big Bang,” said Gilman. “By recreating the conditions and components of the universe shortly after the Big Bang, we ultimately hope to explain why our present universe is made out of matter and not antimatter.”

What’s the Matter with Antimatter?

Matter, as we encounter it in the world immediately around us, comprises three elementary particles: the electron, the up quark and the down quark. These quarks are components of the proton and neutron. The electron belongs to a class of particles known as leptons. Although appearing identical to matter particles, antimatter particles have an opposite charge. For example, matter’s corresponding antimatter particles are the positron, the anti-up quark and the anti-down quark, each bearing opposite charges.

By carrying out an elegant mathematical procedure—applying two operations known as Charge Conjugation and Parity—physicists can mathematically transform a particle into its antiparticle and predict its behavior. Based on these considerations, first made in the 1950s, theoretical physicists had expected particles and their antiparticles to decay (or change into other particles) at the same rate, thereby exhibiting a perfect symmetry, dubbed CP symmetry.

“... we ultimately hope to explain why our present universe is made out of matter and not antimatter.”

– Fred Gilman
A surprise came in 1964. At Brookhaven National Laboratory, James Cronin of the University of Chicago and Val Fitch of Princeton University led a collaboration of physicists who discovered that an exotic particle called a K meson (a subatomic particle comprising a down quark and an anti-strange quark) did not decay in the same way as its antiparticle. This behavior violated the predicted CP symmetry and offered a possible explanation for the apparent dominance of matter over antimatter in the universe.

“Without CP violation, all matter and antimatter would have almost certainly annihilated each other after the Big Bang, leaving nothing behind but cosmic background radiation,” said Manfred Paulini, associate professor of physics at Carnegie Mellon and a member of the Collider Detector at Fermilab (CDF) collaboration.

An Imperfect Fit

The Nobel Prize-winning Cronin-Fitch experiment turned particle physics on its head and sent theoretical physicists back to the chalkboard. For the next 40 years, they worked to incorporate “CP violation” into the Standard Model, a framework that organizes the soup of fundamental subatomic particles (quarks and leptons) and how they interact. To test whether their theoretical predictions governing CP violation are consistent with experimental findings, particle physicists today design experiments using the Standard Model. It now accommodates CP violation, but the fit is far from perfect.

“The Standard Model predicts the CP violation we’ve measured so far,” said Roy Briere, associate professor of physics at Carnegie Mellon and co-spokesperson of the CLEO collaboration at Cornell University. “But the CP violation we know about fails by a factor of one million to explain what happened to antimatter in the early universe.”

Either the Standard Model is altogether wrong or the physicists have yet to find some missing element in it that would account for these extraordinary discrepancies. Through their experiments, Carnegie Mellon physicists are looking for a surprise that they ultimately hope will explain the abundance of matter and the dearth of antimatter.

“One way to test the Standard Model’s prediction of CP violation is to measure the sides and angles of the unitary triangle,” said Helmut Vogel, professor of physics at Carnegie Mellon and a member of the CLEO collaboration.

The unitary triangle is a geometric representation of the Cabibbo-Kabayashi-Maskawa (CKM) matrix. Part of the Standard Model, the CKM matrix outlines how different quarks can transform into one another, which is key to predicting their behavior and interaction. By developing parameters that clearly and conveniently describe this matrix, Lincoln Wolfenstein, emeritus professor of physics at Carnegie Mellon, brought an understanding of the CKM matrix to experimentalists, according to Vogel.

Represented geometrically, the CKM matrix takes the shape of the unitary triangle with specific proportions and measurements. The triangle’s angles correspond to the amount of CP violation that occurs in certain particle interactions, and the lengths of the triangle’s sides are proportional to the probability that one type of quark will decay into another.

Even after decades of experimentation, physicists still haven’t established the exact length of each triangle leg and angle, so they can’t say for certain whether some as yet undiscovered feature of the Standard Model could account for the million-fold difference between the CP violation they’ve measured and the CP violation needed to explain the matter-antimatter imbalance in the universe. To make more measurements, they are conducting experiments at accelerators around the world to determine how fast subatomic particles decay and what they become.
Accounting for CP Violation through Studies of Exotic Particles

In 1999, two new accelerators began operating at the Stanford Linear Accelerator Center in Stanford, California, and at the Japanese National Accelerator Center. They were constructed principally to investigate CP violation in the decays of B mesons (exotic particles consisting of a beauty quark and either an anti-up, -down or -strange). These “B factories” produce B mesons to carry out experiments that measure certain sides and angles of the unitary triangle.

“I think the hope was that the B factories would measure something that didn’t agree with the theory, which might have told us more about CP violation and maybe pointed the way to the eventual asymmetry in the universe. But it looks like, so far, this dam model is too good,” said Tom Ferguson, professor of physics at Carnegie Mellon and a member of the CLEO collaboration.

As part of the CDF collaboration, Paulini and James Russ, professor of physics at Carnegie Mellon, are taking a slightly different approach than the B factories in hopes of measuring more precisely one side of the unitary triangle. They are studying another type of B meson at Fermilab’s Tevatron, the world’s highest-energy particle accelerator currently in operation.

“To constrain the length of one side, you have to use $B_s^0$ mesons, particles with a beauty quark and an anti-strange quark. The Tevatron at Fermilab is the only accelerator that produces these particles right now,” said Paulini.

The Tevatron collides beams of protons and antiprotons at nearly 2 trillion electron volts (2 TeV), which is about 100 million times the energy of the electron beam in an old-fashioned television’s picture tube. The CDF experiment detects the byproducts of these high-energy collisions, including $B_s^0$ mesons and their antiparticles. By measuring and comparing how these particles and antiparticles decay, Paulini and Russ hope to detect something extraordinary.

“The hope is that this side of the triangle is going to be a little shorter than the length the Standard Model predicts,” said Russ. “Then we can go back to the theorists and say, something is not right. What could be going on with the theory?”

The studies of $B_s^0$ mesons underway at Fermilab ultimately could hold the key to understanding how matter changes into antimatter and provide the next big piece of evidence for CP Violation in the universe, according to Gilman.

Lowering Energy in Pursuit of Charm

The theories outlined in the Standard Model make specific predictions about particles and their behavior. But how do we know that the theory is correct? One way to determine whether the current theory measures up to experimental results is to slow things down. Carnegie Mellon faculty Briere, Ferguson and Vogel, members of the CLEO collaboration, are testing the Standard Model in what’s called the charm sector.

The CLEO collaboration, a group of about 140 scientists from 22 universities, was a major player in B physics for more than 20 years. With the advent of the B factories and their high intensity experiments, CLEO could no longer compete in making measurements of B meson decays. So the group did something never done before with an accelerator—it lowered its energy.

“When particle beams collide at higher energies, a lot of particles are produced, and you have to carefully search through the data to find what you are looking for,” said Vogel. “At CLEO, we use just the right amount of energy needed to create charm mesons. No stray particles are produced.”

Because they are able to study the decay of charm mesons (particles that contain a charm quark and either an anti-up, -down, or -strange quark) without any contaminating particles, they can reduce uncertainties and make extremely precise measurements. The more precise the measurements, the more stringent the test of the theory, according to Vogel.

CLEO experiments measure charm meson decays, which can then be compared to theoretical calculations based on a branch of the Standard Model called Quantum Chromodynamics (QCD).
Because quarks are the building blocks that combine to form a host of exotic particles, including charm mesons and B mesons, fully understanding QCD is key to making confident predictions about meson behavior. High-speed computational power is needed, said Colin Morningstar, an assistant professor of physics at Carnegie Mellon, who performs calculations to extract observables from QCD and to better understand its inner workings.

Theoretical predictions from QCD studies of charm meson decays should help experimentalists make better measurements of B meson decay properties.

Testing the QCD calculations against experimental results in charm systems will allow physicists to apply them with confidence in studies of B meson decays. Such checks will be a very important ingredient in using B mesons to probe physics beyond the Standard Model in our search to understand the matter-antimatter asymmetry of our universe.

Higher Energies, New Physics
When it comes down to it, more than 40 years of theory and experiments at various energies have yet to establish the reason why antimatter isn’t here. Perhaps the missing piece of the puzzle is some other aspect of physics that has yet to be discovered, something that could upend the Standard Model altogether. And this new physics might be revealed by colliding subatomic particles at unprecedented energies. Gilman has high hopes that 2007, which marks the opening of the Large Hadron Collider (LHC) at the European Laboratory for Particle Physics (CERN), will usher in a new era of particle physics. Perhaps the LHC’s 14 TeV will give the subatomic world the burst of energy needed to shake loose its secrets.

“Colliding protons at such high energies should produce bits of matter (and antimatter) smaller than anything anyone has seen before, according to Gilman. Four detectors will record some of the 800 million collisions that occur every second. Ferguson, Vogel and Briere are contributing to the construction of one of these detectors, the Compact Muon Solenoid (CMS). Specifically, the Carnegie Mellon team is constructing state-of-the-art electronics for the endcap muon system of the CMS detector.

Consisting of about 150,000 electronic channels, the end cap muon system will detect muons, fundamental particles that belong to the lepton family. By analyzing muons and other particles produced in these high-energy collisions, physicists hope to find evidence of new particles and symmetries that so far have only existed in theory.

Gilman is excited about the future. “At the end of the 20th century, we thought we knew the fundamental particles and interactions in the universe. This was not true. Since 95 percent of the universe is not like the matter immediately around us, we are beginning a new round of exploration that includes finding the missing pieces needed to understand the matter-antimatter imbalance in the universe.”

Higher Energies, New Physics

Physics Collaborations
The Compact Muon Solenoid
http://cmsinfo.cern.ch
The Collider Detector at Fermilab
http://www-cdf.fnal.gov
The CLEO Collaboration
http://w4.lns.cornell.edu/public/CLEO
High-Energy Physics at Carnegie Mellon
http://www-hep.phys.cmu.edu

Research Sites
CERN
http://www.cern.ch
Laboratory for Elementary-Particle Physics
http://www.lns.cornell.edu
Fermi National Accelerator Laboratory
http://www.fnal.gov
T o meet the growing need for computational biologists, Carnegie Mellon University and the University of Pittsburgh are launching a joint doctoral program in this emerging field.

The availability of genome databases and the development of new biological data collection approaches have created the need for a new generation of researchers, according to Robert Murphy, co-director of the program and professor of biological sciences at MCS and biomedical engineering at Carnegie Institute of Technology.

These interdisciplinary scientists will develop and use advanced computational and theoretical approaches to analyze and integrate a rapidly increasing amount of biological data.

“The program will be a truly joint effort of the two universities, with roughly equal numbers of faculty and students participating from both campuses,” said Mark Kamlet, provost and senior vice president of Carnegie Mellon.

“We are especially pleased to have Ivet Bahar and Robert Murphy as co-directors of this program since both have played major leadership roles in building computational biology at the two universities.”

Bahar is professor and chairman of the Department of Computational Biology at the University of Pittsburgh School of Medicine. In addition to his MCS and CIT positions, Murphy directs the Center for Bioimage Informatics and is a member of the Center for Automated Learning and Discovery at the School of Computer Science.

Increased funding by government agencies such as the National Institutes of Health and expanded employment opportunities in the biopharmaceutical and computer industries are compelling reasons to establish the program, according to the co-directors.

“There is an important unmet demand for Ph.D.-level computational biologists, and we are in a position to train the next generation of leaders in this field,” said Murphy. “Future leaders in computational biology need a strong foundation in both biomedical and computational sciences that they can draw on, both to recognize important new computational problems in biology and to apply state-of-the-art computational methods to solve them.”

Training a new generation of scientists is critical, according to Murphy, because they will have the right combination of skills to investigate problems in biological sciences and identify better ways to diagnose illness or identify potential drug targets. In their work, incoming students will have the opportunity to work alongside computational biologists and clinical collaborators.

Computational biology encompasses a broad set of activities, including molecular modeling, image interpretation, studies of protein interactions and large-scale analysis of genome/proteome data. The field has evolved to analyze and relate the ever-increasing amount of biomedical data generated by high-throughput methods.

“Biomedical researchers are learning that protein networks are so large and complex that only computational analysis can reveal the often subtle changes that cause or contribute to disease,” said Murphy.

Students may choose among five tracks within the new program: Computational Genomics, Computational Structural Biology, Cellular and Systems Modeling, Bioimage Informatics, and Computational Neuroscience.

The joint program is expected to reach a steady enrollment of 50 students working in research groups that cross disciplines, departments and schools at both universities. The new program already has accepted a small number of students for fall 2005 and spring 2006. Full enrollment will begin in fall 2006.

The program co-directors expect it to be among the elite programs in the field, given the number of prominent faculty at both institutions and the breadth and depth of their research activities.

The new program leverages this recognized leadership in biomedical research and computer science at the University of Pittsburgh and Carnegie Mellon. Since 1987, Carnegie Mellon has offered a formal undergraduate degree program in computational biology. In 1999, it began offering a master’s degree in the field. Until now, doctoral students with a focus in computational biology have entered Biological Sciences, Computer Science or a related department. Students at Carnegie Mellon will be supported in part by a $470,000 gift from the DSF Charitable Foundation.

Last year, the University of Pittsburgh School of Medicine established the Department of Computational Biology, making it one of the first U.S. schools of medicine to assign the discipline the same status as more traditional clinical and basic science departments. The department evolved from the Center for Computational Biology and Bioinformatics, which was founded in 2000.

For more information about the joint doctoral program, please visit www.compbio.cmu.edu.
Awards and Honors

Krzysztof Matyjaszewski
University Professor and J.C. Warner Professor of Natural Sciences Krzysztof Matyjaszewski has received the 2004 Foundation for Polish Science award, commonly called the Polish Nobel Prize. Granted annually by the foundation since 1991, this award is given to outstanding scientists whose achievements and discoveries within the last four years grant Poland “an important place in the international community of science.” Matyjaszewski received the award in recognition of the “discovery and commercialization of new methods of controlled radical polymerization.”

Russell Schwartz
Computational biologist Russell Schwartz is one of 58 young innovators to receive the 2005 Presidential Early Career Awards for Scientists and Engineers this year. Established by the White House in 1996, the program annually honors scientists and engineers who early in their careers have already blended excellence in pioneering research and service to their communities through scientific leadership and outreach activities. Schwartz, an assistant professor of biological sciences, was recognized for his work to improve computer models and simulation methods for biological self-assembly systems.

Steven Shreve
Steven Shreve, professor of mathematical sciences, a member of the Master of Science in Computational Finance Steering Committee and director of the Bachelor of Science Program in Computational Finance, won “New Book of the Year in Quantitative Finance” for his latest textbook, “Stochastic Calculus for Finance II: Continuous-Time Models.” This honor comes from the members of Wilmott magazine, the leading Web resource for the academic and professional quantitative finance community.

Curtis Meyer
Curtis Meyer, professor of physics, has been elected a fellow of the American Physical Society (APS) for his contributions to and his leadership in the experimental study of the light quark spectrum and the role of gluonic excitations. Election as a fellow is limited to one half of one percent of the APS membership each year. Meyer, who specializes in medium-energy physics, is currently designing part of an instrument for GlueX, a large-scale Carnegie Mellon-led project in nuclear physics.

Roy Briere
High-energy particle physicist Roy Briere has been elected one of two co-spokespersons for the CLEO collaboration, a group of about 140 scientists from 22 universities. CLEO uses an accelerator at Cornell University to conduct high-energy particle physics experiments to understand the forces of nature and the fundamental structure of matter. Along with Edward H. Thorndike, professor of physics at the University of Rochester, Briere, associate professor of physics, will serve a one-year term.

Brooke McCartney
Brooke McCartney, an assistant professor of biological sciences, has received the prestigious Basil O’Connor Starter Scholar Research Award from the March of Dimes. This award supports young scientists just embarking on their independent research careers, according to the March of Dimes. McCartney received the award in support of her research on understanding signaling molecules used within cells to regulate processes during animal development and to maintain daily cell functions.

Robert Murphy
Robert Murphy, professor of biological sciences, has been selected to chair the Biodata Management and Analysis (BMDA) Study Section of the Center for Scientific Review at the National Institutes of Health. The BMDA committee has an important role in reviewing federal grant applications to manage, analyze and visualize biological data.

Gérard P. Cornuéjols
Gérard P. Cornuéjols, IBM University Professor of Operations Research, has been awarded a Society for Industrial and Applied Mathematics Outstanding Paper prize. His paper, “Ideal Binary Clutters, Connectivity, and Conjecture of Seymour,” was one of only three papers to receive this award. In their prize-winning paper, Cornuéjols and co-author Bertrand Guenin (TPR’98) develop a theorem that is a step toward Seymour’s conjecture.

Terry Collins
Terry Collins has received the 2004 Pittsburgh Award from the American Chemical Society’s Pittsburgh Section. The award “recognizes contributions toward increasing chemical knowledge, promoting industry, benefiting humanity or advancing the Pittsburgh Section.” Collins, Thomas Lord Professor of Chemistry, is noted for his scientific contributions to green chemistry, his dedication to education and his public advocacy for use of green chemistry to achieve a sustainable civilization.

Richard D. McCullough
Richard D. McCullough, dean of MCS and professor of chemistry, is being honored with a 2005 Alumni Achievement Award from the University of Texas at Dallas. The award is for his scientific research on the “self-assembly and synthesis of highly conductive organic polymers and oligomers, conjugated polymer sensors, nanoelectronic assembly and other areas.” McCullough has pioneered the development of conducting polymers that form the basis of a Carnegie Mellon spin-off, Plextronics, Inc. (see page 16).
Awards and Honors
(Continued from page 15)

University Teaching Awards
Karen Stump received the William H. and Frances S. Ryan Award for Meritorious Teaching for her unusual devotion and effectiveness in teaching undergraduate or graduate students. Stump’s nominators call her “one of Carnegie Mellon’s true gems as a teacher, a mentor and an educational administrator who reaches beyond the bounds of any possible job description and makes Carnegie Mellon and our Pittsburgh community a better place for students and faculty.” Stump also received a 2005 Honorable Mention from the Carnegie Science Center for University/Post-Secondary Education.

MCS Faculty and Graduate Awards
The Julius Ashkin Award for Excellence in Teaching was presented to Gordon Rule, professor of biological sciences. In nominating Rule for the award, many students wrote about his accessibility, enthusiasm, tireless efforts on their behalf, and ability to make often complicated and confusing concepts easily understandable and memorable.

Peter Berget, associate professor of biological sciences, received the Richard Moore Award for his substantial and sustained contributions to the educational mission of MCS. “He is outstanding as an educator and an innovator, especially in the uses of technology,” wrote Elizabeth Jones, university professor and head of the Department of Biological Sciences, in a letter supporting Berget’s nomination.

The first annual Guy C. Berry Graduate Research Award was presented to Sebastian Stoian in recognition of his excellence in research using Mössbauer spectroscopy to study the detailed electronic structure of iron-containing molecules that are models for active sites in enzymes, catalysts of important biological processes. Stoian, a fourth-year graduate student in the Department of Chemistry, was commended on his ability to tackle difficult problems with creativity and determination.

Kelley Burgin, a graduate student in Mathematical Sciences, was selected as the Hugh D. Young Graduate Teaching Award recipient. The award encourages and recognizes effective teaching by graduate students. Burgin’s excellence as a teaching assistant was cited for the wide variety of courses he has taught, and many students commented in their letters of support on his willingness to take extra time to explain a confusing topic.

MCS Staff Awards
Brenda L. Chambers, administrative associate in the Department of Chemistry, received the $1,000 Merit Award. Patrick Carr, business manager in the Department of Physics, received the $200 MCS Rookie Award. One staff member from each department was recognized with a $250 MCS Outstanding Achievement Award: L. Patsey Haddock, financial assistant (Chemistry), Mary Jane Hutchinson, assistant to the department head (Physics), Clinton A. Perrone, senior systems specialist (Pittsburgh Supercomputing Center), Jennifer A. Sciullo, assistant to the department head (Biological Sciences), and Nancy J. Watson, departmental secretary (Mathematical Sciences). Renee Starek, career center consultant, received the $400 Special Award.

Technology Transfer
Cellumen Venture
Alan Waggoner (director of the Molecular Biosensor and Imaging Center and professor of Biological Sciences) has provided assistance in launching a new biotechnology start-up company, Cellumen. Cellumen, headquartered in Pittsburgh and directed by Lansing Taylor, is focused on understanding the role genes and proteins play in the life of normal, healthy cells, a key step to understanding how they malfunction in the disease process. The company is forming partnerships with the pharmaceutical and biotechnology industries to assist with drug discovery and patient profiling.

Plextronics Poised for Growth
Plextronics, Inc., a Carnegie Mellon spin-off company co-founded by Richard McCullough, dean of MCS and professor of chemistry, was selected by InnovationWORLD as one of the top 21 companies poised for growth in the 21st century. InnovationWORLD conducts research on expansion-stage companies for its subscription-based TechALERT service. Plextronics produces Plexcore™, a plastic that conducts electricity a million times faster than anything comparable, according to the company.
At the Pittsburgh NMR Center for Biomedical Research, scientists are imaging tissues and organs using magnets that are nearly six times stronger than those used in medical magnetic resonance imaging (MRI) machines. Established in 1986 and funded continuously since 1988 by the National Institutes of Health (NIH), the Pittsburgh NMR Center is dedicated to advancing molecular, cellular and functional imaging using small animals. The center, sponsored jointly by Carnegie Mellon and the University of Pittsburgh, is making major contributions to the rapidly growing field of nuclear magnetic resonance (NMR) in biology and medicine. Under the leadership of Professor of Biological Sciences Chien Ho, center investigators are developing novel, non-invasive MRI-based methods to monitor organ function and detect the early signs of rejection in transplanted organs. They also are making significant advances in understanding animal models of autoimmune disease using magnetic resonance microscopy, a technique that provides near-cellular detail of internal organs in living animals. Other NMR Center initiatives include developing new methods to accurately measure blood flow, which may be used to assess organ function and health, and exploring ways to increase the speed and sensitivity of MRI methods, which is fundamental to advancing MRI in research and clinical settings. NMR Center researchers make available their MRI expertise to biomedical researchers in Pittsburgh and across the country. For more information, visit the Pittsburgh NMR Center Web site: www.cmu.edu/nmr-center.

In a first, Eric Ahrens and colleagues have “programmed” cells to make their own MRI contrast agents, enabling unprecedented high-resolution, deep-tissue imaging of gene expression. Here, the brain cells that contain the MRI reporter, which can be linked to a gene of interest, have been identified and imaged at high-resolution (arrow). The results were published in 2004 in *Nature Medicine*.

Chien Ho and his colleagues are using a heterotopic cardiac transplantation model in rats (above) to develop a non-invasive, MRI-based method to monitor organ rejection. NMR Center scientists label immune cells with MRI contrast agents and track their accumulation at the rejecting graft (dark spots), which is an early sign of organ rejection. Successful translation of this work to the clinic will reduce the number of invasive catheterization and biopsy procedures currently used to monitor organ rejection, giving physicians the information necessary to personalize immunosuppressive therapy and improve the care and quality of life for cardiac transplant patients.

NMR Center scientists study models of cardiac disease and organ function in transplantation research using myocardial tagging, a technique that uses MRI to probe regional function of the heart. The tag lines are applied at the diastolic phase of the heartbeat (left), and the lines deform as the heart muscle contracts (right). Analyzing how these lines move over the course of a heartbeat provides detailed information about regional heart function.
Left Brain Meets Right: Mathematician Moonlights as Painter

When not teaching or conducting research, Shlomo Ta’asan enjoys working with a brush and canvas. “Mathematics is gone from my mind when I’m painting.”

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In addition, Carnegie Mellon University does not discriminate in admission, employment or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or gender identity. Carnegie Mellon does not discriminate in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Presidential Executive Order directing the Department of Defense to follow a policy of, “Don’t ask, don’t tell, don’t pursue,” excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-6684 or the Vice President for Enrollment, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-2056.

Carnegie Mellon University publishes an annual campus security report describing the university’s security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The security report is available through the World Wide Web at www.cmu.edu/police/statistics.htm.


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