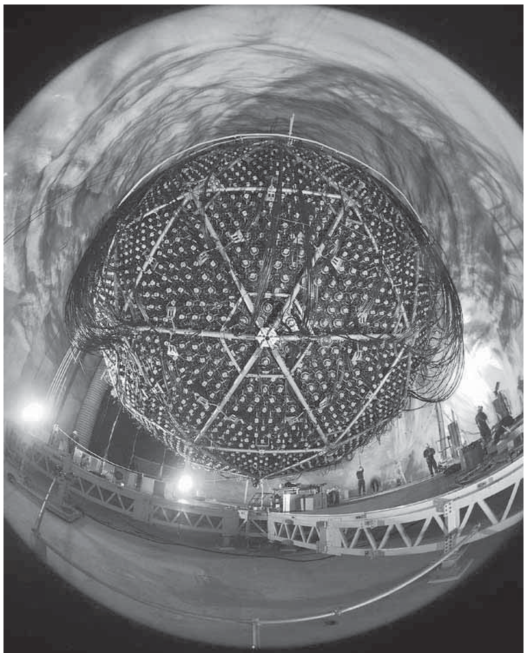
U N I V E R S I T Y   O F   W A S H I N G T O N

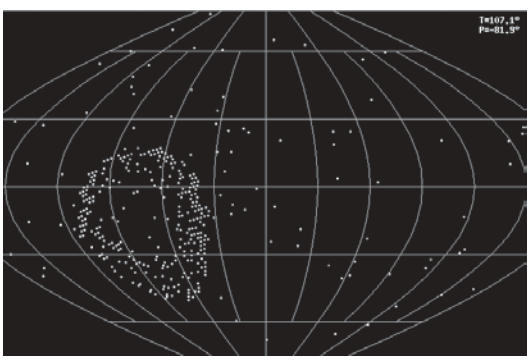
P H Y S I C S

VOL. 11, WINTER 2002

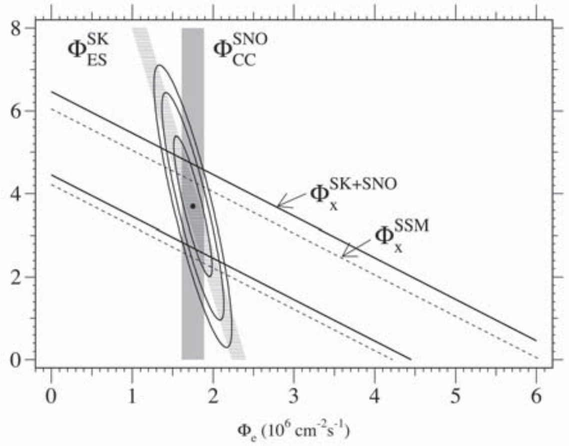


UNDERGROUND PHYSICS:

GREAT SUCCESS, PAINFUL SETBACK AND EXCITING FUTURE



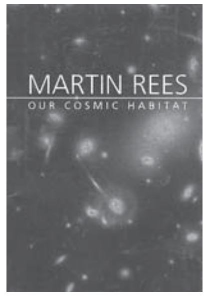
INSIDE



Images from the Sudbury Neutrino Detector:
The detector in its cave
Display of one event caused by a cosmic-ray particle
The results, as published *(See Story, Page 5)*

PHYSICS BOOKSHELF

"Our Cosmic Habitat"
Sir Martin Rees

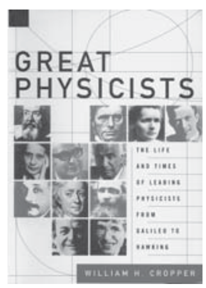


This year, Sir Martin Rees, Astronomer Royal of Great Britain and Royal Society Research Professor at Cambridge University, can do no wrong. Rees, one of the world's leading theoretical astrophysicists, received the 2001 Peter Gruber Foundation Award.

The honor and $150,000 spending cash are a nod to Rees' far-ranging contributions to a better understanding of such fundamentals as how galaxies are formed, the nature of the cosmic background radiation, black holes, gamma ray bursts and quasars. His latest book, "Our Cosmic Habitat," (Princeton, $22.50), is yet another demonstration of Rees' import to the field. The slim volume gathers up the series of Scribner lectures that Rees delivered at Princeton University on such topics as black holes and time machines, the accellerating universe and the first millisecond after the Big Bang.

In the lecture series, he revisits familiar terrain — asking and answering, for instance, whether our universe is part of the "multiverse," a suite of universes inhabited by mostly stillborn and lifeless peers within view and who knows what outside the reach of today's telescopes. "If the universe were literally infinite, then anything, however improbable, could happen," he writes. "Indeed, it could happen infinitely often, leading to replicas of our Earth, even infinitely many of them. But these clones would be located far beyond our own Galaxy — indeed, far, far beyond the horizon of our observations."

"Great Physicists: The Lives and Times of Leading Physicists From Galileo to Hawking"
William H. Cropper



From Galileo Galilei on mechanics to James Joule on thermodynamics, from James Clerk Maxwell on electromagnetism to Werner Heisenberg on quantum mechanics and Edwin Hubble on astronomy, astrophysics and cosmology, this 500-page summary hits the high points of physics through the contributions of the field's 30 greatest luminaries. And, "Great Physicists: The Life and Times of Leading Physicists From Galileo to Hawking," (Oxford, $35), doesn't scrimp on the science or the humanity.

There's a fresh breath of realism that enlivens chapters devoted to each scientist. Rather than a dry recitation of formulae, papers accepted and awards received, William Cropper — a professor emeritus of chemistry at St. Lawrence University — weaves in the hows and whys of discovery. Of Enrico Fermi, the reader learns of early studies in an apartment so cold the young Fermi learned to turn pages with his tongue rather than to risk chilling his hands. The physicist memorized physics and math texts and mentally rehearsed what he had learned during long drives. As chair of theoretical physics, he'd draft lectures and write textbooks during summer vacations in the mountains, lying on his stomach in the meadow, filling blank notebooks with page after page of writing — with no words scratched out or erased. (No erasers.)

Knowing the details of Fermi's thought process — stripping problems of mathematical complications to reveal the essential physical problem — makes his explanation of the process of neutron decay all the better reading.

In each summary, Cropper underscores the "kick in the discovery," as Richard Feynman put it. Of devising a theory to explain weak interaction that permitted reflection symmetry to be broken, Feynman told a biographer: "As I thought about it, as I beheld it in my mind's eye, the goddamn thing was sparkling, it was shining brightly! ... I learned later that others had thought of it about the same time or a little before, but that did not make any difference. At the time I was doing it, I felt the thrill of a new discovery!"

"The Universe at Midnight: Observations Illuminating the Cosmos"
Ken Croswell

Ken Croswell, author of "Magnificent Universe," creates a tidy summary of the last decade's stunning cosmological discoveries tackling the weightiest issues — the universe's origin, its evolution and its ultimate fate. (This at a time when the fate of the universe finds its way to the cover of "Time" magazine.)

"The Universe at Midnight: Observations Illuminating the Cosmos" (Free Press, $27) builds to a crescendo with chapters devoted to the battle over the Hubble Constant, omega and lambda, or, as the astronomer puts it, "Einstein's Curse."

The back stabbing and rivalry in Croswell's account is nothing new. Other authors have covered that tawdry ground. And others, including Joseph Silk, have offered level-headed explanations of the hows and whys of cosmology. What makes Croswell's book the great attractor is the fun he has with writing. Consider this sentence: "It is just before midnight, and stars spangle the sky: newborn stars emerging from magenta gas clouds, middle-aged suns dutifully towing planets through space, elderly red giants about to puff their atmospheres into the void."

—Diedtra Henderson

U N I V E R S I T Y   O F   W A S H I N G T O N

P H Y S I C S

This newsletter is published for alumni and friends of the University of Washington Physics Department. The online version of the Newsletter (www.phys.washington.edu/news/) contains many live WWW links complementing the articles. We invite your comments, complaints, compliments and contributions.

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LETTER FROM THE CHAIR

Greetings,

Like you, I have a vivid memory of where I was the morning of Sept. 11. I was in Rome, unaware of the domestic tragedy, unsuccessfully trying to call the United States. A hotel employee gently broke the news and, back in our room, the television replayed the day's horror.

Back home, I recognized the name of Jon Magnusson, who was quoted in national and local papers explaining how the World Trade Center towers collapsed. Magnusson is Chairman and CEO of Skilling Ward Magnusson Barkshire, a structural engineering firm with the World Trade Center towers in New York, and Seattle's Benaroya Hall, Experience Music Project, Safeco Field, the U.W. Physics/Astronomy complex — and countless other engineering marvels — to its credit. Years ago, when Sept. 11 was simply a day on the calendar, Magnusson was just another freshman in my introductory physics class.

Now, Magnusson had the lessons to give. With the help of the Civil Engineering department, we brought him back to campus for a colloquium to share his insights on the buildings' collapse and to comment on engineering for a radically changed future. For more on that topic, please see Page 7.

And on Page 5, you'll learn the answer to a 30-year-old physics riddle. For three generations, experiments have detected neutrinos' arrival on Earth but researchers never detected as many neutrinos as theories predicted. Were the theories faulty or was our understanding of neutrinos incomplete? According to physics professor and SNO collaborator Dr. Hamish Robertson, the answer lies with the neutrinos, which transform as they travel from the Sun's core to the Earth. Impressive detective work!

I'm also proud to congratulate Professor Lillian McDermott, who was awarded the 2001 Oersted Medal for her work in Physics Education. She also was awarded the 2000 Council of Scientific Society Presidents' Award for Achievement in Education Research. In these pages, you'll read of other faculty kudos and Ph.D. degrees awarded.

And, it's with excitement and optimism that I announce the department is adding faculty. The search is on for anther particle theorist and a nuclear experimentalist. With Craig Hogan moving up (please see Page 8 for "Faculty News"), we'll be hiring a theoretical astrophysicist in Astronomy, and possibly as a joint appointment between the Physics and Astronomy departments. Through their teaching and mentoring, these new faculty members will prepare and inspire the next generation of physicists.

This department newsletter is an ideal vehicle for keeping physics alumni updated, helping you feel involved and attached to the campus, to celebrate milestones and to point with pride to the department's achievements. And it's also an appropriate place in which to alert you about the unsettling events that are affecting this state and its public institutions.

The state's funding crisis has had a direct impact on this campus. The university, generally, is facing a budget that doesn't meet costs. The physics department, specifically, has been unable to fill one faculty position, has lost two-thirds of a teaching assistant and has taken a small cut in its operating budget. We were very fortunate, but worse is yet to come. U.W. administrators expect a 5 percent drop in state funding with consequent reductions in campus budgets. Add to that a recent court ruling that declared illegal an energy fee assessed on Seattle students; the ruling represents $4.5 million in lost funding for this year, $9 million for the biennium. Although state funding represents only one-sixth of the total campus budget, it provides about half of the funding for the College of Arts and Sciences.

Private sources of funding are more important than ever to create an endowment that acts as a buffer between the university and spiraling state budgets. Likewise, meaningful and creative solutions will help this institution weather this latest economic storm.

An example of such visionary efforts is the upcoming "Networking Day" organized by the Career Development Organization for Physicists and Astronomers. One-third of our graduates will work for private industry; this annual event will build contacts between students and faculty with potential private employers. Educators will stay abreast of the changing demands of the industry. Students will connect with recruiters. If you can help with this, please let me know.

The group's spirited time table would lead to our first Networking Day over Spring Break. It's an idea whose time is now. One of the top priorities during last November's Visitors' Committee Meeting was to forge closer connections to industry that would improve student employment prospects and, with hope, help with department fundraising.

Our achievements would not have been possible without the support of alumni and friends of the department. In an uncertain budget year, support from friends of the University will be of utmost importance. Your gift to Friends of Physics will help bridge the gap between declining public funding and escalating costs of providing a quality higher education to undergraduate and graduate students.

Sincerely yours,

David G. Boulware
Chair, Department of Physics

NEWS FROM THE DEPARTMENT

FIRST YOUNG PROFESSOR APPOINTED

Professor **Jeffrey Wilkes** has been appointed as the first holder of the Young Professorship, established by Christopher Young in memory of Physics Professor Kenneth Young who passed away two years ago. Jeff works on the Super-Kamiokande experiment (see "Underground Physics on Page 5, and the Vol. 8 Newsletter cover story).

The Young endowment also provides funds for a graduate student fellowship. This year, the Kenneth Young Fellow is **David Coffee**, an incoming graduate student. It would be difficult to overemphasize the importance of endowments such as this. We recently lost Assistant Professor Michael Romalis who accepted an offer from Princeton. He cited better support for graduate students at Princeton as one reason for his decision...

NEW FACULTY

We are happy to report that we will be joined by two new Assistant Professors and a Senior Lecturer.

Assistant Professor **David Cobden** is a condensed matter experimentalist with a special interest in nanotubes, and — quite appropriately — he will work in connection with UW Center for Nanotechnology. He plans to incorporate nanotubes and nanowires into new devices, and he will probe them over wide ranges of temperature, frequency and magnetic fields.

Assistant Professor **Andreas Karch** is a particle theorist — his 1998 PhD Thesis from the Humboldt University (Berlin, Germany) is entitled: Field Theory Dynamics from Branes in String Theory. The Department is eagerly looking forward to an "official" start of a string theory effort here.

Our large calculus-based introductory physics sequence will benefit from the experience of our new Senior Lecturer **Daryl Pedigo**, who comes to us from Austin Community College in Texas. He will be responsible for teaching in the sequence, as well as for its overall organization and coordination.

AWARDS AND KUDOS

Professor **Jens Gundlach** received the Francis M. Pipkin Award for his measurements of Newton's gravitational constant (see the 1999 Newsletter Vol. # 9 for details about this experiment).

Professor **Lillian McDermott** was awarded the 2001 Oersted Medal by the American Association of Physics Teachers. This is the Association's most prestigious award, recognizing notable contribution to teaching physics.

Two of our faculty received awards from the X-ray Absorption Fine Structure (XAFS) Society: Research Assistant Professor **Alexi Ankudinov** for research in XAFS by a young scientist, and Professor Emeritus **Edward Stern** was recognized for the very invention of this remarkable technique!

Affiliate Professor **Vitaly Efimov** was elected to Fellowship in the American Physical Society.

Congratulations to all!

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PH.D. DEGREES AWARDED, FALL 2000–SUMMER 2001

M.S. DEGREES

Darren Collins *Generating Energetic Particle Populations in the Earth's Magnetosphere*, (Prof. R. Winglee). A computer program is developed that can track many charged particles simultaneously in a given electric and magnetic field. This is used to investigate aspects of solar wind (wind speeds of some 400 km/s !).

Aaron Rivers *Modeling Arctic Ice Clouds in a Single Column Model*, (Prof. M. Baker). Interactions between different aspects of Arctic climate are studied; the result is better understanding of links to global climate change.

Theresa Shane *Investigation of Corona Threshold Voltages on International Space Station U.S. Laboratory and Airlock Orbital Replacement Units*, (Prof. M. Baker). The risk of damaging or destructive discharge is investigated; the studied elements of the Space Station are shown to be safe.

PH.D. DEGREES

Neil Bacon *Evolution and Light Scattering Properties of Single Levitated Ice Particles*, (Prof. M. Baker). This thesis involved the design, construction and testing of a new electrodynamic balance, used to study atmospherically relevant properties of singly levitated ice particles. The study focused on conditions similar to those in atmospheric cirrus clouds.

Lincoln Carr *Solitons in Bose-Einstein Condensates*, (Prof. W. Reinhardt). Solitons are stable localized waves that propagate through a medium without spreading. This Thesis uses field theory to study properties of solitons in BEC (see "Cool Stuff" Page 10).

Steve Konsek *Electronic Transport in Self-Assembled Quantum Dots*, (Prof. T. Pearsall). Quantum transport

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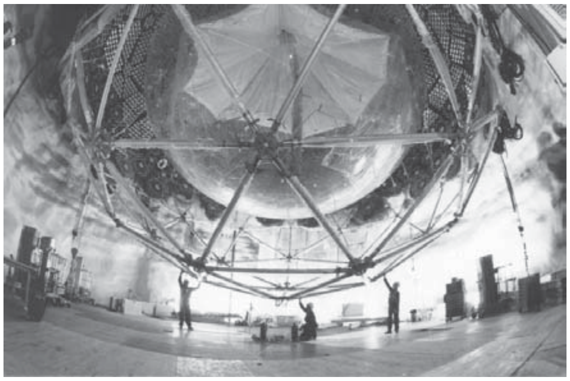

Photo Credits: SNO Collaboration and Lawrence Berkeley Laboratory

UNDERGROUND PHYSICS: GREAT SUCCESS, PAINFUL SETBACK AND EXCITING FUTURE

The cover story of the last Newsletter (Vol. 10) described the anticipation with which the Sudbury Neutrino Observatory (SNO) is being built. To remind readers of the experimental setup, here is another great picture of the detector being built: 6,800 feet below ground, the world's largest plastic sphere holds the world's most expensive water (pure D_20-heavy water), surrounded by thousands of photomultipliers. The main goal is to find out why is it that terrestrial experiments find fewer neutrinos from the Sun than the "standard theory" predicts.

Well, the laboratory was completed, photomultipliers switched on, and background and sensitivity checks performed. When the real data came in, the excitement materialized into a scientific breakthrough: on June 18, 2001, at 12:15 Eastern Daylight Time, there was a News Release:

> *"First Results from the Sudbury Neutrino Observatory Explain the Missing Solar Neutrinos and Reveal New Neutrino Properties."*

And indeed: the novel features on the SNO design, when combined with previous work of the Super-Kamiokande Collaboration and others, reveal clearly the transformation that neutrinos experience as they travel from the Sun to the Earth. So the "standard theory" of nuclear reactions in the Sun producing the neutrinos is correct, but the "Standard Model" of elementary particles needs a major update: different types of neutrinos indeed can transform into each other, and at least one two types of neutrino have a small but non-zero mass. We remind the reader that there is an enormous difference between even a tiny but non-zero mass, and strictly zero mass: in the latter case, each and every neutrino, irrespective of its energy, can only travel at exactly the speed of light. So these results really do change our basic ideas about our Universe. The UW Physics electroweak group plays a leading role in the SNO effort: congratulations!

Meanwhile, the pioneering Super-Kamiokande experiment which has significant UW Physics participation (see our cover story in the Vol. 8 Newsletter) suffered a major (but temporary) setback. As mentioned above, the experiment provided crucial data and early evidence for the resolution of the solar neutrino puzzle. The article in which the main SuperK results were described has by now been cited in more than 1,000 subsequent papers! However, on November 12, a $3,000 phototube (the tube No.# 10,810 — out of total of 13,000 tubes) failed and imploded. This is not unusual — phototubes do fail every now and then. But this time the implosion caused a chain reaction in which more than 7,000 phototubes ended up in a 140-ton pile of debris at the bottom of the tank. The causes of the disaster are under investigation, and the experimenters are determined to rebuild the laboratory. If everything goes well, they might resume data taking by the end of 2002.

Everyone hopes that SuperK indeed will rise from the ashes. And now that the first results are in, everyone expects SNO to yield an abundance of detailed results and measurements. But the future of underground physics goes beyond these two landmark experiments. The first hint of a solar neutrino problem (the unexpectedly small number of neutrinos mentioned above) was obtained in 1968 in a chlorine tank built deep in a mine at Homestake (South Dakota). The mining operations at Homestake are coming to an end, and a group of physicists proposes to convert the mine into a National Underground Science Laboratory (NUSL). At 7,400 ft below the surface, this would be the world's deepest science lab. Experiments at NUSL would not be limited to neutrinos: the environment deep underground is characterized by extremely low "background" rate of cosmic-ray-induced radiation. This makes it possible, and very attractive, to perform a wide range of experiments, from extremely sensitive nuclear physics measurements, through dark matter searches, all the way to materials research for microelectronics. UW Physics faculty are strongly represented on the planning group, and we can all look forward to a deep underground facility from which we will peer deep into the cosmos, as well as deep into atoms and nuclei!

—Vladi Chaloupka

Photo: ©Pete Saloutos

The World Trade Center towers, as captured by Bainbridge Island photographer Pete Saloutos, during the Statue of Liberty's centennial anniversary. The twin towers were a glowing symbol of the potential of structural engineering. The September 11 attack unleashed as much energy as 1,700 tons of TNT and raised questions about whether buildings should be designed to sustain such assaults.

REFLECTIONS OF A STRUCTURAL ENGINEER

"You don't need to be a structural engineer to know what happens if you put a 140-foot-wide hole in a 140-foot-wide building. You don't have to worry about what kind of sprinklers there are. You don't need to worry about how many stairs there are or what's the width of the stairs, or what the fireproofing system is — or anything. If you take a 767 into a regular high-rise building, really bad things are going to happen instantly," said Jon Magnusson, chairman and CEO of Skilling Ward Magnusson Barkshire and a 1975 graduate of the University of Washington's civil engineering program.

The 120-member, Seattle-based consulting structural and civil engineering firm is one of two companies that grew out of Skilling, Helle, Christiansen, Robertson — the structural engineers on the World Trade Center project.

Magnusson returned to the campus where he took physics classes and where the firm designed the Physics-Astronomy Building, to deliver a colloquium "New York Trade Center: Reflections on the Engineering and Thoughts About the Future."

When the Modernist buildings — then the world's tallest towers — rose along the lower Manhattan waterfront in the early 1970s, they instantly became a symbol for engineering's promise.

The engineers created a number of innovative approaches to cope with the demands of gravity and capricious winds.

They studied the area's wind climate, determining where strongest winds would originate and bolstering the building accordingly, much like a tree sinks roots to brace itself to resist winds it endures most frequently. Two different models withstood wind tunnels, confirming the accuracy of computer modeling of building motion. Engineers also took into account one tower's shielding of the other, designing the pair to withstand New York City's wind environment.

Closely spaced columns and beams formed framed tubes that transferred load to the buildings' foundations, which extended 70 feet below ground, through a former landfill, to solid bedrock. And 11,000 special dampers per tower were designed to convert the swaying building's kinetic energy into heat.

But what happens when the demands expected of a building soar off the scale of predictability? Is it time to change the scales?

Not in Magnusson's eyes. He and other engineers are reviewing the sobering videotapes, and flipping through images shot on Sept. 11 and during the recovery efforts, attempting to reconstruct the day's tragedy and learn how to avoid another.

"The fact that the World Trade Center towers, that each of those towers, was able to resist the impact of that airplane, it fooled a lot of people in the public, in the media and in the design profession into thinking that's a realistic expectation. That when a plane hits a building, we need to think about how we're going to fight the fire. That is erroneous thinking," he said.

Some speak, with awe, of New York's Empire State Building withstanding an earlier assault by a pilot flying a B-25. But that was a mere two-prop aircraft with a wingspan of just 67 feet and a total weight of 20,000 pounds. The B-25 carried only 900 gallons of fuel. A 767, by contrast, has a mightier wingspan, takeoff weight and maximum fuel capacity.

"The B-25 hitting the Empire State Building was like an insect," he said. "It wasn't a commercial aircraft like we know it today. Even if you could, somehow, invent some kind of miracle technology to resist a 767, that doesn't address the airplane hazard. Because a 767 isn't the biggest plane flying today."

The 747-400 has a 213-foot wingspan, four feet wider than the World Trade Center. It weighs 880,000 lbs. and carries up to 54,000 gallons of fuel. And the Airbus upcoming A-380 release dwarfs its Boeing rivals by upping wingspan to 261 feet. Fuel rises to 82,000 gallons and maximum weight at takeoff soars to1.235 million pounds — or about four times the fuel and weight of the planes that hit the World Trade Center.

"You can see the idea of designing for airplane strikes is just not in the cards," he said.

"If you think about the World Trade Center being hit by four of those 767s strapped together and going into the building . . . because you couldn't say 'We'll take the hazard of a 767, but that's it.' What good does that do? If someone wants to do evil, they'll just make sure they get their hands on a 747."

Supplying building capacity to deal with the demands posed by gravity, wind and earthquakes? Engineers accept that challenge daily. Coping with the risk posed by a commercial aircraft that's fallen into the wrong hands isn't the work of engineers.

"The good news is (the American society) can control the airplane hazard and the demands an airplane would put on a building by not letting the airplane run into the building. I really do believe that we're already essentially there."

—Diedtra Henderson

News from the Department, continued from Page 4

NEW DEAN AND THE STORY OF GENESIS

We have mixed feelings about the ascent of the Physics and Astronomy Professor **Craig Hogan** to the Divisional Deanship of Natural Sciences. On the one hand, we regret that will now see much less of him. On the other hand, we hope that we now have a friend in high places ☺.

Craig's Little Book of the Big Bang is now available in English, Portuguese, German, Italian and Polish. For those who don't have time even for the little book, Craig kindly prepared the synopsis:

> *"The universe began as a speck of unstable vacuum that flew apart driven by repulsive gravity, creating a large expanding universe.*
>
> *The vacuum energy converted to light which we see today as background radiation. The light created a small amount of matter (more than antimatter), which, as the universe cooled, condensed into hydrogen and helium nuclei and ultimately came to dominate over the radiation. This primordial gas collapsed by gravity into galaxies of gas and stars, which created heavier elements from carbon to iron and beyond and injected them into the interstellar medium which became rich in complex molecules and solid dust particles.*
>
> *New stars formed circled by solid and gaseous planets, and on our own Earth natural selection from the diversity of chemical combinations eventually gave rise to us."*

So, there you have it!

WE NOTE WITH SADNESS

Professor Emeritus **Arnold Arons** died in Seattle on February 28 at the age of 84. Most of us remember Prof. Arons for his Physics Education effort, but he had a distinguished and varied record before turning to research on teaching. He obtained his M.E. degree in physical chemistry in 1937, and an MS degree in Physical Chemistry in 1940, both from the Stevens Institute of Technology, followed by a Ph.D. in physical chemistry in 1943 from Harvard University. From 1943 to 1946 he was a staff member of the Woods Hole Oceanographic Institution; he led the group that made shock wave measurements during the first atomic bomb tests at Bikini Atoll in 1946. Between 1946 and 1968, he was on the faculty first of Stevens Institute, then of Amherst College, and he became well known for his studies of abyssal oceanic circulation and cloud physics.

In 1968 Professor Arons joined the UW Physics Department, with attention to physics education. He was the 1972 recipient of the Oersted Medal from the American Association of Physics Teachers, given in recognition of his notable contributions to teaching of physics (as noted above, the current Director of Physics Education Group at UW, Prof. Lillian McDermott, has just won this prestigious award for 2001!). Among his many books and articles, the text A Guide to Introductory Physics Teaching is considered a physics-education classic. He was known (and feared) for his sometimes sharp wit: one of the better known Arons' sayings goes like this:

"The relativistic model of instruction is based on the premise that, if one starts with an E-N-O- R-M-O-U-S breadth of subject matter but passes it by the student at sufficiently high

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Degrees Awarded, continued from Page 4

phenomena in gallium-arsenide based nanostructures are investigated using a quantum interferometer. New methods for constructing these nanostructures are developed.

Karsten McCollam *Investigation of Magnetic Relaxation in Coaxial Helicity Injection*, (Prof. T. Jarboe). Magnetic confinement is one of the methods being pursued to achieve controlled nuclear fusion. Details of this process are studied, and theoretical predictions are compared with experimental data.

Shuang Meng *Heteroepitaxial Growth of Ga-Se Compounds on Silicon*, (Prof. M. Olmstead). Properties of a two-atom thick semiconductor, grown on silicon, are studied. An investigation of a growth of thicker films on this surface included discovery of a new material that is not stable in bulk form.

Alexey Nesvizhskii *Theory and Interpretation of L-shell X-ray Absorption Spectra*, (Prof. J. Rehr). This study developed new algorithms for calculating and interpreting x-ray absorption spectra. Such spectra are important in many applications, and require techniques that go beyond the usual one-electron approximation.

Stephen Parker *Nucleation, Growth and Sintering of Metallic Films on Oxide Substrates*, (Prof. C. Campbell). An investigation of the kinetics of growth and sintering of metals on oxide surfaces—this mechanism is highly relevant to catalyst function. In the process of "de-wetting," compact islands are formed on the thin metal films. This behavior was successfully modeled with kinetic theory.

Rachel Scherr *An Investigation of Student Understanding of Basic Concepts in Special Relativity*, (Profs. S. Vokos and L. McDermott). Traditional instruction in

continued on Page 9

velocity, the Lorentz contraction will shorten it to the point at which it drops into the hole which is the student mind."

Professor Emeritus **John F. Streib**, died in Seattle on October 5 at the age of 86. He is particularly remembered for his fine teaching and the thoughtful, considerate manner of his interactions with colleagues.

John's undergraduate and graduate education was at the California Institute of Technology, where he received his PhD in 1941. From 1941 to 1943, he worked in Washington, DC on the development of the proximity fuse. Then he moved in 1943 to the Los Alamos Laboratory where he collaborated with Seth Neddermeyer and others on the development of the implosion technique for atomic bombs.

Professor Streib joined our Department in 1947 and participated in the construction and installation of the 60-inch cyclotron, which for number of years was the Department's prime facility for experimental research. His teaching contributions were recognized by his selection as the first recipient of the award for "Excellence in Undergraduate Instruction in Physics" when it was established by students in 1969. After his formal retirement in 1980, John continued to teach for a number of years on a part-time basis, including substitute teaching in at least 19 different courses — a reflection of his breadth of knowledge, his dedication to teaching, and his helpful nature.

LOWELL BROWN RETIRES

Professor Brown has been a towering figure in this Department for many years. His research was primarily in Quantum Field Theory, and — very fortunately for many students and colleagues — he is leaving a book on the subject with us. His interests are not limited to esoteric theoretical developments — he worked on a number of applications, too, such as various aspects of the single electron trapping experiments performed famously by the group of Hans Dehmelt. He has been an outstanding teacher, setting high standards for himself as well as for the students. And for many years, he has been Editor of the Physics Review D — a very important, selfless and thankless job. He will be missed.

CAREER DEVELOPMENT ORGANIZATION SUCCESSFULLY LAUNCHED

A degree in Physics or in Astronomy leads, more often than not, to a job in the industrial sector, or to a variety of positions where the knowledge and skills acquired in school can be applied in an interdisciplinary environment. The new Career Development Organization (CDO) was launched in the summer of 2000 by a group of Physics graduate students, with the mission to assist students and postdocs in career advancement. CDO brings representatives of industrial companies, national laboratories and other potential employers to UW, to interact with students in Career Seminars, round tables and other informal discussions. A Networking Day is planned for Spring 2002 (tentative date is March 29), with the goal of connecting potential employers with the students. For more details about this event (which should turn out to be useful for everyone involved) and about CDO in general see http://students.washington.edu/~cdophys/CAREER/. CDO extends an invitation to all UW Physics and Astronomy Alumni to get involved in their innovative program!

Your contributions to the News section are welcome: vladi@u.washington.edu

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Relativity appears to have little effect on student understanding of some very fundamental concepts. Novel instructional materials are designed as a result of this study.

Brett Schroeder *Surface Enhanced Modification of Semiconductor-on-Insulator Heteroepitaxy*, (Prof. M. Olmstead). Schroeder investigated use of surface modification to promote the growth of flat silicon films on the crystalline insulator fluorite. This Thesis studies surface modification to promote the growth of such films. Measured data agree with only one of several competing theories.

Lane Seeley *Heterogeneous Nucleation of Ice from Undercooled Water*, (Prof. G. Seidler). Although pure H_20 ice will melt at the equilibrium liquid-solid transition at 0 Celsius, with proper care, H_20 can be supercooled in the liquid state down to -38 C — this is "supercooling." This dissertation studies the physics behind several routes by which impurities in the sample may prevent strong supercoolings, resulting in freezing at relatively elevated temperatures. This work may have relevance for understanding how a range of anthropogenic impurities can affect the balance between ice and liquid water in tropospheric clouds.

Jian-Ming Tang *Quantum Mechanics of Quantized Vortices in Dilute Bose Gases*, (Prof. D. Thouless). The usual theory of quantized vortices in superfluids treats the vortex as a classical object with a definite position and structure. This dissertation explores the consequences of quantum uncertainty for such a structure.

Hans Vija *The Differential Attenuation Method: Simultaneous Estimation of Activity and Attenuation Distributions from SPECT Emission Data*, (Prof. J. Rehr). Improved algorithms for producing medical images from X-ray tomography data are developed. The method makes use of data at two different X-ray energies to improve contrast and to better treat differential absorption.

COOL STUFF

The 2001 Physics Nobel Prize went to Eric Cornell and Carl Wieman from Boulder, Colo., and to Wolfgang Ketterle of MIT, for "the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates." As usual in Physics, even a brief discussion of this work reveals concepts of fundamental importance, as well as possible practical applications.

Particles come in two basic categories:

Those with half-integer angular momentum (protons, electrons and some nuclei and atoms) obey the "Fermi exclusion principle": if one of them is in a given state, you cannot put another identical particle into the same state. This may not seem too strange — after all, it is difficult for two people to sit on the same chair. But a "state" in Quantum Mechanics may mean "an orbit", and the fact that you cannot put two identical electrons on the same orbit around the nucleus is responsible for the periodic Table, i.e. for chemistry, i.e. for our existence...

Particles with whole-integer values of angular momentum (photons, mesons and some nuclei and atoms) behave in a complementary, and decidedly non-classical way: they actually like to be in the same state! Such a state is realized in practice when a gas of these particles is cooled very close to absolute zero, and all the particles in the sample condense into the same ("ground") state. This is called a "Bose-Einstein" condensation, and it was observed experimentally for the first time in 1995, seventy years after it was predicted theoretically. Cornell and Wieman produced pure condensates consisting of thousands of rubidium atoms, and, independently, Ketterle succeeded with atoms of sodium. It is interesting to note that the phenomenon of superconductivity, when many pairs of electrons condense into a single quantum mechanical state, is also a manifestation of the same effect, providing one of the rare opportunities to see Quantum Mechanics operating at the macroscopic level. However, it wasn't until the work of this year's laureates that the effect was observed in its pure form.

In addition to opening a new way to study fundamental quantum-mechanical processes, Bose-Einstein condensation is expected to have a variety of practical applications, from novel approaches to ultra-precise measurements, all the way to lithography, nanotechnology and holography. The UW Physics Department does not (yet) have an experimental effort in Bose-Einstein Condensation, but the Reinhardt group of the UW of Physics and Chemistry departments (with three Physics graduate students) is working on theoretical analysis of the properties of the condensates.

This is cool stuff (literally: the work is done at two billionths of a degree above absolute zero!)

—Vladi Chaloupka

Leading Edge, continued from back cover

to be *the world* might actually be as fake as a holographic image is a fake representation of something that truly is existing on a thin piece of plastic. Weird.

There's powerful, rigorous mathematics that led to these conclusions. They're not conclusions that are borne of someone's fantasy about what would sound cool or what would make the world weird. Part of this work is due to a guy who won the Nobel Prize, Gerard T'hooft in Holland, and Leonard Suskind at Stanford. That's a wonderful development.

Physicists struggle with how to make their writing accessible to a lay audience. Whom do you envision as a reader as you write?

I don't literally picture somebody. For instance, I don't picture my mother. You see my mother is a person who doesn't know any physics—but doesn't want to know any physics, either. And that's not the person that I'm writing for. There are physics books for that person, which are extremely descriptive and have the voice of telling you how it is. Not asking you to think through a logical chain to get to an understanding of how things are. But just saying: This is how it is. And that's fine.

I try to write to the person who doesn't know much, necessarily, but who has motivation to really piece the puzzle together. And I feel like I'm the guide through the pieces. So I think it's more work to read my book than other books. I don't consider my book an easy book. But I do think that it is self-contained in that if you approach it with an open mind and energy, you can get through it...

There were definitely sections that were too opaque the first time around that I tried to find some way of communicating the ideas more gently—but not losing the actual science. I think that's also the key thing. You can also communicate science in a cartoon form that makes it more accessible, but loses the true ideas. My goal has always been to make the science accessible without deviating very far from the true ideas themselves.

—Diedtra Henderson

LIGHTER SIDE OF SCIENCE

Each year, the Annals of Improbable Research issues honors dubious scientific achievements. For your reading pleasure, here are the 2001 Ig® Nobel Prizes:

Astrophysics — Dr. Jack and Rexella Van Impe, of Jack Van Impe Ministries, Rochester Hills, Michigan, for their discovery that black holes fulfill all the technical requirements to be the location of Hell. Walter Lewin, an MIT physicist, accepted custody of the astrophysics prize on behalf of the winners, who could not or did not attend the ceremony. Lewin said that, to astrophysicists, "black holes are heaven."

Biology — Buck Weimer, of Pueblo, Colo., for inventing Under-Ease, airtight underwear with a replaceable charcoal filter that removes bad-smelling gases before they escape.

Economics — Joel Slemrod, of the University of Michigan Business School, and Wojciech Kopczuk, of the University of British Columbia, for concluding that people find a way to postpone their deaths if that would qualify them for a lower rate on the inheritance tax. (Reference: "Dying To Save Taxes: Evidence From Estate Tax Returns on the Death Elasticity," National Bureau of Economic Research Working Paper No. W8158, March 2001.)

Literature — John Richards, of Boston, England, founder of The Apostrophe Protection Society, for his efforts to protect, promote and defend the differences between plural and possessive.

Medicine — Peter Barss, of McGill University, for his high-impact medical report "Injuries Due to Falling Coconuts." ("The Journal of Trauma," Vol. 21, No. 11, 1984, pp. 990-1.)

Peace — Viliumas Malinauskus, of Grutas, Lithuania, for creating the amusement park known as "Stalin World."

Physics — David Schmidt, of the University of Massachusetts, for his partial solution to the question of why shower curtains billow inwards.

Psychology — Lawrence W. Sherman, of Miami University, Ohio, for his influential research report "An Ecological Study of Glee in Small Groups of Preschool Children." ("Child Development," Vol. 46, No. 1, March 1975, pp. 53-61.)

Public Health — Chittaranjan Andrade and B.S. Srihari of the National Institute of Mental Health and Neurosciences, Bangalore, India, for their probing medical discovery that nose picking is a common activity among adolescents. ("A Preliminary Survey of Rhinotillexomania in an Adolescent Sample," published in the "Journal of Clinical Psychiatry," Vol. 62, No. 6, June 2001, pp. 426-31.)

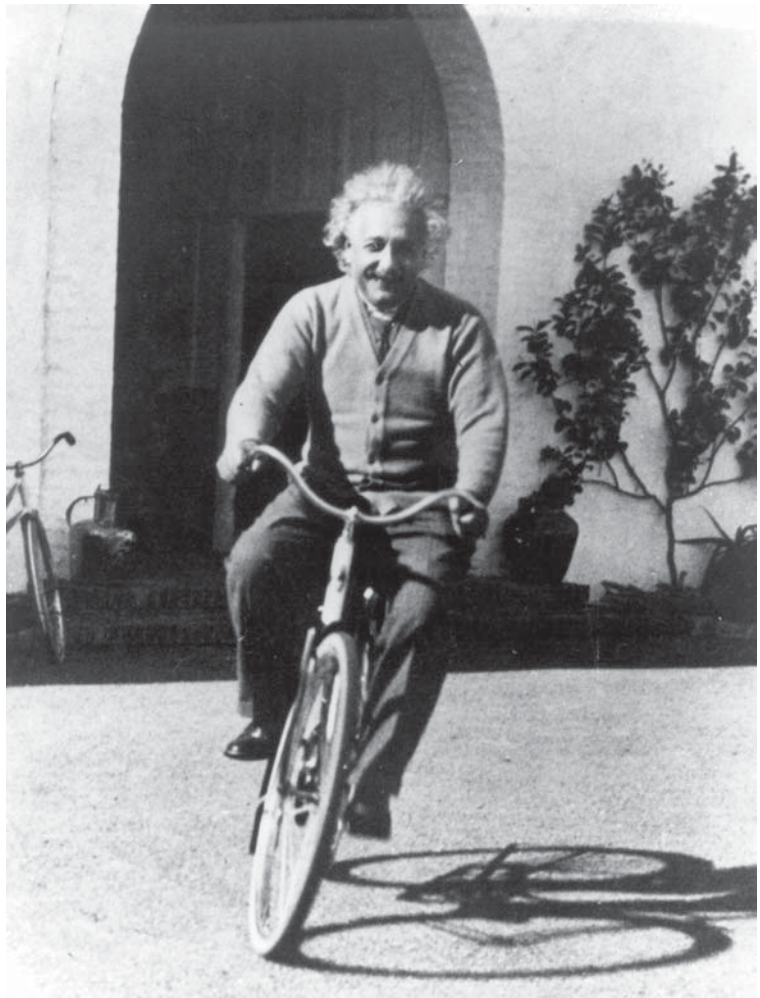

Photo courtesy of The Archives, California Institute of Technology

"Study and, in general, the pursuit of truth and beauty is a sphere of activity in which we are permitted to remain children all of our lives."

—Albert Einstein

Technology — Awarded jointly to John Keogh of Hawthorn, Victoria, Australia, for patenting the wheel in the year 2001, and to the Australian Patent Office for granting him Innovation Patent No. 2001100012.

For past Ig Nobel Prize winners, see: htttp://www.improbable.com/ig/ig-pastwinners.html#ig2001

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Editor's Note: Physicist Brian Greene, in his best-selling book "The Elegant Universe: Superstrings, Hidden Dimensions and the Quest for the Ultimate Theory," stitched together the yawning gap between quantum mechanics and general relativity, theories that describe the largest and smallest aspects of the physical universe. Greene introduced string theory into an every-day conversations thanks to appearances on "Late Night With Conan O'Brien," an appearance on ABC's "Brave New Worlds," a prime-time hour dedicated to string theory, and even a gig with the Emerson String Quartet to combine string physics with string music. The son of a voice coach and vaudeville performer, Greene received his undergraduate degree from Harvard University and his doctorate from Oxford University, where he was a Rhodes Scholar. While at Oxford, John Schwartz and Michael Green came up with compelling evidence that string theory could be the Theory of Everything. Greene, a professor of physics and mathematics at Columbia, has devoted his career to that notion. His most recent paper, submitted to the "Physical Review of Letters," looks at whether string theory one day might be tested through astronomical observations. While on campus for a standing-room only lecture at Kane Hall, he shared thoughts on a few other issues.

How does string theory, once a controversial notion in physics, now rank in terms of acceptance?

Well, it's still controversial in that it doesn't have any experimental proof. But the controversy is no longer a centerpiece. Most physics departments around the country accept that this is an important line of research that may or may not ultimately be true, but certainly is heading the way toward a deeper understanding of particles and fields and a lot of things that other people study from different points of view. I don't think this is a good measure, but, for instance, some of the greatest critics against string theory were at Harvard in the mid- to late-1980s. Most of them whom I've spoken with since are not really great supporters of string theory, but they've definitely said they now recognize that it's an important line of research. In fact, Harvard has now hired three string theorists — something which one would have thought impossible.

What role have you played in this new-found acceptance of string theory?

I wouldn't say that I played any part, in terms of the popularization. I think what really caused that to happen is the tremendous progress that string theorists have made over the last 10 years. And I have played some small part in that. But, I don't think, ultimately, it was the spreading the word of string theory, more generally, that convinced them of anything. No. I think it was the fact that we understood aspects of black holes, we understood aspects of how space can evolve in ways that we had no ability to understand previously. I think these kinds of things really turned around the most vocal critics.

If you were to rewrite "The Elegant Universe" today, what would be different?

I don't think I would change much in the existing text. But I would certainly add new chapters. There are some interesting developments that were just happening as I was finishing writing, that made it into the last few end notes — because I just sort of squeezed them in. But there's recent work on something called holography, which is the weird idea that our universe might be like a hologram. A hologram, you know, is a thin little piece of plastic which, if you illuminate it in the right way, it creates a three-dimensional image. Of course, the three-dimensional image is fake. It's really just the two-dimensional plastic that you're illuminating in the right way. String theory, people have realized, seems to say something like that applies to the universe. Laws of physics may exist on some distant, very thin bounding surface — sort of like that little piece of plastic — and the world that we know about in here might be just like the holographic projection of those bounding laws. So all this stuff around us that seems very real and seems

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