APS NEWS

Physics News in 2004

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World Year of Physics Opens with Paris Conference

By Ernie Tretkoff

The World Year of Physics was officially launched at the conference "Physics for Tomorrow," which took place in Paris at UNESCO headquarters January 13-15. Speakers and participants addressed issues such as the public perception of physics and how physics can help solve social and economic problems.

Photos Credit: Erine Tretkoff

Several prominent scientists, including three Nobel laureates, discuss the role of physics in society at a press conference held during the WYP Launch Conference. From left to right: Denis Le Bihan, Carlo Rubbia, Maciej Nalecz, Martial Ducloy, Sylvie Joussaume, Harold Kroto, and Claude Cohen-Tannoudji.

About 1000 participants, including approximately 500 students from over 70 countries, attended the conference. Eight Nobel laureates spoke on a variety of topics ranging from biophysics to nanoscience to physics education in lectures aimed at highlighting the importance of physics and inspiring the audience. The conference was sponsored by UNESCO, the European Physical Society and a number of other international physics societies.

One focus of the conference was the declining student interest in the subject. It is hoped that the World Year of Physics will help increase interest among students and among the general public as well, and therefore the kickoff conference was designed to have a public focus, said Martial Ducloy, Chair of the International Organizing Committee of the International Year of Physics, in the opening session of the conference. "Physicists must come down from their ivory tower," he said. "Physics is not a discipline turned to the past, but continues to provide answers to fundamental questions."

Several speakers addressed the issue of how to get young people interested in science and insure that all students receive a good science education. Georges Charpak of France said, "When children are young they have spontaneity, but by age 11 or 12 this spontaneity has died. Scientific training is something they're not all that interested in." Science has to compete with television and video games to capture students' interest, he said. He emphasized the importance of hands-on learning in engaging students. "It's very important for people to do their own thinking," he said.

APS President Marvin Cohen also discussed education and outreach as part of a round table discussion on the public perception of physics. He described some of the events APS has planned for this year, and also discussed his own experiences presenting physics in high school classes, where he was able to interest the students in subjects like superconductivity and nanotechnology.

Jose Luis Moran-Lopez, director of the ISTR San Luis Potosi in Mexico, described a project called "Science for everyone," a series of books written by active Mexican scientists aimed at the high school and college level. There are also contests that invite students to read one of the books and do a project or report based on their reading, he said.

Also during the round table discussion, Pierre Lena, vice president of the Association Bernard Gregory, said that many students believe that science is out of reach for them. Strangely, young students in developing countries actually express more interest in becoming scientists than do students in the developed world, he said.

Ana Maria Cetto, Deputy Director General of the International Atomic Energy Agency, said physicists need to bring physics to people "by demystifying it, but without taking away the fascination, by destroying the myth of inaccessibility, by humanizing it, by applying it, showing its usefulness, but not by trivializing it." She said physicists have distanced themselves from society. "We are too busy talking to each other or we are too afraid of losing our academic image."

Many speakers emphasized the importance of physics and the value of the international physics community coming together. Chen Jiaer, Past-President of the National Natural Science Foundation of China, said, "Without physics and science the modern world would lose its very nature and modern society its future. There are new challenges and action that must be taken. Physical societies of all lands must unite."

Another issue discussed at the conference was science and developing nations. In one session, Katepalli Sreenivasan of the International Center for Theoretical Physics in Trieste, Italy, talked about physics and development. He pointed out some of the vast differences between the developed world and the developing nations, including the availability of internet access. Without access to the latest information, it is difficult to practice science, he said. "We live in a connected world, but yet

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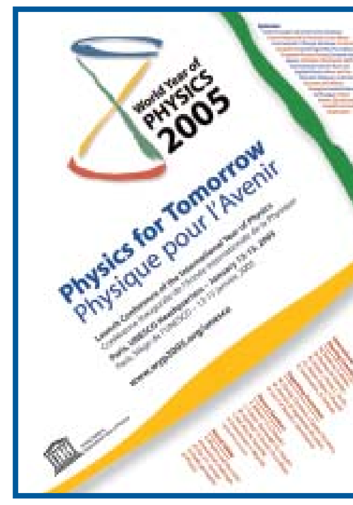

Eight Fellows Reach Back to the '30s and '40s

The December *APS News* featured a picture, taken at a Fellows' reception, of Maurice Shapiro, who informed us that he had been elected an APS Fellow in 1946. We wondered if he might be the oldest (in the sense of having been elected the longest ago) surviving Fellow.

Well, we might have known. Not only are there some older Fellows around, three of them are ex-Presidents of APS, and two of those have won Nobel Prizes. In chronological order, they are:

—Hans A. Bethe, elected Fellow in 1935, served as APS President in 1954, and won the Nobel Prize in 1967;

—John A. Wheeler, elected Fellow 1937, and served as APS President in 1966. He was one of the inaugural recipients of the APS Einstein Prize in 2003

—Norman F. Ramsey, elected Fellow 1940, served as APS President in 1978, and won the Nobel Prize in 1989.

In addition to these ex-presidents, we have heard from five other Fellows whose election dates from before 1950. They are:

—Scott Anderson, elected 1943; founded Anderson Physics Laboratory in Urbana, Illinois in 1944. He is a creative and prolific entrepreneur, who developed metal halide lighting systems. APL now has a 60- to 70-percent worldwide market share of the metal iodides used in metal halide lamps.

—Leo Beranek, elected 1946;

See **OLDEST FELLOWS** *on page 3*

Sixteen "Physics on the Road" Teams Selected for WYP

Sixteen teams from colleges and universities all around the country will participate in the World Year of Physics "Physics on the Road" project. Making use of funds provided by the NSF and DOE's Office of Science, the 16 teams will each receive a $10,000 grant, to be used for program supplies, vehicle maintenance, room and board for participants, and other costs associated with performing physics demonstrations. In addition, four alternate teams were selected, who will also receive support as more funding becomes available.

The 16 teams and 4 alternates were chosen from among 39 applicatants by a panel composed of representatives of APS, AAPT and the Society of Physics Students (AIP).

"Many of these local touring programs currently exist in physics departments across the country, but the lack of funding and external recognition limits their scope to small numbers of visits in localized areas," said Vinaya Sathyashelappa, APS project coordinator for the World Year of Physics. "Even so, each year these dedicated groups, composed largely of volunteers, manage to reach thousands of people, the majority of which are children."

For instance, 15 years ago, Dan Dahlberg of the University of Minnesota created "The Physics Force" outreach program for K-12 students, although the strongest focus is on sixth graders. The aim is "to create an enthusiasm for math and science in the youngest students," through fast-paced demos that teach a series of physics concepts, each building on the ones that came before. Two years ago, the group performed for a full two weeks at Disney's Epcot Center.

Today, Dahlberg's performances reach more than 30,000 local students,

See ON THE ROAD *on page 11*

And the winners are…

Speaking at the recent AAPT meeting in Albuquerque, Astronaut Don Pettit reads the names of winning high school teachers in the World Year of Physics reduced-gravity competition. The six winning teams of three teachers each will fly aboard NASA's "weightless wonder" parabolic aircraft later this year to perform experiments in microgravity.

PhotoCredit: Jessica Clark

Highlights

Members in the Media

"General relativity just relaxes me."
—Harry Ringermacher, General Electric, on his hobby, the Times Union (Albany, NY), December 12, 2004

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"A shuttle servicing mission is the best option for extending the life of the Hubble telescope. It is highly unlikely that the science life of Hubble would be extended with a robotic mission."
—Louis J. Lanzerotti, New Jersey Institute of Technology, The New York Times, December 9, 2004

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"This is a victory for freedom of speech."
—Marc Brodsky, American Institute of Physics, on the government's announcement that it would allow publishers to engage in publishing activities with people in Cuba, Iran, and Sudan, Associated Press, December 15, 2004

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"The fact that we can design satellites and space shuttles that don't come crashing back to Earth is because we take special relativity into account."
— Nergis Mavalvala, Massachusetts Institute of Technology, the Times-Picayune (New Orleans), January 2, 2005

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"String theory is not like anything else ever discovered. It is an incredible panoply of ideas about math and physics, so vast, so rich you could say almost anything about it."
—Edward Witten, Institute for Advanced Study, The New York Times, December 7, 2004

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"We bemoan the fact that Einstein spent the last 30 years of his life on a fruitless quest, but we think it's fine if a thousand theorists spend 30 years of their prime on the same quest."
—Lawrence Krauss, Case Western Reserve University, on string theory, The New York Times, December 7, 2004

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"If it were 30 light years away, this would go beyond being an exciting event and would be on the borderline of being in trouble."
—Robert Kirshner, Harvard-Smithsonian Center for Astrophysics, on the possibility of a supernova going off in our galaxy, The Boston Globe, December 21, 2004

Mixed Results for US Students in International Comparisons

The results of the 2003 Trends in International Mathematics and Science Study (TIMSS) were released on December 14, 2004. US students continue to score significantly above the international averages in both math and science. The results suggest that US eighth-graders have made strides in both subjects over the last eight years, but that US fourth-graders' performance has stagnated. In another international comparison, US 15-year-olds did not measure up to the international average in mathematics literacy and problem-solving skills.

The TIMSS assessments are carried out by the International Association for the Evaluation of Educational Achievement (IEA), and the first assessment was conducted in 1995. Follow-up studies are conducted every four years, providing an ongoing source of international comparison.

The 2003 assessment tested fourth- and eighth-graders in mathematics and science. More than 360,000 students in 49 countries participated in the 2003 study. Students from Singapore outperformed students from all other countries in both math and science, at both grade levels.

US eighth-graders scored better in both science and math than in previous assessments. Gains in math occurred primarily between 1995 and 1999, with the greatest gains in science occurring between 1999 and 2003.

In science, US fourth-graders were outperformed by their peers in five countries and regions. In math, fourth-graders from the US were outperformed by their peers in 11 countries and regions.

The 2003 assessment also found that, in almost all countries, higher parental education levels were associated with higher student achievement.

Another international comparison of students, the Program for International Student Assessment (PISA), showed US 15-year-olds performing below the international average of participating countries in an assessment of mathematical literacy and problem-solving.

Highlights of the TIMSS and PISA studies are available at http://nces.ed.gov.

—Excerpted from FYI, The American Institute of Physics Bulletin of Science Policy News (http://aip.org/fyi/)

This Month in Physics History

Einstein and Brownian Motion

In March of 1905, a young patent clerk in Switzerland named Albert Einstein submitted a groundbreaking paper extending Planck's 1900 notion of quanta to the wave/particle dual nature of light. It was published in the *Annalen der Physik*. In May the journal received another paper from Einstein. This time, his subject was the kinetic theory of gases, but the paper was equally groundbreaking in its conclusions.

In the 19th century, physicists had refined the kinetic theory of gases, which described heat as an effect of the nonstop agitated motion of atoms. Along with the American physicist J.Willard Gibbs, Ludwig Boltzmann used the kinetic theory to resolve the so-called "reversibility paradox" in physics. This arose from the second law of thermodynamics, which dictates that most natural processes are irreversible, in seeming contradiction to the Newtonian mechanics of atoms.

Bolztmann reinterpreted the second law as statistical, rather than absolute. He reasoned that there are so many atoms and molecules that make up something as small as an ice cube, for example, that it is extremely unlikely—although not impossible—for the molecules in a melted ice cube to return from the disorder of a liquid to their original orderly arrangement. The statistical improbability of those molecules doing so, however, was the source of the seeming irreversibility observed in nature.

Photo Credit: American Institute of Physics

Einstein and his first wife with their first-born son.

While a student at the Zurich Polytechnic Institute, Einstein met a young Serbian woman, Mileva Maric, the only woman in his physics class. Einstein's family opposed any talk of marriage, even after Mileva gave birth to a daughter (who was apparently given up for adoption). The pair finally married in 1903 after Einstein got his job at the Patent Office. Their first son was born in 1904. [A second followed in 1910.]

Einstein was supposedly unaware of Boltzmann's work when he began independently deriving the second law of thermodynamics from 1902 to 1904 to develop his own form of statistical mechanics. He used mechanics, atoms and statistical arguments to formulate a "general molecular theory of heat."

Einstein developed this statistical molecular theory of liquids for his doctoral dissertation at the University of Zurich. In a separate paper, he applied the molecular theory of heat to liquids to explain the puzzle of so-called "Brownian motion".

Photo Credit: American Institute of Physics

The Patent office in Bern.

In 1827, the English botanist Robert Brown noticed that pollen seeds suspended in water moved in an irregular "swarming" motion. Einstein then reasoned that if tiny but visible particles were suspended in a liquid, the invisible atoms in the liquid would bombard the suspended particles and cause them to jiggle. Einstein explained the motion in detail, accurately predicting the irregular, random motions of the particles, which could be directly observed under a microscope.

When Einstein's paper first appeared in 1905, the notion of atoms and molecules was still a subject of heated scientific debate. Ernst Mach and the physical chemist Wilhelm Ostwald were among those who chose to deny their existence. They argued that the laws of thermodynamics need not be based on mechanics, which dictated the existence of invisible atoms in motion. Ostwald in particular advocated the view that thermodynamics dealt only with energy and how it is transformed in the everyday world. [He and his followers were known as "energeticists" as a result.]

However, by May 1908, Einstein had published a second paper on Brownian motion providing even more detail than his 1905 paper, and suggesting a way to test his theory experimentally. That same year, a French physicist named Jean Baptiste Perrin conducted a series of experiments that confirmed Einstein's predictions. Perrin wrote that his results "cannot leave any doubt of the rigorous exactitude of the formula proposed by Einstein," and his work later earned him his own Nobel Prize in Physics, in 1926.

Eventually the experimental evidence supporting Einstein's theory of Brownian motion became so compelling that the naysayers were forced to accept the existence of material atoms. His fundamental work on applying statistical methods to the random motions of Newtonian atoms also led to his insights into the photo electric effect, through the discovery of a critical connection between his statistical theory of heat and the behavior of electromagnetic radiation. This was the first step in his goal to unify the two fields. Thus far, the electromagnetic theory developed by James Clerk Maxwell in the late 19th century had resisted all attempts to reduce it to mechanical processes. Einstein set out to do just that.

Next month: Special Relativity

See the special exhibit on Albert Einstein's life and work by the American Institute of Physics: http://www.aip.org/history/einstein/

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PHYSICS AND TECHNOLOGY FOREFRONTS

Thermal Management for Automotive Electronics

Alaa A. Elmoursi

With the continuing trend in automotive electronic systems toward higher power and increased packing density, efficient thermal management has become a crucial issue. Typical electronic devices and their packages consist of a variety of different types of materials, including metals, semiconductors, ceramics, composites, and plastics. The most important physical properties in the use of materials in thermal management are thermal conductivity (k) and the coefficient of thermal expansion (**a**). It is also quite evident that in general there is an enormous disparity between the **a**'s of good metals used for heat sinks (aluminum and copper) and insulators used for electronic substrates (alumina, BeO, AlN, *etc.*). The magnitude of this problem can perhaps be best visualized with the aid of *Figure 1*, which displays the thermal conductivity of various materials as a function of their **a**. While silicon and the best materials for insulating substrates occupy the left hand portion of this plot, aluminum and copper reside on the far right hand side. One of the many challenges of electronic packaging is bridging this thermal expansion gap in a manner that doesn't compromise the thermal efficiency of the package.

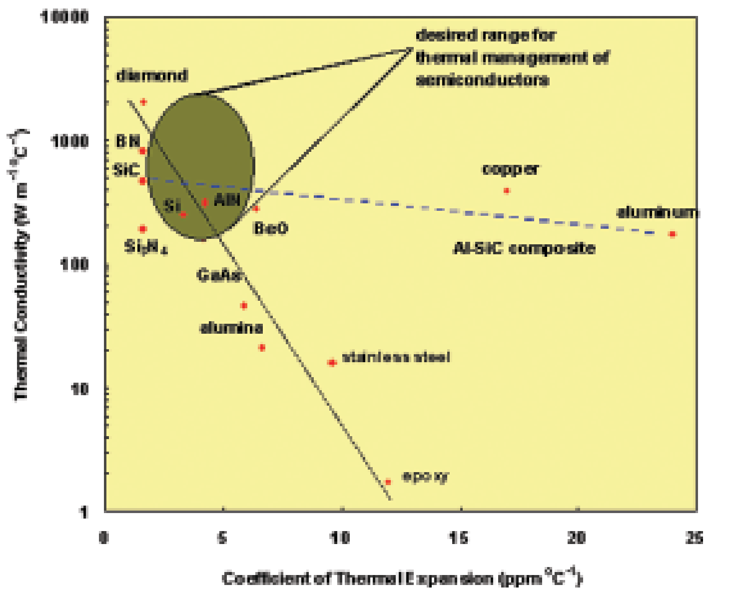

Figure 1. Thermal conductivity of electronic packaging materials as a function of their thermal expansion coefficients

It is well known that composite materials, which in the present context means two or more materials consolidated together, can possess a wide range of physical properties. Their use in electronic packaging is not new: the printed circuit board familiar to all of us is an example of a polymer matrix composite (PMC). Metal-matrix composites (MMC) are fabricated using a high thermal conductivity metal matrix such as aluminum or copper, with a low **a** material added to reduce the overall **a** of the composite. One such material that has undergone considerable commercial development is the aluminum/silicon carbide composite, represented by the dashed lines in *Figure 1*. By proper adjustment of the relative composition of the composite, the **a** can approach that of silicon and insulating materials while maintaining high thermal conductivity. The use of kinetic spray to fabricate MMC's addresses two important areas: further improvement of the material properties of MMC's for thermal management, and advanced manufacturing techniques that will allow cost-effective MMC fabrication on a production scale.

Kinetic spray processing: MMC's are typically made by squeeze casting molten metal into a ceramic perform. Because of the high temperature involved, undesirable compounds can be formed between the molten metal and the ceramic. In addition, this process cannot be employed to make MMC coatings. In 1994, Alkhimov and collaborators suggested a process whereby particles less than 50 microns in diameter could be sprayed to form a coating, with particles impinging on the substrate at about room temperature or even below. Delphi Research Labs (DRL) researchers discovered how to breech the 50 micron diameter barrier in making coatings with "cold" particles via an innovative spray gun design, producing coatings with particles as large as 200 microns. They named their new process kinetic spray because, for their particles to stick to the substrate, all of the incident particle's kinetic energy must be converted to heat or strain energy via plastic deformation upon impacting the substrate. Moreover, the DRL researchers found that they could kinetic spray mixtures of ceramic and metal particles, thereby forming MMC coatings without the requirement of melting the metal.

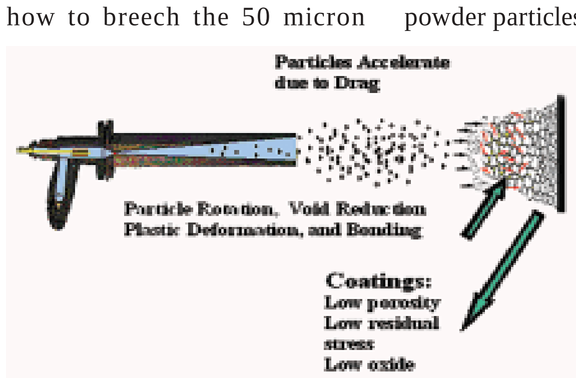

Figure 2. Schematic diagram of the kinetic spray process

A schematic diagram of the kinetic spray nozzle we use at DRL is shown in *Figure 2*. The main gas flow is delivered to the premixing chamber located downstream of the flow straightener at a pressure of about 2 MPa (300 psi) and a temperature that is controllable between 100 and 500 °C. Simultaneously, powder is delivered to the premixing chamber at a pressure of about 2.4 MPa (350 psi). The nozzle inlet has a restricted zone with a selected diameter such that the gas achieves supersonic velocity upon exiting the nozzle. The powder particles accelerate due to drag effects with the gas. These high velocities cause the powder particles to plastically deform as they impact the substrate and form a coating. However, the mechanism for solid particles colliding with a substrate to form a coating is not completely understood and requires further research.

Aluminum composites have been formed by kinetic spraying of powder mixtures. The Al/Diamond and Al/SiC mixtures had a composition of 70% Al by volume and the balance diamond and SiC, respectively. The Al/AlN and Al/W mixtures had a composition of 50% Al by volume and the balance AlN or W. All composites were sprayed on brass, stainless steel, aluminum and alumina substrates.

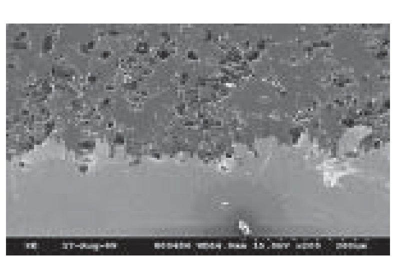

Figure 3: Cross-sectional SEM image of the Al/diamond composite on a brass substrate (bottom). The diamond particles are the dark contrast in the upper layer.

In order to facilitate a better understanding of the properties of Al MMC's we have studied the properties of kinetically sprayed pure Al. The as-deposited coating has a room temperature thermal conductivity of only about half of that of bulk aluminum (114 $W \cdot m^{-1} \cdot {}^{o}C^{-1}$ *vs* 240 $W \cdot m^{-1} \cdot {}^{o}C^{-1}$), but after annealing at 550 °C the conductivity rises to approximately 168 $W \cdot m^{-1} \cdot {}^{o}C^{-1}$ (70% that of bulk).

The powder mixtures of the Al-based composites were kinetic sprayed on several substrates. A summary of the coating thickness deposited on an aluminum substrate is shown in *Table 1*. The thickness of the composites is about one half of that of the pure aluminum, suggesting that the hard material in the matrix is eroding away the aluminum during spraying. However, as can be seen in the cross-sectional scanning electron microscope (SEM) images, the hard material also becomes lodged in the aluminum matrix. With the exception of the Al/AlN composite, all other composites could be deposited to several millimeters of thickness.

Results for adhesion of the Al-based composites to several substrates are shown in *Table 1*. The "*Yes*" and "*No*" in the table refer to whether the sprayed composite powder formed a uniform coating on the substrate or not. *Table 1* also displays thermal conductivity results on the as-deposited coatings as well as that after annealing at 550 °C. The pure aluminum and the aluminum/SiC composite coatings were thick enough to measure the thermal conductivity both perpendicular and parallel to the spray direction. The other composite coatings were not thick enough to perform measurements in the direction parallel to the spray.

Al/Diamond composite: *Figure 3* is a cross-sectional SEM image showing the interface between the Al/diamond composite and the brass substrate, which was sand blasted before applying the coating. The interface shows no sign of delamination and the aluminum is clearly providing the bonding to the brass substrate. The diamond is uniformly dispersed in the matrix. EDX results indicate 66% C and 34% Al by weight (56% C by volume, measured without standards), indicating a high content of diamond in the matrix.

The thermal conductivity at room temperature of the as-deposited Al/diamond MMC perpendicular to the spray direction is only 168 $W \cdot m^{-1} \cdot {}^{o}C^{-1}$, but rises to 202 $W \cdot m^{-1} \cdot {}^{o}C^{-1}$ after annealing. As far as I know, this is the first time an Al/diamond composite has been successfully formed by any method. Johnson and Sonuparlak reported the formation of a diamond/Al composite by pressureless infiltration, but in this case it was necessary to coat the diamond particles with SiC prior to infiltration to prevent the formation of Al_4C_3. A distinct advantage of the kinetic spray process is that it allows the formation of Al/diamond at low temperatures, thus obviating the need for any additives or reaction inhibitors.

In conclusion, the work at Delphi has shown that the kinetic spray method can be successfully used to fabricate composites of an aluminum matrix and hard materials such as SiC, AlN, diamond and tungsten. Kinetic spray lends itself to low-cost and high-volume processing. In addition unique composites can be fabricated.

Alaa Elmoursi is the Group Leader-Coating Materials in the Manufacturing Dept. of Delphi Research Labs in Shelby Twp., MI.

Composite	Thickness (mm)	Adhesion to Brass (MPa)	Adhesion to Stainless Steel (MPa)	Adhesion to Aluminum (MPa)	Adhesion Alumina (MPa)	Thermal Conductivity as-deposited	Thermal Conductivity annealed
Al/Diamond	7.5	Yes	Yes / slow buildup	34.5	23.2	168	202
Al/SiC	6.0	Yes	Yes	85.6	Yes	135 perp	165 perp
						155 par	190 par
Al/AlN	0.8	19.3	No	Yes / slow buildup	Not sprayed	129	144
Al/W	6.0	33.8	Yes / slow buildup	Yes	Yes	108	125
Al	14.0	Yes	6.9	Yes	4.8	114 perp	168 perp
						108 par	160 par

Table 1. Qualitative adhesion of the Al-based composites and pure aluminum to brass stainless steel, aluminum and silver coated alumina. "Perp" indicates thermal conductivity perpendicular to the spray direction; "par" indicates parallel to the spray direction.

OLDEST FELLOWS *from page 1*

with cofounders Bolt and Newman, Beranek started Bolt, Beranek, and Newman in 1948. BBN began as an acoustical consulting firm, but later entered the budding industry of computing and did contract work with NIH and ARPA.

—Wilbur Hummon Goss, elected 1946; joined Johns Hopkins Applied Physics Laboratory in 1942, retiring as assistant director in 1967. Goss had a leading role in the development of the "proximity fuze," which played a key role in the Allied victory in WW II, and the ramjet engine.

—Maurice Shapiro, elected 1946; founded the Laboratory for Cosmic Ray Physics at the Naval Research Laboratory in 1949, and headed it until 1982. He was also the director of the Nuclear Physics Division of the NRL from 1953 to 1965. In 1970, he helped to organize the APS Division of Astrophysics, and was the Chair of DAP in 1971-72.

—Abraham Taylor, elected 1948; born in England, he worked at English Electric Company during World War II, then moved to Mond Nickel Company, where he conducted crystallographic investigations of complex Ni-Cr-Ti-Al and similar alloys. He moved to Westinghouse in Pittsburgh, continuing his work on ultrahigh temperature alloys. He received an honorary DSc from the University of Manchester in 1965.

zero gravity

Young Albert E. and the Miracle Year

By James Riordon

Listen my friends, and shortly you'll hear
Why 1905 was a miracle year
For that was the time that a young patent clerk
By the name Albert Einstein did incredible work.

Now this is a story that comes in three parts
And the beginning, of course, is the best place to start.
But how it begins, I confess I don't know
So I made up a lie, and here's how it goes.

One day Al was walking and stopped to look down
At a puddle that spread in his way on the ground
As he studied the muck and the mud, Albert found
That his mind wandered back to the motion of Brown.

A small bit of dust or pollen or fluff
Would dance in the water, if 'twas tiny enough.
Some thought that the motions were signs of life
But old Reverend Brown had proved that's not right.

"The way the dust jiggles and wiggles and writhes,"
Al said, "it's no wonder some think it's alive."
He sat and he pondered and grasped for some notion,
What could possibly lead to this Brownian motion?

Well, he thought and he thought and he thought a bit more,
He thought 'til the thoughts made his thinking parts sore.
And with a little statistics and persistence galore,
He thought of an answer not thought of before.

"It's molecules," cried Albert, "too small to see
That are bumping the bits, that's what it must be.
And if water has molecules then so has that tree
And this rock and that bird, and yes, you and me!"

Well molecules and atoms at last were confirmed,
And solid state texts were rewritten or burned.
'Twas a wondrous discovery, though not without peer,
And it's hardly enough for a miracle year.

Now photons, like atoms, were once speculation,
Since light comes in waves with well known undulations.
But when light fell on metals and started a current,
Though the theories were clear, the experiments weren't.

Turn up the brightness and more electrons emerge,
While it's the color of light makes their energy surge.
How could this be? Albert knew it was wrong
If light was a wave as we'd thought all along.

He thought and he thought and he thought a bit more,
He thought 'til the thoughts made his thinking parts sore.
With a little deduction and persistence galore,
He thought of an answer not thought of before.

with apologies to Dr. Seuss ©2005 Paul Dlugokencky (aDailyCartoon.com) for APS NEWS

Light is sometimes a wave, that much is true,
But at other times it's a particle too.
And the same goes for atoms and marbles and pigs-
It just hard to tell when things get too big.

'Twas a wondrous discovery, and now he was near.
Yes, it's almost enough for a miracle year.

One day he was dreaming and thought if he might
Travel as fast as his photons of light.
What strange things would happen, what wonders there'd be
If he could approach the speed of light: *c*.

He thought and he thought and he thought a bit more,
He thought 'til the thoughts made his thinking parts sore.
With a little deduction and persistence galore,
He thought of an answer, not thought of before.

Now light speed is constant, experiment showed,
If you move quickly or move very slow.
But if light speed is constant, it's time that must change.
The answer's the answer no matter how strange.

This one little notion, while modest enough,
Led to a whole bunch of powerful stuff.
From time dilation to lengths that contract
To the source of the sunshine and cloud chamber tracks.

And perhaps Al's most famous discovery of all
Is the simple equation that most folks recall.
$E=mc^2$ made the fact plain
That energy and matter are one and the same.

And now there you have it, the case is quite clear
Why 1905 was a miracle year.
For in five famous papers and less than twelve months
Einstein came up with some fabulous stuff.

Washington Dispatch

A bi-monthly update from the APS Office of Public Affairs

ISSUE: RESEARCH FUNDING

Congress finalized the fiscal year 2005 budget in December, with mixed results for science agencies. The NSF budget was cut 1.9% from FY 2004, while the DOE Office of Science fared relatively well, with R&D programs increasing by 4.3% to $3.32 billion. NIST Labs received a 9.6% increase, while NASA research programs decreased by 5.5%.

President Bush is scheduled to send his FY 2006 budget to Congress on February 7. Research budgets are expected to be tight. Please refer to the AAAS R&D website for updates (www.aaas.org/spp/rd).

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ISSUE: INNOVATION

The Task Force on the Future of American Innovation, of which APS is a member, is planning a February 16 press conference to unveil a series of benchmarks on the health of science and technology in the United States.

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ISSUE: NEW S&T-RELATED APPOINTMENTS

Dr. Arden L. Bement was recently confirmed by the Senate as the new Director of the National Science Foundation, after serving for two years as director of NIST. President Bush has nominated Dr. Samuel W. Bodman as his new Secretary of Energy. Bodman is currently Deputy Secretary of the Treasury and served previously as Deputy Secretary of Commerce. He is also a former associate professor of chemical engineering at MIT. Carlos M. Gutierrez, CEO of the Kellogg cereal company, has been nominated as Secretary of Commerce.

In Congress, the House and Senate Appropriations Committees have new chairmen. Jerry Lewis (R-CA) succeeds Bill Young (R-FL) in the House, while Thad Cochran (R-MS) takes over for Ted Stevens (R-AK) in the Senate.

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ISSUE: SCIENTIFIC ADVICE TO CONGRESS

At its January 9 meeting, the APS Panel on Public Affairs members drafted a statement that calls for enhancing the capabilities of Congressional organizations that carry out technically based studies. The APS Council will vote on whether to approve the statement at its April 15 meeting. POPA also chose to explore mechanisms for joining with other scientific societies to provide science advice to Congress.

Log on to the APS Web Site:
(http://www.aps.org/public_affairs) **for more information.**

Viewpoint...

Einstein: Standard of Greatness

John S. Rigden

When the editors of *Time* magazine selected Albert Einstein as the person of the 20th century, they explicitly acknowledged his greatness. Today, 50 years after his death, Einstein commands a unique place in contemporary minds: "He's no Norman Einstein, but"… said a television announcer commenting on a smart NFL player or "He's no Einstein, but"… say proud parents as they boast of their prodigy's intelligence. There are many smart people, but it is always Einstein that is held up as the standard. Why? Why the physicist, Einstein?

In his autobiography, Einstein said, "The essential in...a man of my type lies precisely in *what* he thinks and *how* he thinks...." We know what the physicist Einstein thought and how he thought because it is in the historical record. The "what" and "how" cannot be over emphasized; however, they provide only part of the answer as to why Einstein occupies such a special place in contemporary culture. Einstein is special for two additional reasons: because of who we are as *homo sapiens* and because physics itself connects in a cogent way with the human species.

Einstein's accomplishment in 1905 has no equal. In six months, from March 17 to September 26, Einstein wrote five papers. The fundamental nature of these papers implicitly reveals *how* Einstein approached his physics: *"I want to know how God created this world… I want to know His thoughts, the rest are details,"* said Einstein in his autobiography. "God's thoughts" are not trivial and Einstein's 1905 papers were so basic that they shifted the tectonic footings that underlay physics and put a new face on Nature.

Einstein's March paper confronted the affirmed physical fact that light leaves its source and spreads through the surrounding space as a continuous wave. Einstein challenged this view as he built a powerful case to support his contention that light was *not* continuous, but consisted of individual, discrete, localized particles. The March paper was the only 1905 paper that Einstein himself called "revolutionary." Indeed, physicists were so repelled by Einstein's particle notion that they totally rejected it for 18 years. Today, Einstein's light particle, named the photon in 1926, is built into the foundation of physics.

Einstein's April and May papers were closely connected. The first was Einstein's doctoral dissertation and led directly to his May paper. Both papers focused on particles in a liquid. In his dissertation, the particles are sugar molecules and Einstein opened the way to determine their size. This was at a time when the reality of atoms was still debated. The dissertation is different from Einstein's other papers in that it has many practical applications, from cement to cow's milk, and is one of Einstein's most cited papers.

In the April paper, the particles are pollen suspended in water. For decades, pollen particles were observed to move throughout the liquid in a random, zigzag fashion. There was no explanation for this motion until Einstein showed that water molecules could depart from their average behavior, unite together, and bombard a pollen particle such that the zigzag motion was the result. This paper turned the last atomic skeptics into atomic believers: with only a ruler and a stopwatch, one could confirm Einstein's theory and observe incontrovertible evidence for atoms.

Einstein's June paper is one of the great papers in the history of physics. In this paper, Einstein presented his *Special Theory of Relativity*. Starting from two simple axiomatic statements, Einstein transformed our understanding of the two most basic concepts of physics: space and time. The June paper is a masterpiece.

The September paper was a logical extension of Einstein's June paper. In this paper, Einstein showed that two attributes of Nature that

See VIEWPOINT *on page 10*

ANNOUNCEMENTS

Proposed Bylaws Amendment
Regarding Endorsement of Non-APS Meetings

FIRST VOTE
Approved by Council, November 21, 2004

At the October 2, 2004 meeting of the Executive Board, the following motion was unanimously approved:

That the Executive Board delegates the endorsement of non-APS meetings to the appropriate units in consultation with the Executive Officer and approves moving ahead with amending the Society Bylaws to reflect this change.

The amendment below seeks to fulfill the motion of the Executive Board.

ARTICLE XI - Meetings and Endorsed Conferences

3. Endorsed Conferences.—The Society or a Division, Topical Group, Forum, or Section may endorse a conference devoted to the advancement and diffusion of knowledge in a sub-field of physics. Such a conference shall be known as an Endorsed Conference. Endorsed Conferences shall conform to the goals of the Society. They are distinct from Meetings of the Society and its units. Endorsed Conferences may set limitations on attendance and on the presentation of papers. Details of the organization of an Endorsed Conference shall be submitted to the Executive ~~Board, which shall approve or disapprove endorsement or co-endorsement by the Society. Endorsement or co-endorsement must be disapproved if, in the judgment of the Executive Board~~ Officer - who will ensure the proposed Conference does not conflict ~~importantly~~ in substance and time with planned Meetings of the Society or ~~its~~ other units. Endorsement or co-endorsement by the Society shall include suitable announcement of the Endorsed Conference in a Society publication.

Publication by the Society of abstracts of technical papers from an Endorsed Conference may be requested by the organizers of the Endorsed Conference; if approved by the ~~Executive Board~~Executive Officer, the additional cost of such publication shall be borne by the Endorsed Conference.

Proposed Amendment to the APS Bylaws
Regarding Enlarging the Audit Committee

FIRST VOTE
Approved by Council on November 21, 2004

The 2004 Audit Committee Report made the following recommendation:

We recommend that the Audit Committee be expanded to four members who will serve four year terms. The member in his/her third year will serve as Chair. At present, the Chair is only in his/her second year and should have more experience to be a more effective chair. We believe the auditors, Tom McIlrath and Michael Stephens concur in this recommendation.

The Audit Committee points out that increasingly complex regulations and responsibilities put upon the committee in recent years have made service on the committee a significant learning experience. By adding a fourth member and giving the members two years to become familiar with committee requirements before becoming chair, it is hoped that the chair will provide more effective leadership for the committee.

The 2004 Committee on Committees has considered this recommendation and voted to recommend Council approve a bylaws amendment to expand the Audit Committee to four members and that the Chair serve in his or her third year rather than their second year on the committee. The following is wording addressing the appropriate section of the APS Bylaws to enact such a change.

ARTICLE III—Standing Committees

A. Operating Committees

Audit ~~C~~ommittee—The membership of the Audit Committee shall consist of ~~three~~ four members of the Council, who are not members of the Executive Board or are not otherwise directly involved in the ~~busi~~ness management of the Society, elect~~ed~~ by Council to staggered ~~three~~ four-year terms which may extend ~~one~~ two years beyond their term on Council.

The member in his or her ~~second~~ third year of service shall ordinarily chair the committee. Following each fiscal year, the Committee shall review the audit with the Society's auditors and submit a written report to the Executive Board and to the Council, which shall include recommendations on fiscal management issues.

In addition, the Committee will also review the Society's Business Continuity Plan and assure that it is up-to-date.

EDITOR
REVIEWS OF MODERN PHYSICS
http://rmp.aps.org/

The American Physical Society is conducting an international search for a successor to the current Editor of RMP, who is retiring at the end of 2005. The Editor is responsible for editorial standards, policies, and direction of the journal, and leadership of a board of remote Associate Editors, composed of distinguished physicists who solicit review articles in all fields of physics. The Editor reports to the Editor-in-Chief and is supported by an in-house Assistant Editor.

It is expected that the Editor will maintain his/her present appointment and location and devote approximately 20% of his/her time to the position.

A candidate should possess the following qualifications:

- *recognized stature as a research physicist;*
- *broad knowledge and interest in physics and its frontiers;*
- *experience with the editing/refereeing process in physics publication.*

In addition, the Editor needs good interpersonal skills to promote the journal's aim of publishing critical reviews that serve a wide physics readership.

The initial appointment is for three years with renewal possible after review. Salary is negotiable. To ensure a smooth transition, the new Editor is expected to become involved in the fall of 2005, while the current Editor is still active. The APS is an equal opportunity employer.

Inquiries, nominations, and applications (including CV, publications, and letter of intent) are requested by 1 May 2005 and may be directed to: Robert Siemann, Chair, RMP Search Committee, c/o American Physical Society, 1 Research Road, Box 9000, Ridge, NY 11961-9000; or electronically to edsearch@aps.org.

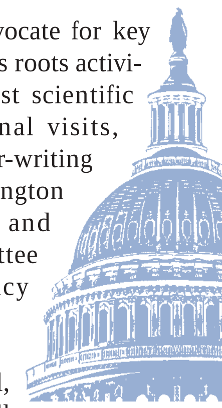
APS March Meeting Job Fair

Come to the Job Fair at the APS March Meeting whether you are conducting a job search or recruiting. Companies, universities and government labs will be showcasing their opportunities in condensed matter physics, materials science, engineering, high polymer, laser science, computational, biophysics, chemical, fluid dynamics, optical and semiconductor.

The APS March Job Fair offers employers and job seekers a more effective and economical way to solve their employment needs.

For More Information,
contact Alix Brice at
301-209-3187 or at abrice@aip.org.

American Physical Society Washington Office Senior Science Policy Fellow



Responsibilities: Craft and advocate for key science policy issues. Develop grass roots activities for one of the nation's largest scientific societies. Organize congressional visits, programs, "APS Alerts," and letter-writing campaigns. Represent APS Washington Office at selected APS national and divisional meetings, APS committee meetings and science advocacy coalition meetings.

Requirements: Excellent verbal, writing and interpersonal skills. Hill experience desirable. Science degree strongly preferred.

Salary: Commensurate with experience.

To apply, please send cover letter, resume, and three references to:

American Physical Society
529 14th Street, NW, Suite 1050
Washington, DC 20045
Attn: Michael Lubell, opa@aps.org
(202) 662-8700 [voice], (202) 662-8711 [fax]

American Institute of Physics Prize for Industrial Applications of Physics
2005-2006

Awarded on behalf of the Corporate Associates of the American Institute of Physics

Sponsored by the General Motors Corporation and AIP Corporate Associates

PURPOSE

To recognize outstanding contributions by an individual or individuals to the industrial applications of physics.

THE AWARD

The prize consists of $10,000, an allowance for travel to receive the prize, and a certificate citing the contributions made by the recipient(s). The award will be presented at the 2005 Industrial Physics Forum, November 6-8, in Gaithersburg, MD.

For rules and eligibility requirements, phone (301) 209-3131 or see:
www.aip.org/ca/iaprize.html

Nominations must be postmarked by May 2, 2005.

Send nomination and supporting documentation to:
Executive Director's Office
Attn: Committee for IAP Prize
American Institute of Physics
One Physics Ellipse
College Park, MD 20740-3843
Or e-mail your nomination to: assoc@aip.org

ON THE ROAD *from page 1*

teachers and members of the general public every year, and he estimates that in the last three years alone, more than 2% of the total population of Minnesota attended a performance. However, most of those people hail from the Twin Cities region. The APS grant will enable Dahlberg's group to give performances in more rural areas of the state.

Another one of the selected teams is the "Physics Circus," a joint demonstration show between the University of Texas at Brownsville and Texas Southmost College. It is a classroom-sized program that emphasizes direct interaction among students and scientists, but to date it has not been available to students outside of Brownsville. With the APS grant money, the "Physics Circus" will be expanded into an auditorium show and travel throughout the Rio Grande Valley.

Brownsville is the largest city in the Rio Grande Valley. The region is 95% Hispanic and bilingual, poverty-stricken, and most of the parents have less than a high school education, but hope for better opportunities for their children.

The new and improved demonstration will feature such crowd-pleasing feats as moving a cart across the stage with a fire extinguisher and using a frozen banana to hammer a nail. (This also makes use of local resources, since banana trees are common in most backyards in the area.)

Faculty at Northern Illinois University provide a "Frontier Physics Road Show," as well as an annual "Haunted Physics Laboratory," and the APS grant will allow the group to bring these events to more remote locations, particularly community college campuses in areas where there are few other scientific activities. The "Little Shop of Physics" team from Colorado State University will be bringing its award-winning performances to schools and other venues on the reservations of four Native American groups: the Navajo, the Southern Ute, Ute Mountain Ute, and the Jicarilla Apache. And Idaho State University's Physics Demonstration Road show will extend its performances to the surrounding states of Utah, Wyoming, northern Nevada and eastern Oregon, as well as all of Idaho. No other similar physics outreach program currently serves those areas.

Physics on the Road Teams

Chicago State University
Colorado State University
Idaho State University
Illinois State University
Northern Illinois University
Northern Kentucky University
Syracuse University
Towson University
University of Iowa
University of Maine
University of Minnesota
University of North Carolina, Chapel Hill
University of Oregon
University of Rochester
University of Texas at Brownsville/ Texas Southmost College
University of Wisconsin, Madison

Alternates
Angelo State University (Texas)
Purdue University
St. Mary's University (Texas)
University of Nevada, Reno

The Back Page

Remembering M. Hildred Blewett

By Rosalind Mendell

Editor's Note: As reported in the November 2004 *APS News*, M. Hildred Blewett, who died last year, bequeathed a considerable sum to APS to establish scholarships for women physicists. One of the explicit purposes is to enable women who have discontinued their careers to get back into research. The memoir that follows shows that encouraging women in this way was something Hildred Blewett cared about throughout her life.

Looking into my computer, I found a long letter written to Hildred Blewett on December 18, 1999. It began:

Dear Hildred—How great it was to hear your voice. If you recall, we used to keep in touch once a year. When I didn't hear from you last year, I was a bit concerned. And as the year went on, I thought of you more and more. I shall never forget that you were a mother to me at Cornell, helping me through that early difficult period, when I was emotionally and educationally unprepared for graduate school. And now that you can use a bit of mothering, we are at opposite ends of the continent.

I graduated from Hunter College in June 1940, the day that Paris fell. My physics professor, Ruth Messenger, had been active at the APS meeting, searching for a university that would give me a fellowship or assistantship to graduate school. The University of Ohio told her, "Why should we support her? She'll get married and have babies and the money will be wasted."

Miraculously, Cornell University offered me the President White Fellowship in Physics, for the first time for a woman since World War I. The approach of World War II to our country's portals was opening up the doors of physics to the opposite sex. As a chemistry major and physics minor in a woman's college, I was woefully unprepared as I walked into the long grim brick building of Rockefeller Hall. There I met about 50 young men, all happy to meet an unattached girl, and one married woman. Her name was Hildred Blewett. She told me that her husband, John Blewett, was working on magnetrons at General Electric, and that she had gone back for her doctorate because she loved physics and could no longer endure life as a "useless" company wife.

Hildred was 29 years old; I was not quite 20. It took a while for me to understand why this brilliant student of Hans Bethe was willing to take over the problems of a displaced neophyte in the autumnal chill of Rockefeller Hall. Our relationship was that of a mother and daughter. When I visited her in her room in the town of Ithaca, we played with her cats and we discussed our lives and mutual interests. She even gave me advice about whose attentions I should accept and whom I should avoid. We tramped together through the Ithaca gorges on the Physics Department hikes, which were usually led by Hans Bethe and his wife, Rose. We rowed in tandem on Lake Cayuga. Alone with Hildred, I left those long hours of solitude, hours spent in the library by day and in my laboratory at night.

I remember Hildred as that cheerful, confident and breezy Canadian blonde, at ease with people and delightfully crisp in conversation. Only twice did Hildred's good humor turn to annoyance and that was in response to the usual problems of women in physics. There was the time that she worked all summer on a problem. She found a solution that looked great for a doctoral thesis, only to have it brushed aside as inadequate and then taken over and presented at an APS meeting. And although she was well prepared to take her preliminary examinations for the doctorate when she entered Cornell, she was informed that she would have to take the preliminary graduate courses first—another year of wasted time. There was also that day when Chandrasekhar, about to give an invited colloquium in the Physics Department, looked about the room, smiled and said, "Lady and Gentlemen." I was amused but I still preferred to be one of the boys.

Cornell was a very exciting place in 1940-1942. My major professor-to-be, Robert Bacher, left the university just before I arrived and was replaced by Marshall Holloway, who stood by the cyclotron as he told me that we were doing "real " physics while Bacher was off somewhere in, hmpfh, "government." Little did I dream that my research paper on the range-energy relationship of alpha particles in argon would end up as part of the unpublished secret research of World War II.

Against Hildred's advice, I married the boy back home the day after Pearl Harbor. I left Cornell in August 1942 with just an MS degree, because my new husband wanted me back home for a bit of time before he had to leave for the Signal Corps and war. When I said goodbye to Hildred, neither she nor I suspected that her thesis advisor, Hans Bethe was about to follow the path of Bacher. Within the year, Holloway also left to join Bacher and Bethe in Los Alamos, along with George Placzek and Bruno Rossi, and fellow students like Ken Greisen, Boyce McDaniel and recent graduate Robert Marshak.

Hildred, the theorist, returned to General Electric, where she worked with her husband John, an experimentalist, from 1942 to 1947. They were working on a betatron and, later, on a synchrotron. Hildred had entered her career as a theorist for particle accelerators.

I ended the war in a laboratory at the National Bureau of Standards. There I worked to build an ionization chamber, similar to the one at Cornell, but with more sophisticated electronics. I then used my apparatus to measure the energy of alpha particles coming from the samples of "W metal" that were sent to me from Oak Ridge National Laboratories. From my measurements, I knew that I was determining the enrichment of U-235 relative to U-238 in uranium samples. There had been some literature on neutron-induced fission in 1939 and 1940 before the long silence.

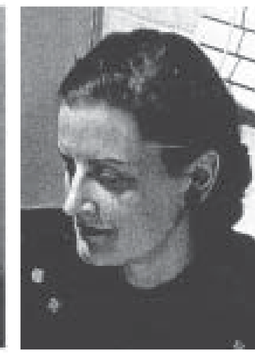
I shared my laboratory with Burrell Brown, who was working on Geiger counters. Burrell and I often discussed our secret work over lunchtime. We guessed that we were associated with a project that was attempting to use a chain reaction in uranium to develop a device that would fuel submarines in wartime; nuclear-fueled submarines would not have to expose themselves to the danger of surfacing. One day I discovered a new alpha particle in my ionization chamber. Leon Curtiss, our boss, was in his office for one of his occasional visits from Oak Ridge. Since Curtiss rarely spoke to me—a woman—Burrell dashed into his office to announce my discovery. Excitedly, Curtiss phoned Oak Ridge. Then he looked back, crestfallen, and said "Never mind." I learned why a few weeks later. First an atom bomb using uranium enriched in U-235 fell over Hiroshima. Then a bomb using Pu-239 fell on Nagasaki. My "discovery" was Pu-239.

On his next visit from Oak Ridge, Curtiss greeted me directly and jovially. At first I wondered why, but then he said, "I guess now you're going to go home and have babies." I was appalled, but I did do just as he had predicted. Their names are Laura and Henry. As for Burrell Brown, the *Rocky Mountain News* reported early this year that his daughter has filed for compensation for her mother. Her father had died of a leukemia-like disease, caused, she believed, by exposure to radiation during Word War II. And I suffered from five miscarriages during my childbearing days.

When my second child was born, my husband, Lesley and I moved into a UN development in Queens. There, the garden apartments were "staffed" by women who had been separated from their beloved professions by marriage and motherhood. One of these mothers was the future feminist, Betty Friedan. I would be the first mother in Parkway Village to break the mold. It all began when Lesley suggested that I get back into physics before I was too old. After all, my friend Rosalyn Sussman, now Rosalyn Yalow, had already pioneered the way, with no more than a two-week break after each baby. (Yalow later won the Nobel Prize for her work in nuclear medicine). One day, Les and I decided to hire a baby-sitter and go folk dancing in Manhattan. It was there I met John Blewett and renewed my friendship with Hildred.

I told Hildred about my life as a housewife and of Lesley's wish to have me reconnect with my

Rosalind Mendell ca. 1940



Hildred Blewett in the 1940's

beloved physics. Hildred immediately took up the lance. She said, yes, I must go back to physics; I could be a physicist and still be a mother. She was now happy and fulfilled, working with John in Brookhaven on the new Cosmotron. John was the experimentalist in charge and Hildred was both the accelerator theorist and the emotional support of the men on their project. Between the urgings of Hildred and Lesley, I agreed to move to larger quarters and hire a nanny/housekeeper and look for a job and go back to school.

Established in my new house in 1956, I found that the to-be-called affirmative action that was at large during the war was really over and that women physicists were no longer wanted. I phoned the Radiation Lab at Columbia University, where I had a great experience in 1944 before running off to be with my husband, who was in basic training in Neosho, Missouri. I had loved my work in microwave radiation, and I enjoyed the stimulating conversations that I had with my fellow neophytes and with the three Nobelists-to-be. The current professor-in-charge responded with, "Why should we hire you when we don't have to pay our graduate students regular salaries, and they are so much better?" Only Professor Dunning, who was still running his offshoot of the Manhattan Project, finally returned my call months later. By then, I was pregnant again and unavailable.

Fortunately my return to physics was "saved" by Sputnik, which created a new demand for students of physics. I ended up as a graduate research assistant at NYU, with an experiment on large BF3 neutron counters and responsibilities for teaching a class to undergraduates—and also with graduate physics classes to take at night. The effort was hard on my resources and trying for my children, although the young girls that we and others imported from Europe as nanny-housekeepers were a blessing for our family. Hildred was there to support me, if only by phone, cheering me on with her positive breezy comments. I could sense that all was not joy with Hildred. Hildred told me that John, the experimental physicist in charge of the alternating gradient synchrotron in Brookhaven, often told Hildred, who had the theoretician's grasp of the synchrotron, that she was there because of his position at Brookhaven. And yes, she was still mothering the young physicists at Brookhaven.

By 1957, Hildred and John were well known in the field of accelerators. Years earlier, they had helped with the initial stages of setting up the accelerators at CERN in Switzerland. They wrote papers, notices and reports and received citations from other accelerator physicists on their work, both individually and together. Then one day around 1957, Hildred told me that she was leaving John. She was going to work at Argonne, where she would be a physicist on her own worth. Hildred moved to Fermilab. She stayed for several years before moving permanently to CERN in Switzerland.

Our intermittent communication stopped completely after the trip across the Atlantic. But I did know that Hildred was very active with the SPS and IRS accelerators at CERN. I was now quite occupied with my Cosmic Ray Project at NYU. I did not try to communicate, but occasionally a visitor arrived at NYU from CERN. I learned from the physicists that used the accelerators that Hildred was a prominent member of the CERN accelerator community. As for the external evidence, it is in the numerous documents, the in-house reports, the long conference reports on particle accelerators, and the work as editor of the proceedings of conferences on high-energy accelerators.

I finally heard from Hildred herself after 1977, when she retired from CERN. She wrote that she was living in England, where she had access to the opera and concerts and the theater. Her address was in that cultural center, Oxford. Eventually Hildred moved on to Canada. She said that she wanted to be closer to her nieces, who live in Halifax. Our communications became that once-a-year long phone call and the Christmas card packed with personal information and photos. Even as Hildred became feebler and more dependent on others for help, her voice remained resilient and crisp over the telephone.

I found the notice of Hildred's final gift in the *APS News*, just weeks before the day of my annual telephone call to her apartment in Halifax. It all makes good sense. Hildred had never spent time or money on the activities that deplete the bank accounts of so many of the fair sex. And now here is concrete evidence that even in her last days, Hildred chose to be mother to those women in physics who are still riding against the current of male-dominated physics. Over a million dollars! Thank you, Hildred.

Rosalind Mendell was Senior Research Scientist and Research Associate Professor of Physics before retiring, after 35 years, from New York University.