

History of Physics

NEWSLETTER

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News of the Forum:

Lillian Hoddeson Wins 2012 Pais Prize

By Elizabeth Garber and Michael Riordan

Lillian Hoddeson of the University of Illinois has been selected to receive the 2012 Abraham Pais Prize for the History of Physics to recognize her many contributions to the discipline. In its recommendation the Pais Prize Committee cited Hoddeson “for her leadership and contributions to writing the history of twentieth-century physics, her pioneering studies of American research laboratories—particularly Bell Labs, Los Alamos and Fermilab—and her perceptive scientific biography of John Bardeen.”

After earning her Ph.D. in physics from Columbia University, Hoddeson did early historical studies on the beginnings of industrial research at Bell Telephone Laboratories, which led to her work on the development of solid-state physics and the invention of the point-contact transistor. With Spencer Weart she organized the American section of the International Project on the History of Solid State Physics. This research led eventually to publication of *Out of the Crystal Maze: Chapters from the History of Solid State Physics* (Oxford, 1992)—an invaluable resource on the history of solid-state physics for which she served as lead editor.

With Michael Riordan, Hoddeson published *Crystal Fire: The Birth of the Information Age* (Norton, 1997), which is widely regarded as the definitive history of the invention and development of the transistor. Its award-winning PBS-TV adaptation “Transistorized!” has had a broad impact on general audiences.

Hoddeson has also worked on the history of the development of the atomic bomb. While researching this subject, she realized that Los Alamos was in danger of losing its wartime documents and proposed that the Laboratory create an archive and a history project. She directed a team of scholars, which included Paul Henrickson, Roger Meade and Catherine Westfall, and used both classified and unclassified documents to publish *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943–1945* (Cambridge, 1993). This monograph is considered the definitive technical work and the standard reference on the history of the building of the atomic bomb. It was widely acclaimed by Manhattan Project participants, including Hans Bethe, Robert Bacher and Norman Ramsey.

At Fermilab, Hoddeson established an archive and a history program focused on particle accelerators and high-energy



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Editors' Corner

I thought I'd devote this particular plot of newsletter real estate to a topic of potential interest to FHP members, the Laboratory History conferences that have been held biannually or annually for over a dozen years.

The Laboratory History conferences started in 1999, with a meeting I organized at Stony Brook University and Brookhaven National Laboratory. Since then, the conferences (whose driving force generally has been Catherine Westfall) have been held among other places at Jefferson Lab in Virginia; at the University of Illinois, Urbana-Champaign; at the University of British Columbia; and at Johns Hopkins University. They now have an international membership, and cover a broader spectrum of laboratories and issues. The 7th Conference took place in June 2011 in Leuven, Belgium, and the 8th is to be held at the Georgia Institute of Technology in Atlanta on March 30 and 31, 2012, in conjunction with the April APS meeting.

History of Physics NEWSLETTER

The Forum on History of Physics of the American Physical Society publishes this Newsletter biannually at <http://www.aps.org/units/fhp/newsletters/index.cfm>. If you wish to receive a printed version of the Newsletter, please contact the editor. Each 3-year volume consists of six issues.

The articles in this issue represent the views of their authors and are not necessarily those of the Forum or APS.

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The Seventh Laboratory History conference was organized by Geert Vanpaemel, a professor of history of science at the University of Leuven. Vanpaemel directs the Laboratory Project, a 4-year research program supported by the Flemish Research Council (FWO) that examines the interface between laboratory cultures and their social and institutional environment to examine how labs have changed the practice of science.

Many of the laboratories examined were Belgian. Lyvia Diser, one of the Laboratory Project's graduate students, spoke about the founding of the Belgian Pasteur Institute. Truus van Bosstraeten, another of the grad students, showed the contents of a recently discovered photo album of Leuven laboratories from the early 20th century. Since much of the town was destroyed in WWII, this album provided a valuable record of the labs, sometimes providing the only existing pictures of them. The album illustrated typical features of university labs at the time, including the persistence of the "physics cabinet," the precursor of a true natural science lab, where the classic instruments were collected. It included pictures of the laboratory in the brewery school, which served as an important link between the university and industry.

Sofie Onghena, another of the Laboratory Project's grad students, gave a talk on the differences between physics and chemistry laboratories in Belgian high schools at the end of the 19th century. Belgium was then torn by an ideological debate between clerics (Catholics) and anti-clerics (or advocates of secularism in government). This debate, Onghena showed, was reflected not only struggles over the proper character of education, but even in the different kinds of laboratories found in Catholic and Belgian Royal State schools. While labs in Catholic schools tended to consist of cabinets and natural history museums, and were designed to portray the harmony of God's creation and inculcate knowledge of its eternal laws, those in the state schools stressed inquiry and experimentation, and sought to prepare the students for practical industrial careers.

Peter Schollers, a professor at the Vrije Universiteit in Brussels, discussed the events leading to establishment, in 1856, of the Chemical Laboratory of the City of Brussels, one of the first official laboratories in the world and still in operation. These events had much to do with the social and cultural factors. In 1830, Brussels became the capital of the new nation: Belgium. Municipal officials were keenly aware that the city's huge health problems, including abysmal sanitary conditions, food adulteration, and frequent epidemics, reflected poorly on a city that was, after all, a European capital. Therefore, Schollers argued, although the political climate ran strongly against state intervention in commerce, and although pharmacists traditionally had the role of analyzing food samples, city officials found it necessary to establish a municipal laboratory to supersede these traditional practices.

Several talks concerned physics labs. Dirk van Delft, of Leiden University, spoke on the cryogenic laboratory of superconductivity discoverer Heike Kamerlingh Onnes. In 1882, Onnes was appointed professor of experimental physics at Leiden, and began to transform its physics department building into a modern research laboratory. This required more than a talent for physics, Delft showed, but also the ability to coordinate a wide variety of appliances and instrumentation – pumps, compressors, engines, liquefiers, gas supplies, glass-blowing equipment, and so forth – overseen by diverse research organization with managers, engineers, glass-blowers, instrument-makers, students, and supervisors in what Delft calls "Big Science avant la lettre." This work culminated in the discovery of mercury's superconductivity on 6 April 1911.

Sonja Petersen, a historian of technology from Offenbach Academy of Art and Design, Germany, spoke about a short-lived "piano laboratory" that existed in Germany between 1927 and 1931, which attempted (unsuccessfully) to span laboratory science and handicraft. Joseph Martin, a graduate student in history of science at the University of Minnesota, spoke about the "National Magnet Laboratory and the Maturation of Solid State Physics," and discussed

what the trajectory of this laboratory can tell us about the emergence of solid state research and the role of large laboratories in the U.S.

Other talks concerned the history and fate of various European laboratories. Ida Stamhuis, for instance, from the Vrije Universiteit Amsterdam, discussed the First German Genetics Institute, established in 1914 at the Agricultural College in Berlin. Though its director was male, for a while its scientific staff was entirely female, and it had a strikingly high percentage of female staff members for similar European genetics institutes.

Two papers concerned visits to laboratories. One, by Mineke Bosch from the University of Groningen discussed the travel letters of Utrecht physiologist Dr. Marianne van Herwerden (1874-1934) during her research trip to the US in 1920, in the course of which she visited the Rockefeller Institute for Medical Research, laboratories of the Johns Hopkins Medical School, and the Woods Hole Marine Laboratory. These descriptions are interesting in the way they highlighted the then-new way of life for researchers in America as compared to Europe—you had to work faster, be more enterprising, labor for longer hours, and sometimes had to skip dinner. Still, you could not spend all your time in the lab but had to network; in short, you had to be socially active as a scientist, having to travel, organize, seek funding, expand your projects, and network.

Elizabeth Neswald from Brock University in Canada examined someone going the other way: Francis Benedict, the director of the Carnegie Nutrition Laboratory, toured European laboratories between 1907 and 1913 to examine the structure, organization and resources of European laboratories to mine for features he could integrate into the Carnegie Nutrition Laboratory. His reports provide a valuable analysis of European metabolism laboratories during this period.

Other papers concerned different

7th Laboratory History Conference

6 - 8 June 2011



Georganiseerd door de onderzoekseenheid Cultuurgeschiedenis vanaf 1750 in samenwerking met het Leuven Interdisciplinary Platform for the Study of the Sciences (LIPSS)

Locatie: Justus Lipsiuszaal, Faculteit Letteren (6 juni)
& Louis Janssenszaal, Heilige Geestcollege (7-8 juni)

<http://laboratoryhistoryconference.wordpress.com>

Poster for the 7th Laboratory Conference

types of laboratories. Raf de Bont of the Katholieke Universiteit in Leuven spoke about the emergence of biological field stations at the end of the 19th century. These have reputations as being lonely retreats in unspoiled nature for the use of loners amusingly stereotyped as “worm slicers” (morphologists), “egg-shakers” (experimental physiologists), and “bug hunters” (collectors). Yet, de Bont showed, these labs were quite strategically positioned scientific habitats inside a bigger habitat. Jesse Olszynko-Gryn from the University of Cambridge discussed the role of laboratories in pregnancy testing in the 1930s, in what amounted to a revolution in obstetric practice, as well as development of a new kind of laboratory—the routine diagnostic laboratory.

Several talks concerned computers. Michiko Tanaka, of Brookhaven National Laboratory, spoke about the history of computing at Brookhaven National Laboratory. She discussed the vast

changes wrought in computing at BNL by the surging scale of information from its major instruments, and changing patterns of publication as tracked by various bibliometric measures. These patterns include a sharp drop in single-authored papers, and huge increase in interdisciplinarity. Still, she found a retention of strong and consistent mathematics and physics orientation, and noted the impact of major national and international events. Meanwhile, David Nofre and Gerard Alberts, of the University of Amsterdam, spoke about the development of the programming language ALGOL, from 1958-1964.

Economics seems a subject scarcely amenable to experimentation. Yet Andrej Svorencik of the University of Amsterdam showed that, thanks to computers, this is not the case. In the 1940s and 1950s, experiments were “pen and pencil” exercises where instructors distributed pieces of paper with information about goods to students, and recorded the contracts they

made amongst themselves. Computers revolutionized these inquiries. Screens in cubicles now allowed labs to make subjects privy to some information in private, while an overhead projector made other information visible to all on a whiteboard. In the 1960s, Berkeley established the first computerized economic laboratory, and since then they have grown ever more elaborate. Sophisticated computer programs and removable partitions allow limited communication between certain subgroups. Today, about 150 economics labs are in operation around world, though about 3 dozen produce the bulk of published research.

In the course of the conference, the vast differences between laboratories discussed by the papers, and the multiplication of perspectives on these laboratories, served to raise increasingly difficult questions not only about what

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Report on Historic Sites Committee (HSC) Activities

By Benjamin Bederson

The APS Historic Sites Committee (HSC) named four sites to honor in 2011. These were: the old Bell Telephone Laboratories in New York City (Davisson-Germer experiment), the Scripps Oceanographic Institute, La Jolla, California (Keeling Curve), the Brookhaven National Laboratory, Upton, NY, for general outstanding accomplishments, and the National Bureau of Standards (now NIST), Washington DC (non-conservation of parity). The 2011 HSC committee consists of Ruth Howes, J. David Jackson, Kurt Gottfried, and Benjamin Bederson (Chair).

Bell Telephone Laboratories

The Westbeth artists community in New York City was honored on May 9. It is named after its location on West and Bethuane Streets in Greenwich Village. From 1898 until 1966 it was the home of the famous Bell Telephone Laboratories, with the address 463 West St, before the laboratories moved to Murray Hill NJ. It was here that many of the twentieth century's most significant technological and scientific advances took place, for example crucial advances in electronics, radio, television, and radar. It was at this location that Claude Shannon made his landmark contributions to information theory, playing a crucial role in the development of computers. APS singled out a specific set of experiments, led by physicist C J. Davisson, for recognition. In 1927 at this site, he, along with L.H. Germer, showed that free electrons exhibited wave-like properties, under certain circumstances. This was the final link that established the reality of quantum mechanics. Davisson received the Nobel Prize for this work in 1937.

After the move to Murray Hill the West Street group of buildings was renovated by the architect Richard Meier and was taken over by what is now the Westbeth artists condominium. It has become a thriving center of artistic culture on the New York scene.

A plaque was installed at the site, reading:



Original appearance of Bell Telephone complex (note the railroad, now metamorphosed into the High Line).

At this site, the original location of Bell Telephone Laboratories, in 1927 C. J. Davisson and L. H. Germer performed the first direct demonstration of the wave-like behavior of elementary particles, predicted by L. de Broglie in 1923. The Davisson-Germer experiment provided crucial empirical evidence for the validity of the then rapidly evolving theory of quantum mechanics. In those years and subsequently many important scientific and technological discoveries were made at the same laboratory.

The President of the successor to Bell Labs, Alcatel-Lucent Bell Labs, H. Kim Jeung, and Alice White, Chief Scientist, attended the dedication as well as representatives of the Westbeth community. Presiding was Curtis Callen, Past APS President. To our knowledge this was the first formal meeting of the two groups—artists and scientists—a striking confluence of the two cultures.

Scripps Oceanographic Institute

On June 17 we honored the Scripps Institute of Oceanography for the lifetime achievement of Charles Keeling in demonstrating the annual increase in the concentration of carbon dioxide in the atmosphere. This accomplishment

revealed hard evidence of the impact of human activity on the concentration of greenhouse gases in the atmosphere. The citation reads:

The Keeling Curve and the Scripps Institution of Oceanography. At this location Charles David Keeling planned and led his project to measure the level of carbon dioxide gas in the atmosphere. The rise of the level over the decades reveals an influence of human activity.

In 1957 Roger Revelle, Director of Scripps, and Hans Suess, a staff member, published a prediction that there would be a buildup of carbon dioxide gas in the atmosphere, since the oceans could not absorb the gas as rapidly as human industry was emitting it. For more than half a century scientists had speculated that a rise in the gas would have a strong effect on global climate, so Revelle decided to check whether the level of carbon dioxide was in fact rising. He hired Charles David (“Dave”) Keeling (1928-2005), a young post-doc who had already been making measurements of the gas because of its important role in geochemistry and agriculture.

Keeling's measurements were done with physical instrumentation that he had developed himself, and which was much more precise than previous systems for measuring atmospheric carbon dioxide. He measured the gas's absorption of infrared radiation—the same physical phenomenon that produces the so-called “greenhouse effect”. (Carbon dioxide, water vapor, and other “greenhouse gases” trap heat as it radiates from Earth into space; if there were no carbon dioxide in the atmosphere, our planet would be mostly frozen.) By going to pristine locations Keeling was able to determine a true baseline level.

The plan was to take a “snapshot” of the planet's carbon dioxide levels at a number of locations during the International Geophysical Year (IGY) 1957-1958, and then repeat the observations a few decades later to see whether the predicted rise had occurred. But Keeling was so dedicated to precision that he was able to detect a rise within two years. These first results,

published in 1960, were done with instruments in the extremely pure air of Antarctica. Keeling was meanwhile gathering measurements from other parts of the globe, of which the most significant came from a station near the summit of Mauna Loa in Hawaii, located in mid-Pacific in the pure air above the tropical inversion layer.

The Mauna Loa curve rose steadily year by year, in a sawtooth pattern as plants in the Northern Hemisphere took up carbon dioxide during their spring growth and released it in autumn and

winter decay—a phenomenon that Keeling exploited for significant studies of the carbon cycle. By the early 1970s the rise of the curve was accepted by scientists as highly significant.

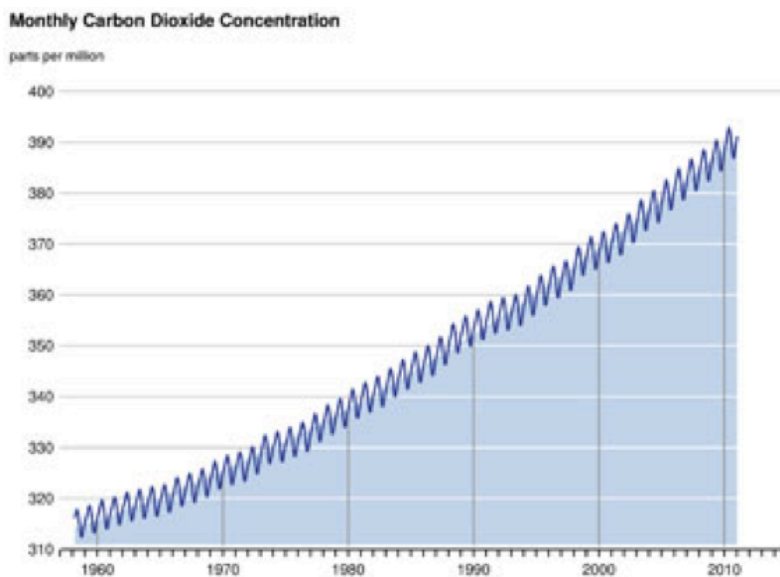
Meanwhile theoretical studies suggested a strong likelihood that the additional gas would eventually produce a profound global warming. From the 1980s to the present, as the world's scientific academies, governmental agencies, and intergovernmental panels increasingly voiced worries about future climate change, the ever-climbing "Keeling Curve" became an icon familiar to all concerned members of the public. These measurements are fundamental to all studies of climate change.

After his death the work at Scripps has continued under the direction of his son, Ralph Keeling.

Brookhaven National Laboratory

On September 23 we honored the Brookhaven National Laboratory for its many discoveries—you might say, for a lifetime's achievement. The citation reads:

At this laboratory, over many years, physicists and engineers have made numerous fundamental discoveries in the fields of nuclear and high energy physics, the physics and chemistry of materials, energy and environment, biology and medicine. Among



Concentration of CO2 in the atmosphere vs. year—the Keeling Curve.

many landmark experiments are establishing the spin direction (helicity) of the electron neutrino, first observation of solar neutrinos, proof of more than one species of neutrinos, first observation of a lack of symmetry between matter and antimatter, and the principle of strong focusing that led to more compact and powerful accelerators.

A convocation to celebrate the award was held September 23 in the Berkner Hall Auditorium. The lead article in the BNL publication *The Bulletin* of October 14 describes the event in detail; part of it, including a summary of the four talks presented, appears below.

Historic Site Hurrah at BNL



APS President Barry Barish (right) presents Lab Director Sam Aronson with a commemorative plaque recognizing BNL as a historic site.

Heavy rain fell on Friday, September 23—the day that the American Physical Society (APS) recognized Brookhaven National Laboratory as a historic site in the advancement of physics. The planned walking tour was postponed, but members of the Lab community, undaunted by the weather, gathered in Berkner Hall to attend the award ceremony.

The purpose of the APS Historic Sites initiative is to increase public awareness of physics and physicists' awareness of important past scientific advances and their place

in the historic evolution of their work. Brookhaven is now one of about 20 historic sites designated by the APS, this being the first time an entire national laboratory has received this prestigious recognition.

"This is a tremendous event at the Laboratory for all of us who work here now, those who worked here in the past, and those who will work here in the future," said Laboratory Director Sam Aronson, as he welcomed everyone to the ceremony.

Robert Crease, BNL historian and Stony Brook University Philosophy Department chair, gave the first talk. "The history of Brookhaven is one of the most important stories of post-World War II science," said Crease, highlighting some of the important people, facilities, and scientific developments in the evolution of BNL during its six-decade-plus history.

BNL Senior Physicist Emeritus, former APS Editor-in-Chief, and former BNL Deputy Director Martin Blume spoke next. Blume focused on the story of two Brookhaven scientists: Renate Chasman and Kenneth Green. They developed the Chasman-Green Lattice—an arrangement of magnets that bends, focuses, and corrects an electron

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FHP-Sponsored Sessions at the 2012 March and April Meetings

By David L. Huber

The FHP Program Committee has assembled what we hope will be engrossing and unusual sessions for the upcoming APS meetings in Boston (February 27-March 1) and Atlanta (March 31-April 2). You will find detailed listings below of all the talks and speakers, with their dates, times, and rooms. Let me just give a few highlights.

In the March session, we have decided to honor the 150th anniversary of Maxwell's formulation of his equations for electromagnetism by assembling three eminent authorities (Francis Everitt, Bruce Hunt, and Jed Buchwald) to speak about the discovery, propagation, and application of these equations, followed by two Nobel laureates, Roy Glauber and Frank Wilczek, who will look back at Maxwell's equations from our present point of view. This year marks the centenary of Edward Purcell, whose seminal work brought NMR into the world and transformed radio astronomy, among other signal accomplishments as teacher and researcher. To consider his scientific legacy, we will hear several of his closest collaborators speak about the discovery of NMR (Nicolaas Bloembergen), Purcell's work in biology (Howard Berg), his contributions to radioastronomy (Harold Ewen), his involvement advising the government (Richard Garwin), and (very much not least) his immense influence as a teacher (John Rigden). Finally, we will have a session on the history of metrology, with the new developments in the SI at the forefront, addressed by five eminently qualified speakers. Robert Crease, who has organized this session, will begin with the history of the quest for absolute standards, followed by Terry Quinn (on the early years of the International Bureau of Weights and Measures), James E. Faller (on measurements of g and G), Howard P. Layer, Sr. (frequency measurements of visible light at NBS/NIST), and Richard Steiner (on Planck's constant measurements and SI kilogram standard).

At the April meeting, we will have a session on Bruno Rossi, the great cosmic ray physicist, and his legacy, organized by Dan Kleppner. Three notable speakers will address Rossi's influence on x-ray astronomy (George W. Clark), space physics (Edward Stone), and cosmic rays (James W. Cronin). Our next session will consider the history and implications of physicists involved in advising on national security, organized by Gloria Lubkin. Once again, the speakers bring extensive experience to this important topic. Richard Garwin will address PSAC (the President's Science Advisory Committee) and other modes of advice; Roy Schwitters will address the perspective of those involved in JASON, and former Secretary of Defense John S. Foster, Jr. will speak on advisory experience with DOD, DOE, and the intelligence community. Finally, our last session will concern developments in the national laboratories since 1980, organized by Catherine Westfall. We are specially pleased that this session will begin with Lillian Hoddeson, this year's Pais Prize winner, giving her Pais Prize talk on the failure of the SSC and its historical lessons. Then Burton Richter will give his view of the evolution of relations between the national laboratories and the DOE. Finally, Joseph Martin will discuss the assimilation of solid state physics into the national laboratories.

All these sessions promise to be valuable and interesting occasions; the gathering of these very special speakers may give us several unique occasions that probably will never happen again. Such opportunities to hear about the history of physics from some of its most important protagonists are history itself. I urge you all to attend and participate in what we hope will be truly memorable events.

Peter Pesic
Co-Chair, FHP Program Committee
2011-2012

March Meeting 2012: Feb. 26–March 2, 2012 Boston, Massachusetts

March 2012 FHP Sessions
(Boston Convention Center, Boston, MA)

I. One Hundred Fifty Years of Maxwell's Equations

(organized by Peter Pesic)

Session B-19

Monday, February 27, 2012 from
11:15-2:30

Room: 253AB

C. W. Francis Everitt (Stanford), "The discovery of Maxwell's equations"

Bruce Hunt (Univ. of Texas), "The Maxwellians and the Remaking of Maxwell's Equations"

Jed Buchwald (Caltech), "Using Maxwell's equations in the late 1800s"

Roy Glauber (Harvard), "Maxwell's equations and quantum optics"

Frank Wilczek (MIT), "Taking off from Maxwell's equations"

Chair: Edward Gerjuoy (University of Pittsburgh)

How Maxwell discovered his equations, how they affected the physics of his time and our own, including current perspectives on this seminal discovery.

II. The Scientific Legacy of Edward Purcell (1912-2012)

(organized by Peter Pesic)

Session Q-19

Wednesday February 29, 2012 from
11:15-2:30

Room: 253AB

Nicolaas Bloembergen (Univ. of Arizona), "Purcell and NMR"

Howard Berg (Harvard), "On small things in water moving around: Purcell's contributions to biology"

Harold I. Ewen (EK Associates), "Purcell and the development of radioastronomy"

Richard Garwin (IBM Watson Research Center), "Purcell's work advising the government"

John Rigden (Washington Univ.), "Purcell the Teacher: In and Out of the Classroom"
Chair: Gerald Holton (Harvard)

The historical context and continuing importance of the discoveries of Edward Purcell (1912-1997), including NMR, its application to radioastronomy, his work in biological physics, in advising the government, and in physics education.

III. History of Metrology: The Evolution from Physical to Electronic Measurements

co-sponsors: FHP and GPMFC (organized by Robert P. Crease)
Session X-2

Thursday, March 1, 2012 from 2:30-5:30
Room: 204AB

Robert P. Crease (Stony Brook), "Dreams of a Final System: Origins of the Quest for an Absolute Standard."

Terry Quinn (Emeritus Director BIPM), "From Artifacts to Atoms: The Origins and Early Years of the International Bureau of Weights and Measures"

James E. Faller (JILA), "Measurement of the gravitational quantities g and G : Learning how ideas for precision measurement experiments come about"

Howard P. Layer, Sr. (NIST), "The Odyssey of the Frequency Measurements of Visible Light at NBS/NIST"

Richard Steiner (NIST), "Evolving Planck Constant Measurements into the SI Kilogram Standard"
Chair: Richard Davis (BIPM)

The history of measurement standards from individual manufactured artifacts to standards based on constants of nature.

April Meeting 2012: March 31-April 3, 2012, Atlanta, Georgia

April 2012 FHP Sessions
(Hyatt Regency, Atlanta, GA)

I. The Scientific Legacy of Bruno Rossi
(organized by Daniel Kleppner)
Session C5
Saturday, March 31, 2012 at 1:30-3:18
Room: International Ballroom South

George W. Clark (MIT), "Rossi and x-ray astronomy"

Edward Stone (Caltech), "Rossi and space physics"

James W. Cronin (Univ. of Chicago), "Rossi and cosmic rays"

Chair: Daniel Kleppner (MIT)

The session is intended to portray the science that Rossi helped to pioneer in X-ray astronomy, cosmic ray physics and space science. The spirit of the session is to help the younger generation understand more about the heritage of physics that makes their research possible and to learn something about the great scientists who helped to create that heritage.

II. Physicists Advising on National Security

(organized by Gloria Lubkin)
Session H5
Sunday, April 1, 2012 at 10:45-12:33
Room: International Ballroom South

Richard Garwin (T. J. Watson Research Center, IBM Fellow Emeritus), "Experience with the President's Science Advisory Committee, Its Panels, and Other Modes of Advice"

Roy Schwitters (University of Texas, Austin), "Experiences Advising our Government from the Point of View of a JASON"

John S. Foster, Jr. (Private consultant), "Advisory Experience with DOD, DOE, and the Intelligence Community"

Chair: Gloria Lubkin (Physics Today editor emerita)

The session is intended to present the perspectives of three physicists who have spent many years advising the government on national security.

III. The National Laboratories After 1980 (Pais Prize Session)

(organized by Catherine Westfall)
Session T5

Monday, April 2, 2012 at 3:30-5:18
Room: International Ballroom South

Lillian Hoddeson (Univ. of Illinois, Urbana), "The Failure of the SSC: Lessons for the History of Physics" (Pais Prize talk)

Burton Richter (SLAC), "A View of the Evolution of Lab/DOE Relations."

Joseph Martin (Univ. of Minnesota, Minneapolis), "A Good Name and Great Riches: Rebranding Solid State Physics for National Laboratories"

Chair: Catherine Westfall (Lyman Briggs College, Michigan State University)

This session will describe the various changes that took place within the national laboratories and between the national laboratories and the overall physics community and the Department of Energy. ■

beam. This lattice is a critical component for BNL's National Synchrotron Light Source (NSLS), other light sources around the world, and the future NSLS-II.

"The development of a design expressly for a synchrotron radiation source, with a laboratory staff that could make varied use of it and colleagues in many universities and industrial laboratories, showed the advantage of a multidisciplinary laboratory like Brookhaven," Blume said.

Nicholas Samios, director of the RIKEN BNL Research Center and former Brookhaven Laboratory director, then discussed physics discoveries and contributions resulting from work done through the Laboratory's facilities and major programs. "Major programs are important because although you can't pick one big thing, they greatly add to a body of knowledge," Samios noted.

National Bureau of Standards (now NIST)

The final convocation took place on November 9, at the former site of the National Bureau of Standards, now NIST, which is now partially occupied by the University of the District of Columbia, where the plaque will be installed. The installation is in honor of the landmark non-conservation of parity experiment performed there by a group of NBS scientists headed by Ernie Ambler, in collaboration with the Columbia University physicist C. S. Wu. The citation reads:

Non-conservation of Parity in Weak Interactions. At this location in 1956, C.S. Wu, E. Ambler, R.W. Hayward, D. D. Hoppes, and R.P. Hudson measured the asymmetry of the angular distribution of electrons emitted by polarized ^{60}Co nuclei demonstrating that weak interactions are not symmetric under a change of parity. This work led to the recognition that the weak and electromagnetic forces are aspects of a single force.

It was long believed that in both classical and quantum physics the laws



From left to right: Katherine Gebbie, Allen Sessoms, Kate Kirby

of nature do not distinguish between pairs of physical processes that differ only by mirror symmetry, which interchanges left and right. Before 1955 it was generally believed consistent with experiment that all physical interactions are symmetric when left and right are interchanged.

After World War II, physicists rapidly discovered a zoo of new particles. One of the new particles, the K^+ meson, decayed sometimes to two pions (positive parity) and sometimes three pions (negative parity). Clearly, there were either two nearly identical particles that decayed in different ways or the parity symmetry did not hold for a single particle (now known as the K^+ meson). In 1956 T.D. Lee (Columbia University) and C.N. Yang (Brookhaven National Laboratory), studied this puzzle. Their careful review of the literature revealed that while there was lots of evidence that interactions governed by the strong nuclear force (nuclear physics) and the electromagnetic force (atomic physics) were symmetric under a change of parity, the symmetry had never been tested experimentally in interactions governed by the weak force such as beta decay in nuclei and the decays of particles like the K^+ . In a 1956 paper, Lee and Yang proposed experiments to test the conservation of parity in systems governed by weak interactions. For this work, they were awarded the 1957 Nobel Prize in Physics.

One of the experiments that Lee and Yang proposed was to measure the changes in the distribution of electrons emitted in the beta decay of ^{60}Co along the axis of nuclear polarization as the direction of polarization was changed from up towards the detector to down away from the detector. ^{60}Co was an ideal candidate for this test. Its beta decay was well-studied and governed by a single matrix element so there would be no interference terms to provide background in the measurement. Cobalt is ferromagnetic and so the nuclei could be polar-

ized by placing them in a strong magnetic field at very low temperatures. The experiment sounds simple; however, it posed major challenges. The source had to be kept at temperatures below 0.01K and placed in a magnetic field of 2.3 tesla. The radioactive nuclei had to be very close (50 μm) to the surface of the material so that the electrons would not interact with the molecules of the crystal after beta decay. Finally the electron detector had to be placed inside the dewar if decay electrons were to be detected. Remember that at this time electronics were vacuum tube and low temperature seals were made with soap. Growing crystals with thin radioactive surface layers was anything but an established field.

C.S. Wu, a leading expert on beta decay and Lee's colleague in the Physics Department at Columbia University, and Ernest Ambler, an expert on low temperature spin polarization and his colleagues at the low temperature laboratory of the National Bureau of Standards, accepted the challenge of conducting the experiments. In January 1957, they submitted a paper to Physical Review presenting the results of their experiments conducted in late 1956. The experiment demonstrated conclusively that interactions governed by the weak force are not symmetric under a change of parity.

The results of the beta decay experiment by C.S. Wu, E. Ambler, R.W.

Haywood, D.D. Hoppes, and R.P. Hudson were confirmed by experiments on the decay of μ -mesons published by Garwin, Lederman and Weinrich in the same issue of *Physical Review*. The demonstration that weak interactions are not symmetric when a system's parity is changed lead to new theoretical understanding of neutrinos, the role of fundamental symmetries in shaping the physics of the universe, and the eventual unification of the weak and electromagnetic forces.

A small ceremony was conducted at the University Board Room, attended by the university president Allen Sessoms, Katharine Gebbie, Director, Physical Measurement Laboratory, NIST, APS Executive Officer Kate Kirby, Allen Chodos, Benjamin Bederson, and a number of UDC teachers and administrators. ■

Editor's Corner

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constitutes a laboratory, but also the impact of laboratories on constituting science itself. What, for instance, is a laboratory "space," especially after the impact of the computer? Is it a container space, people at work, computer networking, or the space of an ideal language such as mathematics? Such issues occupied more and more of the discussion as the conference drew to a close, and will no doubt be raised again at future Laboratory History conferences.

LHC 8

The Eighth Laboratory History conference will be held at Georgia Tech on March 30 and 31, held to piggyback off the APS April meeting March 31 - April 3. John Krige, Kranzberg Professor in the School of History, Technology, and Society at Georgia Tech, is the local host. The program chair is the FHP's own Catherine Westfall. Those who are interested should contact one of them for further details. ■

— Robert P. Crease, Editor

physics. With Laurie Brown, and later with Max Dresden and Riordan, she organized a series of three international symposia on the history of particle physics, which resulted in *The Birth of Particle Physics* (Cambridge, 1983), *Pions to Quarks* (1989), and *The Rise of the Standard Model* (1997). All of them books are indispensable resources on the history of particle physics.

Hoddeson's most recent historical work, *Fermilab: The Frontier, Physics and Megascience* (Chicago, 2008), co-authored with Adrienne Kolb and Westfall, reflects some 30 years of research and is in many ways one of her most important works. Its narrative involves two novel, intertwined themes—the emergence and evolution of big science at Fermilab, and how the imagery of the American frontier was imaginatively invoked by Robert Wilson and Leon Lederman in building and directing the laboratory. This book is a sophisticated analysis of "megascience" and a study of the narrowing focus of big science following the budgetary tightening that began around 1970. Peter Galison observed that its authors have done "a superb job of following the turbulent confluence of science policy and created a major study of broad interest to anyone who wants to understand what large-scale research looks like in the real world." Gino Segre described the book as "masterful in being both a major scholarly contribution to the history of physics and a riveting read."

Hoddeson has also contributed importantly to the writing of scientific biography by virtue of her numerous,

extensive interviews with leading scientists, and by writing with Vicki Daitch the biography of John Bardeen, one of the outstanding 20th century physicists. *True Genius: The Life and Science of John Bardeen* (Joseph Henry, 2002) was recognized by the Times Higher Education Supplement as one of the best non-fiction books of 2002 and named a Silver Winner in *Foreward Magazine's* Book of the Year awards.

Hoddeson has conducted over 500 oral-history interviews. Her work instructing students and colleagues in the art of interviewing, especially through a graduate seminar in the University of Illinois History Department, has extended the work of Charles Weiner and Weart in new directions and to new audiences. She has introduced hundreds of students to the methods and theory of oral history in other fields such as sociology, policy studies, education, and anthropology. Her publications in this area are widely circulated, translated and cited, not just by historians of science and physicists but by scholars in cognitive psychology and education. Hoddeson's current work in progress includes a biography of the prolific inventor Stanford Ovshinsky and a monograph on the theory and methodology of interviewing that takes into account what is presently known about the psychology of human memory.

Lillian Hoddeson richly deserves the recognition of the 2012 Abraham Pais Prize for her impressive achievements in the history of physics. ■

New Books of Note

BCS: 50 Years

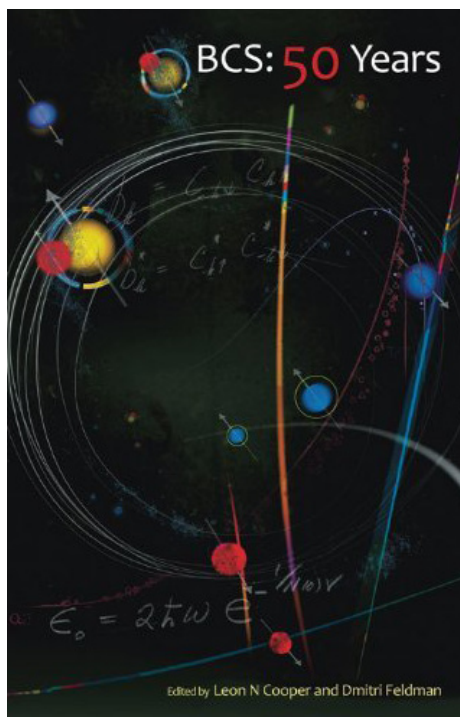
By Leon Cooper and Dmitri Feldman, Editors, World Scientific, 2010, 588 pp., \$135 (hardback), \$65 (paperback), \$176 (ebook)

Reviewed by Joseph D. Martin

Superconductivity routinely vexed the most accomplished theoretical physicists for almost half a century after H. Kamerlingh Onnes first documented the phenomenon in his Leiden laboratory. The Bardeen-Cooper-Schrieffer theory of superconductivity, which appeared in 1957, surmounted decades of frustration and garnered immediate acclaim. Its larger legacy would emerge gradually as expansions and applications of the theory cemented its relevance for a broad range of physical phenomena. *BCS: 50 Years*, edited by Leon Cooper and Dmitri Feldman, unites 23 contributions from a range of physicists, many of whom contributed to the early development and application of BCS theory. Taken together, these essays represent a valuable first step towards understanding the manifold aspects of the BCS legacy.

The volume's first section establishes the historical background of BCS with contributions from each of its architects. Leon Cooper, J. Robert Schrieffer, and John Bardeen recall their personal intellectual journeys leading to the theory's formulation, each pointing to a different critical factor. Cooper observes that isolating one qualitative feature of the superconducting state—the distinctive energy gap below T_c —led to the discovery of a new ground state for interacting electrons. Schrieffer's account opens a window into the geography of collaboration at the University of Illinois: Cooper shared an office with Bardeen, but also spent much of his time at the "Institute for Retarded Studies," the lively graduate student offices where Schrieffer had his desk. Bardeen, characteristically sharing recognition for his accomplishments, credits BCS to the robust interplay between theory and experiment that guided their work.

These narratives are not contrasting so much as complementary. Each isolates an element of the mid-1950s



intellectual context in which BCS emerged that illuminates the story in a slightly different way. The volume's other historical recollections further detail to that picture. Slichter, reinforcing Bardeen's claim that understanding superconductivity required rich theory-experiment dialogue, discusses how the experimental underpinning of BCS intertwined with contemporaneous developments in NMR. Pines recalls that the political climate during the development of BCS was just as frenzied as the intellectual climate. Through a careful reconstruction of several unsuccessful theories of superconductivity, Schmalian develops a compelling account of how "failed" efforts in science build the scaffolding on which future successes rest. Gor'kov and Anderson show how BCS immediately generated further advances: Gor'kov recounts the rapidity with which the theory took hold in the Soviet Union, leading to its reinterpretation with QFT methods, and Anderson describes how BCS paved the way for the appreciation of electron-electron pairing mechanisms, which undergirds current

understanding of superconductivity as a single phenomenon that comes in two manifestly different flavors.

With the historical background in place, the rest of the volume tours the full and colorful variety of ways BCS motivated subsequent theoretical and experimental work. Clarke's description of experimental developments and applications of SQUIDS is particularly engaging. Adjacent articles from Chu and Abrahams describe the evolution of high- T_c superconductivity from the experimental and theoretical angles, respectively. It is a testament to the editors' care that they introduce these two pieces with Cohen's thorough overview, including historical background, of BCS's utility for understanding critical temperatures. These articles come as part of a sequence outlining the state-of-the-art in superconductivity research, a category in which the contributions of Fulde, Goldman, and Le Doussal also belong. Linking these works with insights from the book's historical overview imparts a distinct sense of the theory's enduring impact.

The scale of BCS's import for twentieth-century physics comes into sharpest focus through the papers discussing its broader applications. Leggett reviews how BCS and the phenomenon of Cooper pairing proved useful, often in unexpected ways, for superfluidity research—a sentiment echoed in Ketterle, et al., Halperin, et al., and Zwicky and Wosnitza. The full breadth of BCS's influence is most evident in the form of contributions to this volume from high energy, nuclear, and astrophysicists. Baym describes the role of BCS in aiding understanding of neutron stars and high-density quark matter and Nambu, Weinberg, and Wilczek each acknowledge the high energy community's debt to BCS for highlighting the importance of spontaneous symmetry breaking.

Readers of *BCS: 50 Years* should be aware that many contributions are highly technical. Even so, the contents are rich enough that historians and

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New Books of Note

The Infinity Puzzle

Quantum Field Theory and the Hunt for an Orderly Universe

By Frank Close, New York: Basic Books, 2011, 417 pp. & index, illustrated, \$28.99

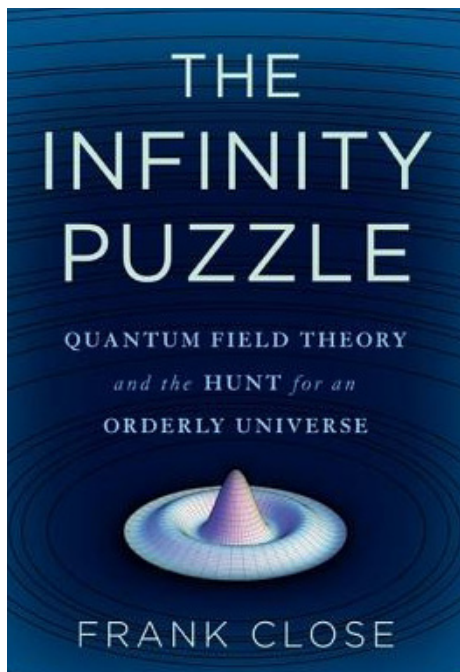
Reviewed by Michael Riordan

In the early 1980s, Nobel laureate Paul Dirac told Princeton University theorist Ed Witten that the most important challenge in physics was “to get rid of infinity.” Some of the most beautiful, appealing physical theories have however been plagued by infinities that erupt as theorists try to prod their calculations into new domains. Ridding them of these infinities has likely occupied far more effort than was spent in their origination.

In quantum electrodynamics, or QED, the equations initially led to infinite results for the self-energy or mass of the electron. After nearly two trying decades, this problem was solved by a the “renormalization” procedure (See article by Silvan Schweber, Fall 2011 issue) and thereafter conveniently ignored. Richard Feynman referred to this sleight of hand as “brushing infinity under the rug.”

In *The Infinity Puzzle*, Oxford University theorist and writer Frank Close tells the intriguing tale of the dogged efforts of physicists to apply quantum field theories to Nature, from QED to today’s dominant Standard Model of particle physics. Much of his account concerns attempts to cure the infinities of these and similar field theories, hence the book’s title. Close focuses on the minutiae of the calculations involved, to the nearly total exclusion of experimental and other contemporaneous theoretical work.

Because of seemingly unresolvable infinities, quantum field theory came to be perceived during the 1960s as a backwater of particle theory. But in 1970 Dutch theorists Gerhard ‘tHooft and Martinus Veltman showed how to renormalize gauge field theories, throwing the door wide open to a magnificent



revival—“the moment when field theory was reborn as the golden path for understanding” Nature.

Close was himself one of these true believers. He did his graduate work in the mid-1960s at Oxford under Richard Dalitz, one of the few theorists at the time who thought quarks might in fact exist. Then he came to the Stanford Linear Accelerator Center late in that decade, just as these fractionally charged fundamentals started to turn up in electron-scattering experiments there.

The core strength of this book is its discussion of how the electromagnetic and weak forces were painstakingly unified into the “electroweak” force, a drama that took nearly two decades to unfold and involved over a dozen principal actors. Five of them have already received Nobel Prizes, and more now wait in the wings, hoping for the discovery of the Higgs boson at the LHC. In fact, as Close explains in detail, there

are six theorists who made worthy contributions to the electroweak theory’s mass-generating mechanism, widely associated with theorist Peter Higgs.

Close has done his homework researching this and other breakthroughs. He unrelentingly called and emailed the physicists involved in a given advance (myself included) until their accounts began to gel into a coherent picture. And where they sometimes do not, he duly acknowledges the difficulties in his copious footnotes—a treasure trove of additional insight for historians of physics.

Unfortunately, however, Close’s intense focus on theoretical minutiae means that the experimental side of the story gets short shrift. One egregious example is his discussion of quantum chromodynamics—the theory of the interquark force. Its source is a radically different property of matter called “color” that emerged from theoretical and experimental work of the 1970s. But color pops onto the page in a few paragraphs two thirds of the way through the book, with almost no explanation of how it arose. By contrast, Close’s discussion of asymptotic freedom, whereby this force weakens as two quarks approach, gets 15 pages plus extensive footnotes.

Card-carrying historians might scoff at this account as “Whig history”—one told by the winners. Indeed, the great majority of particle theory going on from the mid-1950s to 1970 gets only passing mention. But such a Whiggish, “internalist” account serves a valuable purpose: to record in superb detail the inner workings of what was a small but successful theoretical subculture that few particle physicists paid much heed until 1970. And for physicists interested in following such details, *The Infinity Puzzle* makes for a gripping read. ■

physicists of all stripes will find much of value in its pages. Aside from the omission of the original BCS paper, the inclusion of which would have added a useful reference point, the primary shortcoming of this volume is that much of its content is available elsewhere. Mitigating this criticism is the fact that the juxtaposition of these chapters, not their contents alone, makes the volume well worth the price. Like superconductors themselves, the book gains its most striking and useful properties from the interaction between its component parts. Superconductivity—and, indeed, condensed matter physics as a whole—is ripe for concentrated historical attention. Just as BCS acted as a powerful motivator for further physical research, the descriptions of the theory and its influence contained within BCS: 50 Years furnish a valuable foundation on which historians may build. ■

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History of Physics

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