Forum on History of Physics

February 1999 Newsletter

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FHP at the APS Centennial

The American Physical Society will celebrate a Century of Physics at its Centennial Meeting in Atlanta, March 20-26, 1999. This meeting marks a milestone in the history of APS and offers a once-in-a-lifetime opportunity to reflect on the achievements and influence of physics and physicists over the past one hundred years.

The APS Forum on the History of Physics has played an important role in planning the Centennial Meeting and arranging symposia and sessions designed to make this meeting a memorable and historical event. Members of the Forum contributed their expertise in the preparation of a large historical wall chart highlighting the momentous discoveries in all branches of physics, and the men and women who made them, during this past century. Also on display will be the series of posters that the American Institute of Physics Center for History of Physics prepared on the occasion of the 100th anniversary of Einstein's birth in 1979.

The Forum's Program Committee, chaired by Allan D. Franklin (University of Colorado), has arranged three sessions that are certain to be of high interest. Two have been designated as Centennial Symposia. The first, "Physics in the 20th Century: The Revolution -- Quantum Mechanics and Relativity," chaired by Ruth H. Howes (Ball State University), will feature as speakers John D. Norton (University of Pittsburgh), David C. Cassidy (Hofstra University), John S. Rigden (American Institute of Physics), and Lillian Hoddeson (University of Illinois). The second, "Physics in the 20th Century: World War II, Accelerators, and the Rise of High-energy Physics," chaired by Michael Riordan (SLAC), will feature Wolfgang Panofsky (SLAC), Robert W. Seidel (University of Minnesota), Peter L. Galison (Harvard University), and Steven Weinberg (University of Texas).

A third session on I.I. Rabi's life and work, chaired by John S. Rigden (American Institute of Physics), will feature Norman F. Ramsey (Harvard University), Dudley R. Herschbach (Harvard University), William D. Phillips (National Institute of Standards and Technology), Daniel Kleppner (Massachusetts Institute of Technology), Martin L. Perl (SLAC), Hans A. Bethe (Cornell University), and Neal Lane

(National Science Foundation).

A fourth session, "20th Century Developments in Instrumentation and Measurements," which also has been designated as a Centennial Symposium, is cosponsored with the Instrument and Measurement Science Topical Group and chaired by William E. Evenson. And a fifth session is being cosponsored with the Committee on the Status of Women in Physics and the Division of Nuclear Physics, "Women and Men Inside the Atom: A Historical Look." Finally, former Forum chair Martin J. Klein (Yale University) will deliver a Plenary Talk on "Physics and the American Culture."

The Forum, however, has no exclusive claim on the history of physics, and we applaud the many other APS Divisions, Topical Groups, Forums, and Committees that have arranged historical sessions on their particular branches of physics or areas of concern. To name but some of them, there will be Centennial Symposia dealing with the historical development of various sub-fields of physics -- nuclear, particle, plasma, statistical, gravitational -- as well as neighboring fields of physics -- astrophysics, biophysics, biochemistry, chemical physics, molecular, and polymer physics. Others will treat particular topics -- chaotic dynamics, nonlinear systems, magnetism, neutrinos, physical constants and precision measurements -- and particular devices -- lasers, atomic clocks, and semiconductors. Still others will address the contributions of women in physics, of physicists in industry, and of immigrants to physics in America. Finally, issues of broad concern such as physics education, science policy, and physics in the national defense will be treated historically. All these events will show collectively why this past century has indeed been the Century of Physics.

-Roger H. Stuewer, Forum Chair

Editor's Note: Research News

The following request appeared in the August 1998 issue of *History of Physics Newsletter*:

A Call for News
Forum members would like to know what others are doing in history of physics activities. This could include news of future, present or past participation in conferences, seminars, workshops, etc., announcements and/or programs for such events, mention of recent publications by members, or other items you think might be of interest to our audience. Please send suggestions to the Newsletter editor (evenson@byu.edu).

In response to this appeal, I received the two items of "Research News" printed on this page and a couple of notices of conferences that

appear in a later section. With thanks to those who sent information about their work or conferences, I would like to renew this "Call for News" and invite other readers to email me information that might be of interest to our audience.

-Bill Evenson, Editor

Research News
The 8th International Conference on the History of Science in China was held at Berlin University of Technology in Berlin, Germany, August 23-28, 1998. Scholars from Australia, Canada, China, Denmark, France, Germany, Italy, Japan, Korea, the Netherlands, Russia, Spain, the United Kingdom, and the United States attended the conference. Papers directly dealing with the history of physics included: "The Introduction of Newton's Theory into China before 1860" by Han Qi; "Einstein and China: Einstein's planned trip to China and the introduction of his relativity theory" by Danian Hu; "The Preliminary Study on the Knowledge of the Conservation of Matter between the West and China in Ancient Times" by Hu Huakai; "Criticism of Science during the Cultural Revolution: a case of the Journal of Dialectics of Nature" by Liu Bing; "Several Opinions on Spreading the Western Knowldege of Mechanics to China in the 17th Century" by Wang Bing; "The Activities of the First Generation of Physicists in Modern China" by Yang Jian; and "The Introduction of European Astronomical Instruments and the Technology Related into China during the 17th Century" by Zhang Baichun.

-Contributed by Danian Hu, doctoral candidate, Yale University

Professor Valeri V. Dvoeglazov of the Univ. Aut. de Zacatecas, Mexico, reports that he is working on the history of theories of electromagnetism, most recently relativistic theories. His address is
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Forum Elections

Nominees for Vice-Chair

Lillian Hoddeson, trained in physics (Ph.D. Columbia, 1966), has been a practicing historian of science for over thirty years. She is an Associate Professor of History at the University of Illinois. Her research encompasses both "little" and "big" physics in the 20th century: solid-state physics and semiconductor electronics, atomic weapons, and high energy physics. In solid-state physics, she coauthored a popular history of the transistor, with Michael Riordan,

Crystal Fire: the Birth of the Information Age (1997). During the 1980s, she was research director of the American section of the International Project on the History of Solid-State Physics, whose work resulted in the edited volume, *Out of the Crystal Maze: Chapters from the History of Solid-State Physics*, Hoddeson, Ernest Braun, Jürgen Teichmann, and Spencer Weart (eds), Oxford, 1992. Presently she is completing a biography of John Bardeen, coauthored with Vicki Daitch, tentatively titled, *Gentle Genius: the Life and Science of John Bardeen*. In big science, she has been serving since 1978 as Fermilab's part-time historian, directing the lab's archival program, studying the history of Fermilab and other particle physics labs, and co-organizing three conferences on the history of particle physics that resulted in the edited volumes published by Cambridge: *The Birth of Particle Physics* (1983), *Pions to Quarks* (1989), and *The Rise of the Standard Model* (1997). Between 1985 and 1992, she directed a group working at Los Alamos National Laboratory, resulting in a technical history of the atomic bomb, *Critical Assembly: A History of Los Alamos During the Oppenheimer Years, 1943-1945*, Cambridge, 1993, coauthored with Paul Henriksen, Roger Meade and Catherine Westfall. She is presently working on two collaborative histories in the area of big science.

Statement:
Thoughout my career in the history of physics I have worked primarily to satisfy my intellectual curiosity about how individuals and institutions have contributed to the advancement of physics. While practicing physicists tend to seek simplicity in their quest to understand natural processes, as an historian I have sought complexity, trying to elucidate the contingent interplay of all relevant social and intellectual factors. Although in the past I have been primarily concerned with writing scholarly histories, the popular success of my recent book with Riordan, *Crystal Fire*, has underscored the importance of reaching out to the public, and I will try to do so in all my future work in the history of physics.

Michael Nauenberg received his PhD in physics at Cornell (with H. Bethe) and taught at Columbia and Stanford before coming to the University of California at Santa Cruz in 1966. He was one of the founding members of its Physics Department, where he is now a Professor emeritus. His primary research interests are in particle and condensed matter physics, and nonlinear dynamics, and he has written numerous articles in these areas. His most recent work is on a new quantum mechanical treatment of neutrino and neutral meson oscillations (Physics Letters, 1999), and on the dynamics of wave packets in weak external fields. He has had a long-standing interest in the history of physics and mathematics, particularly during the 17th century, and published about a dozen articles on the works of Hooke, Newton and Huygens, and several reviews of recent books on Newton's *Principia*, including an essay review, "The mathematical principles underlying the *Principia*, revisited" (J. Hist. of Astronomy 29,(1998) 286-300), and *The Foundations of Newtonian Scholarship*,

edited with R. Dalitz (World Scientific, 1999). Currently he is collaborating with J. B. Brackenridge on an article for *The Cambridge Companion to Newton*, edited by I.B. Cohen and G. Smith, (Cambridge U. Press, 1999).

Statement:
The history of physics enriches the understanding of our field and illuminates its role in our culture and society. Biographies and studies of original writings of great physicists provide us with new insights and a deeper appreciation of their creative work. It also helps to inspire young students. During the past years I have given many lectures and participated in conferences on the history of science, keeping in regular contact with historians of science. The Forum activities are designed to enhance awareness and to encourage research in the history of physics, and my experience will help me to foster this goal. I have been involved in various activities in the history of physics which have brought historians of science and physicists together. Recently I helped organize: 1) a session on Hooke and Newton at the 1993 meeting of the History of Science Society (with E. Drake); 2) the FHP session at the 1995 March meeting of the APS which featured a talk by Chandrasekhar; 3) a symposium on Newtonian scholarship which was held at the Royal Society of London in 1997 (with R. Dalitz and J.B. Brackenridge); 4) in light of recent criticism of our field by science studies advocates, a well-attended two-day debate at UCSC which brought together some of the principal contenders, including Alan Sokal and David Mermin who represented physics. Under the auspices of the Forum, I propose to stimulate and help organize similar activities which promote the history of physics and a better understanding of our field.

Nominees for Executive Committee

A.P. French received his bachelor's and doctor's degrees in physics from Cambridge University. After working in the British and US atomic bomb projects he continued research in nuclear physics at the Cavendish Laboratory 1948-55. He was on the faculty of the University of South Carolina 1955-62, and then moved to MIT, where he was chiefly engaged in undergraduate curriculum projects and teaching until he retired in 1991. He has written several textbooks, and has also edited centenary volumes on Einstein (1979) and Bohr (1985). His current activities consist of writing about various topics in physics for pedagogical purposes, and getting better acquainted with the history of physics. He was chairman of the International Commission on Physics Education (1975-81) and President of the American Association of Physics Teachers (1985-6).

Statement:
I cannot presume to call myself a historian, but I have always been interested in the history of physics and have long believed that it should figure more prominently in the teaching of physics at all levels. From my own experience I know that this is hard to achieve in face of the pressures to encompass the actual subject matter of physics in

typical academic programs. I think, however, that it is important to continue to add to the resource materials in the historical field, and to work on spreading awareness of them through the teaching community. The Forum appears to me a valuable agency for promoting these goals (among others).

Richard Haglund was educated at Wesleyan University and the University of North Carolina at Chapel Hill. After postdoctoral research in nuclear physics with spin-polarized beams at the Los Alamos National Laboratory, he joined the staff of a laser-fusion project, serving eventually as both section and group leader. In 1984, he moved to Vanderbilt University, where he pursues research on ultrafast nonlinear optics in metal quantum dots, laser-induced desorption and ablation with pico- and femtosecond mid-infrared lasers, and laser-assisted synthesis of nanostructured materials. He is a member of the Committee on Atomic, Molecular and Optical Sciences of the National Research Council, chaired the Gordon Research Conference on "Laser Interactions with Materials" in 1998, and was an Alexander von Humboldt Fellow in 1982-83. Haglund directs Vanderbilt's program in Science, Technology and Humanities (funded by the National Endowment for the Humanities), and was a faculty fellow at Vanderbilt's recent "Science and Society" project at the Robert Penn Warren Center for the Humanities.

Statement:
The recent crisis in Federal support for physics research sprang not only from widespread misunderstanding of the links between basic science and "the general welfare," but also from a failure to appreciate the cultural dimensions of physics. A partial remedy is for physicists to pay as much attention to educating the 97% of Americans who do not pursue careers in the sciences as to the 3% who do. Since historical approaches to science are among the most accessible, we should use the recent outpouring of historical materials in modern as well as classical physics to develop instructional materials for students whose primary interests lie outside science. The Forum has already brought physicists, historians and philosophers into a stimulating conversation about the cultural dimensions of physics. The time is now ripe for the Forum to take the lead in pursuing an interdisciplinary project in this area using the latest information technologies.

Allan A. Needell is Chairman of the Space History Division of the Smithsonian Institution's National Air and Space Museum. He has published on the history of physics, the origins of American national laboratories, and government/science relations. He has recently completed a biography of American science administrator, Lloyd V. Berkner. Needell joined the National Air and Space Museum in 1981, when he led the museum's efforts to commemorate the twenty-fifth anniversary of the beginning of space flight, and edited a collection of essays: *The First 25 Years in Space: A Symposium* (Smithsonian Press, 1983; paperback, 1989). He is responsible for the museum's

manned space flight collection -- Mercury through Apollo. From 1978-81, Needell served as associate historian at the Center for History of Physics, American Institute of Physics, where he had responsibility for a three-year, federally funded project to investigate and recommend ways of improving the identification and preservation of records documenting the history of the U.S. Department of Energy's research laboratories. Needell was born in Paterson, New Jersey in 1950. He graduated (BA Physics) from Cornell University in 1972 and (Ph.D. History of Science) Yale University in 1980.

Statement:
As a member of the Executive Committee of the APS History Forum my major goal would be to help continue and expand communications between the physics, historical and museum communities. I sincerely believe that the professional interests and public responsibilities of all three communities intersect at various places in many ways. I believe that my Museum and the Smithsonian can benefit greatly from close association with the efforts of physicists to preserve, understand and celebrate their history and accomplishments. I look forward to having a chance to work more closely with them in those efforts.

Michael Riordan is the Assistant to the Director at the Stanford Linear Accelerator Center, a Lecturer in the History and Philosophy of Science Program at Stanford, and a Research Physicist at the University of California, Santa Cruz. After earning his Ph.D. in physics from MIT in 1973, he did research in particle physics at MIT, the University of Rochester and Stanford before turning to the history of science in the 1980s. He is author of *The Hunting of the Quark* (Simon & Schuster, 1987), which won the 1988 Science Writing Award of the American Institute of Physics. Riordan is also coauthor with Lillian Hoddeson of *Crystal Fire: The Birth of the Information Age* (W. W. Norton, 1997) -- a history of the invention and development of the transistor. In addition, Riordan was principal organizer of the Third International Symposium on the History of Particle Physics, held at Stanford in June 1992, and an editor of the associated volume, *The Rise of the Standard Model: Particle Physics in the 1960s and 1970s* (Cambridge University Press, 1997). He is currently leading a group of scholars researching and writing a history of the SSC titled *Tunnel Visions: The Rise and Fall of the Superconducing Super Collider*, and teaching a course on the history of twentieth-century physics at Stanford.

Statement:
Riordan considers history a highly effective means for communicating the practice and content of physics to interested parties beyond the field -- especially in public and general education. As a member of the Executive Committee, he will work hard to encourage wider use of the history of physics in such contexts.

Sister Society Celebrates Centennial (June 1999)

The American Astronomical Society will also be 100 years old in 1999 and is planning a variety of appropriate special activities for its meeting in Chicago, May 30th to June 3rd (yes, that's the Memorial Day weekend), though admittedly on a somewhat smaller scale than the APS Centennial Celebration. Interested FHP members would be most welcome to participate, at a slightly higher registration rate than AAS members pay, but you could always join, either the full society, or the History of Astronomy Division at the much lower affiliate rate!

Historically-oriented activities include the debut of a multi-media exhibit curated by Sara Schechner Genuth, plenary lectures on the past and future of the society and the discipline, visits to Yerkes Observatory (where AAS was founded) and to the newly-renovated Adler Planetarium, and sessions (some in parallel with other AAS sessions, some not) of invited and contributed papers and posters, some on focused topics (like "my favorite AAS meeting" and "other astronomical anniversaries"), some open to contributions on any topic in or closely related to history of astronomy.

All registrants will receive a copy of the new book, *The American Astronomical Society's First Century*, edited by David DeVorkin, chair of the History Division. It has chapters on all the aspects you would expect, and some you might not (like how we almost lost our high energy astrophysicists en masse to APS and our planetary scientists to AGU, but lured them back with a new division structure).

Additional and updated information (including how to register and reserve a room at the headquarters Hilton Hotel or elsewhere, names of speakers, etc) will appear on the Web pages of AAS and HAD: http://www.aas.org and http://www.aas.org/~had/had2.cfm

-Contributed by Virginia Trimble, chair-elect, History of Astronomy Division, AAS

AIP Center for History of Physics Grants-in-Aid for History of Modern Physics and Allied Fields (Astronomy, Geophysics, etc.)

The Center for History of Physics of the American Institute of Physics has a program of grants-in-aid for research in the history of modern physics and allied sciences (such as astronomy, geophysics, and optics) and their social interactions. Grants can be up to $2,500 each. They can be used only to reimburse direct expenses connected with the work. Preference will be given to those who need funds for travel and subsistence to use the resources of the Center's Niels Bohr Library, or to microfilm papers or to tape-record oral history interviews with a copy deposited in the Library. Applicants should name the persons they would interview or papers they would microfilm, or the collections at the Library they need to see. You can consult the online catalog at the Center's website, http://www.aip.org/history, and feel free to make inquiries about the

Library's holdings.

Applicants should either be working toward a graduate degree in the history of science (and include a letter of reference from the thesis adviser), or show a record of publication in the field. To apply, send a vita, a letter of no more than two pages describing your research project, and a brief budget showing the expenses for which support is requested to: Spencer Weart, Center for History of Physics, American Institute of Physics, One Physics Ellipse, College Park, MD 20740; phone: 301-209-3174, Fax: 301-209-0882 e-mail: sweart@aip.org. Deadlines for receipt of applications are June 30 and December 31 of each year.

Recent and Forthcoming Books

NASA & the Exploration of Space, by Roger D. Launius and Bertram Ulrich, was published in October 1998 by Stewart, Tabori & Chang in New York City. This book covers NASA's 40 years of exploration with beautiful reproductions of works from the NASA Art Collection accompanied by informative narrative text. *NASA & the Exploration of Space* also includes a foreword by Senator John Glenn and sidebar narratives from a number of well-known astronauts.

Ronald A. Schorn's *Planetary Astronomy: From Ancient Times to the Third Millenium* was published in November 1998 by Texas A&M University Press. This book discusses the history of ground- and space-based astronomy, with a focus on the twentieth century. In *Planetary Astronomy* Schorn looks at what is arguably the world's oldest science, reviewing how society, mindsets, and planetary astronomy have changed over the millennia. This book is available in hardcover for $44.95.

Joan L. Bromberg's *NASA/Industry Relations in the U.S. Space Program, 1958-1990* will be the latest volume in the Johns Hopkins University Press New Series in NASA History. Projected to be available Spring 1999, this book analyzes the relationship between NASA and its contractors from NASA's founding through the release of the seminal Augustine Commission Report in 1990.

Roger D. Launius has edited the forthcoming *Innovation and the Development of Flight*, set to appear in Spring 1999 from Texas A&M University Press. This is a collection of essays, each by a different historian, on aeronautical innovation in the context of both technological and organizational systems.

Wernher von Braun: The Man Who Sold the Moon by Dennis Piszkiewicz was published recently by Praeger (Westport, CT).

Semaphores to Short Waves, edited by Frank A.J.L. James, contains the proceedings of a 1996 conference. It is a collection of eleven essays charting the development of communications technology from the late 18th to early 20th century. The book costs #15 plus shipping

and can be ordered from Susan Bennett, RSA, 8 John Adam Street, London, WC2N 6EZ, England.

Octavo Corporation (www.octavo.com) is a new publishing company formed to create advanced digital facsimiles of historically significant books and manuscripts. The texts so far available are Hooke's *Micrographia* (1665), Newton's *Opticks* (1704), and Franklin's *"Experiments on Electricity"* (1751). During the summer they will be releasing amongst other texts Vesalius's *De Humani Corporis Fabrica* (1543), Copernicus's *De Revolutionibus Orbium Coelestium* (1543), Galileo's *Sidereus Nuncius* (1610) and Harvey's *De Motu Cordis* (1628).

Web Resources

John Agar of the University of Manchester has put together a page of links to 44 journals for history of science, philosophy of science, sociology of science, history of technology, history of medicine. The URL is http://www.man.ac.uk/Science_Engineering/CHSTM/journals.cfm

The complete version of *Vanguard: A History* (NASA SP-4202, 1970) is now available on-line at http://www.hq.nasa.gov/office/pao/History/SP-4202/cover.html. This book by Constance McLaughlin Green and Milton Lomask was previously available in text-only format in conjunction with the NASA site related to the 40th anniversary of Sputnik. *Quest for Performance: The Evolution of Modern Aircraft* (NASA SP-468, 1985) is now on-line at http://www.hq.nasa.gov/office/pao/History/SP-4202/cover.html. This generously illustrated book is an excellent overview to the development of the airplane during the twentieth century. The first section covers propeller planes and the second section covers subsonic jet aircraft. Written by Laurence K. Loftin, Jr., this book focuses on U.S. aircraft and the roles that the NACA and NASA had in their development.

Journal

Quest: The History of Spaceflight Quarterly is being renewed into a more academic journal, with fully peer-reviewed articles. The editor is seeking academic articles along with shorter pieces on space history. Information about Quest can be found at http://www.space.edu/quest.

Upcoming Conferences

A meeting on the **History of Electricity** will be held at the Royal Institution in London on April 7, 1999. This meeting is jointly organized by the Royal Institution Centre for the History of Science and Technology and the History of Technology Group of the Institution of Electrical Engineers to mark the bicentenaries of the invention of the electric battery and the founding of the Royal Institution. Further information is available from Dr. Frank James,

email: fjames@ri.ac.uk.

A conference on **Teaching and Learning in 19th Century Cambridge** will be held at Trinity College, Cambridge, 8 and 9 April 1999. Contact Jonathan Smith, Trinity College Library, Cambridge, CB2 1TQ.

The Interdivisional History of Physics Group of the European Physical Society with the Commission on the History of Modern Physics is seeking papers for presentation at the **4th European Physical Society Conference on the History of Physics, "Volta and the History of Electricity,"** to be held on 11-15 September 1999 at Pavia University, in Italy. Deadline for submission is 1 May 1999. For more information check the Web site at http://www.cilea.it/volta99 or e-mail: volta99@pv.infn.it.

The above conference will be followed by the **5th International Conference of the International History, Philosophy and Science Teaching Group**, 15-19 September 1999 at Pavia University. See the same email and web sites as above.

The British Society for the History of Science will hold a conference **"On Time: History, Science, Commemoration"** in Liverpool 16-19 September 1999. Contact Dr. William J. Ashworth, Department of Economic and Social History, The University of Liverpool, 11 Abercromby Square, Liverpool L69 3BX or Dr. Roland Quinault, School of Historical, Philosophical and Contemporary Studies, Faculty of HTE, University of North London, 166-220 Holloway Road, London N7 8DB.

The International Committee of Historical Sciences will hold its 19th international congress in Oslo, Norway, on 6-13 August 2000. It invites proposals for presentations on all subjects. Contact the 19th International Congress of Historical Sciences, Department of History, P.O. Box 1008, Blindern, N-0315, Oslo, Norway. An **International Workshop, "Lorentz Group, CPT, and Neutrinos**," will be held at Universidad Autonoma de Zacatecas, Mexico, June 23-26, 1999. This conference will consider current work as well as historical topics. Participation will be by invitation only. Formal letters of invitation can be sent on request. The deadline for abstract submissions is March 31, 1999. Contact: Dr. V. V. Dvoeglazov, Escuela de Fisica, UAZ, Apartado Postal C-580,Zacatecas, 98068, Zac., Mexico, Phone: (52 492) 4 13 14, Fax: (52 492) 4 02 86, Email: valeri@cantera.reduaz.mx.

Books of Possible Interest

Physicists in Conflict

Neil A. Porter (Institute of Physics Publishing, Bristol and

Philadelphia, 1998). Pages xv + 275; illustrated. $39.50 (#25.00).

Reviewed by Laurie M.
Brown, Northwestern University

Neil Porter is an English cosmic ray physicist who was Professor of Electron Physics at University College, Dublin, for twenty-four years. His book is a study, mainly through examples, of several types of conflict in which physicists have been engaged, involving some combination of science, religion, and politics ("pure" conflict is almost an oxymoron). The prominent individuals whose trials are treated at chapter length or less, are: Hypatia of Alexandria, Roger Bacon, Giordano Bruno, Galileo, Kepler, Boltzmann, Einstein and Bohr, and Oppenheimer. Other subjects discussed are atomism vs. positivism, N-rays, operational research and total war, the Big Bang vs. continuous creation, multiple vs. plural particle production, and missing magnetic monopoles.

Even the author's terse writing style does not allow for much detail about these, for the most part well-studied, examples of scientists under fire, but having them displayed in parallel is thought-provoking and leads the reader to refresh and/or further his or her knowledge of their important histories. The book contains appendices that can be useful for additional study.

Most of Porter's references are to secondary sources, and he takes his primary quotations from them; that is, they have already been preselected by others to make certain points. In addition to an index, there is a glossary. A short stretch of the items in the latter reads as follows: "...B29; Babylonian mathematics; Bacon, Francis; Bacon, Roger; Baldwin, Stanley; Balmer series..." This gives some feeling for the breadth of matter covered. Besides a bibliography, Porter provides a bibliographical discussion, arranged by chapter, which is a great place to begin a more detailed study of one of the topics.

It would make little sense to attempt to discuss here the book's treatment of any one of its many topics, but some remarks on style may be worthwhile. Some of Porter's pithy remarks are quite startling, and often given without any elaboration; they had me heading for my reference library, and may well produce the same effect on you. Let me conclude by giving a few examples:

"Galileo was not a threat to the Bible, he was not even a serious threat to Aristotle, he was a threat to Urban VIII. The parallel may be extended into the twentieth century...It seems fairly certain that Oppenheimer was not a threat, but was caught up in anti-communist hysteria."

"At least three suicides of distinguished physicists in this century can be traced directly to situations in physics."

"If the history of kinetic theory were a guide it might seem better if no philosophy were applied to physics at all, but in fact philosophy is

unavoidable. Science creates philosophy whether or not the scientist wants it."

"Most physicists are probably, in practice, realists, though they may claim allegiance to the Copenhagen interpretation. Investigation seems somewhat pointless if there is no reality to investigate."

"[Einstein] carried the aura of a nineteenth century German professor, profoundly respected and with assistants at his beck and call, into the new world where graduate students regard their professors with ill-concealed contempt. It is improbable that we will see his like again."

"Oppenheimer, somewhat unconvincingly and rather preciously, said that his reason for accepting a post at Berkeley in 1928] was that Berkeley had a very fine collection of sixteenth- and seventeenth-century poetry."

If you do not find some at least of these statements highly provocative, then I guess this book is not for you.

The Story of Spin

Sin-itiro Tomonaga, translated by Takeshi Oka (University of Chicago Press, 1998). Pages xii + 258; illustrated. $21.00 (paper), $50.00 (hardcover).

Reviewed by Jean-François Van Huele, Brigham Young University

Spin, "this classically indescribable two-valuedness" as Wolfgang Pauli once called it, is a fundamental property of any particle, or of any system of particles in quantum theory. It should come as no surprise that spin also played a key role in the development of quantum mechanics. In *The Story of Spin* Sin-itiro Tomonaga uses the singular property of spin to guide us through the intricacies of quantum theory.

Even the fact that some particles may actually lack spin becomes an intriguing prospect in the hands of Tomonaga, and the subtitle of one of the chapters in the book reads: "There is No Reason for Nature to Reject Particles with Spin Zero." By the time you finish the book your head will . . . "self-rotate" at the thought of how different physics would be if spin were not part of nature. In the meantime you will enjoy a beautiful presentation of many concepts in theoretical physics, and you will gain considerable insight in the style and motivation of some of the founding fathers of quantum mechanics.

Sin-itiro Tomonaga (1907-1979) is the eminent Japanese physicist who developed a version of quantum electrodynamics in the nineteen forties and who shared the 1965 Nobel Prize in Physics with Feynman and Schwinger for this fundamental work. The story he tells is one that unfolds before he achieved a prominent place in physics and one in which he is not directly involved. In fact until the very last lecture, "addenda and recollections," the author is conspicuously absent from

the story. This story covers the development of quantum theory after the completion of the Bohr model and before the formalization of quantum field theory by Tomonaga and others. It starts roughly in 1920 with the struggle of the physics community to make sense of atomic spectra beyond those of hydrogen and hydrogen-like ions, and it ends with Pauli's considerations on spin and statistics using some of the machinery of quantum field theory. In between is the development of quantum mechanics in both its nonrelativistic and relativistic versions, and its application to the physics of molecules, solids, the nucleus, and the newly discovered subnuclear forces and particles.

The book, originally published in 1974, was translated into English by Takeshi Oka. It appears that the lectures were delivered verbally before being written down by Tomonaga. The twelve lectures are supplemented by an epilogue, a short biography of Tomonaga, a bibliography and a very complete index. The bibliography, annotated by Tomonaga, is a very useful source of original references. Most remarkably, the text is complemented by excellent illustrations, consisting mostly of contemporary photographs of the physicists involved in the story. How refreshing it is to see portraits of these young men in their twenties when their work was unfolding and their reputations still at stake. You are in for a surprise if you try to identify, say, Wolfgang Pauli or Paul Ehrenfest, based on your experience with portraits in a typical text in modern physics.

Despite its title and conversational tone, this book is about physics rather than about history. The author's main objective is to explain how spin appears in the laws of physics and how it affects physical systems. The description of the circumstances surrounding its discovery, the stories of failed attempts, the anecdotes on the research styles of the main protagonists, all seem to serve this one purpose. We are thus confronted with several concepts that did not quite make it: the "gamma rays" that Frederic Joliot and Irene Curie failed to properly identify as a neutral massive particle, the "spin-1/2 bosons," the neutrino-electron exchange particle of the nuclear force. By giving them serious consideration Tomonaga shows exactly which contradictions they lead to. In the process he recreates the true atmosphere of discovery.

As a case in point, the first chapter discusses at length the quantum numbers and conventions introduced by Arnold Sommerfeld, Alfred Lande, and Wolfgang Pauli to describe the additional degree of freedom apparent in the spectra of alkalis and alkaline earths. It was believed at the time that the origin of this new freedom lay in the core electrons, namely in all the electrons but the outermost "radiant" electron. To probe this idea, Lande constructed an "Ersatzmodell" giving an angular momentum quantum number to the core. Tomonaga expands the discussion to include the Ersatzmodell based on Sommerfeld's prescription for quantum numbers even though, as he recognizes, Sommerfeld never did so himself explicitly: "Therefore this model is really my version of Sommerfeld's model." The analysis

of all the implications of the model motivates its eventual rejection. As for the model based on Pauli's quantum numbers, Tomonaga chooses not to pursue it because, as he emphasizes throughout the book, Pauli did not believe in model building himself and always insisted that quantum numbers should be related to experiment in the most direct possible way.

In the second lecture the new quantum number is related to a "self-rotation" of the electron which Bohr later called spin. The exciting events associated with the introduction of spin by the very young Ralph de Laer Kronig, Samuel Goudsmit, and George Uhlenbeck are left for the last chapter. In Chapter 2, the many difficulties associated with the explanation of spectra using the nonrelativistic theory are reviewed and we learn that Pauli remains unconvinced until the end of the chapter when Thomas provides an explanation for the missing factor 1/2. The motivation for this lecture is a challenge issued in 1972 to Tomonaga by J.H.D. Jensen. Jensen wanted to know if Thomas happened to be lucky in finding the correct answer, or whether the result is generally valid and can be derived in a quantum treatment that includes an anomalous magnetic moment. It is inspiring to think that forty-six years after the facts, two senior physicists would care enough about a factor 1/2 to repeat the calculations and to verify that, what most textbooks have long adopted as a fact, is not just a coincidence. Unfortunately, Jensen did not live to hear the end of Tomonaga's story.

The third lecture explains how Pauli introduced spin in Schrödinger's equation but was eventually "scooped" by Dirac. Pauli's previous work which showed the equivalence of matrix mechanics and wave mechanics placed him ideally to introduce (Pauli) matrices in a wave equation. His conviction that the relativistic theory was too difficult led him for once to compromise his high standards and publish a tentative theory. Not so for Dirac whom Tomonaga characterizes more than once by contrasting him to "us mortals."

In lecture four the proton spin appears and is shown to determine the relative intensities in the band spectra of diatomic molecules by influencing the statistics. The fifth lecture deals with the influence of spin in many-electron systems and the transformation properties of the wave functions under the permutation of the electron coordinates. We recover some of the results from the first lecture but with the additional understanding that the Pauli exclusion principle follows from the antisymmetry of the wave function.

The sixth lecture starts with more "daring acrobatics" by Dirac, namely second quantization. In the background two major questions loom. Are the basic objects in the new mechanics defined in real space as originally envisioned by Erwin Schrödinger or in configuration space as preferred by Dirac? Simultaneously the relative merit of the Klein-Gordon equation and the Dirac equation are discussed. The climax consists in the discovery by Pauli and Victor Weisskopf of a

consistent interpretation of the Klein-Gordon equation as a spin-zero field equation. This opened the way for Yukawa (and nature) to make good use of this new possibility.

At this point the lectures become significantly more mathematical. Tomonaga discusses covariance, spinors, the connection between spin and statistics, and finally nuclear physics, where Bohr believed that quantum theory ceased to be valid. The discoveries in 1932 of the deuterium, the positron, and the neutron certainly changed physics forever. The fact that the properties of the neutron were extracted from those of the deuteron reminds us of the subtle ways of reductionism. Tomonaga marvels at Heisenberg's gift for analogies and shows how Heisenberg recognizes the nuclear force as an exchange force and how he introduces isospin.

We learn in the last lecture how Tomonaga struggled as a student with some of the concepts that he so masterfully covers in the previous lectures. In his years of relative isolation during the Second World War, Tomonaga made good use of all the quantum theory he learned during his formative years. *The Story of Spin* gives us a unique opportunity to glimpse at a very great mind and to be entertained with fascinating physics in the process. It is an opportunity that nobody should want to pass over.