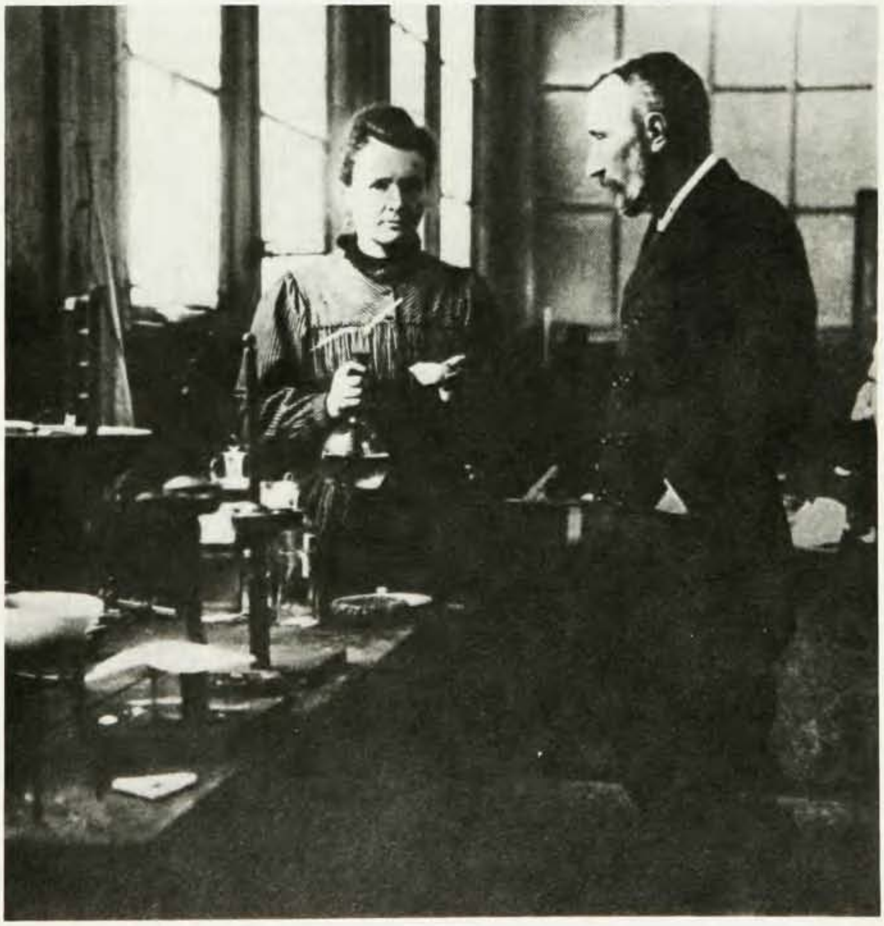
Physics' golden age seen by C. P. Snow

The Physicists
C. P. Snow
191 pp. Little, Brown, Boston, 1981. $15.95
Reviewed by Joan Bromberg

What might we expect from Charles Percy Snow in a first draft, written from memory, of the history of 20th-century physics? Snow was himself a physicist; he got his PhD from Cambridge University in 1930 and published both research papers and popularizations before he abandoned science for literature. Snow was chief of scientific personnel for a British Government ministry during World War II. Later, he served as a civil service commissioner and a board member for English Electric. Thus, he had an opportunity to see first hand both scientists and the formulation of science policy. His novels often concerned scientists, their emotions and ambitions, their relation to their work and their profession. Snow finely honed his novels; he read widely; he had a robust intelligence. He was not, however, a practicing historian of science. From such an author we might expect sound explanations of physics, insight into character, and strong, direct prose. We might also expect errors of historical fact. Snow's posthumous *The Physicists* does not disappoint either expectation.

The Physicists begins with an *aperçu* over nineteenth-century physics up to the seminal discoveries, at the end of the century, of electrons, x rays and radioactivity. After that, Snow settles down to the familiar tale of physics' golden age in the first decades of this century and the idyll's abrupt end in the radar and atomic-bomb projects of the second world war. The final third of the book takes the story from 1950 to 1980. Here, Snow is as concerned with the technologies born of science and their social effects as with the physics itself. These science-based technologies—computers and genetic engineering are among those he discusses—have potential for both good and evil. Overshadowing all of them as an exemplar of "the double legacy" of physics is the technology of hydrogen fusion. On the one hand, in the hydrogen bomb it has spawned the threat of nuclear annihilation. On the other, it raises the possibility of thousands of years of assured energy through fusion reactors. Snow is sanguine that the US and USSR will avoid precipitating a nuclear conflict. He is less optimistic that smaller nuclear powers can be prevented from dropping their bombs.

Snow cast his draft as an essay. This informal structure allows him insightful digressions on the personal and moral qualities and even the literary qualities of the men and women he treats. Herein lies the contribution Snow makes to the history of science, for the book's scope is not unique. There are of course, other histories, both popular and scholarly, covering much of the same ground. Moreover, Snow's account is not trustworthy. Three examples will illustrate: First, he reproduces Ernest Rutherford's story that he was as surprised by the Geiger–Marsden experiments—in which alpha particles rebounded from gold foil—as if a 15-inch shell fired at a piece of tissue paper had come back and hit the gunner. Historian John L. Heilbron, however, showed as early as 1968 that the story is a later invention and that Rutherford's statements at the time of the experiment reveal a very different reaction. Second, historians Martin J. Klein and Russell McCormmach have amply demonstrated that Albert Einstein did not ignore quan-



Marie and Pierre Curie in a photograph that appears in C. P. Snow's *The Physicists*, reviewed here. (Courtesy of the American Institute of Physics Niels Bohr Library.)

tum physics between his "photoelectric effect" paper of 1905 and his paper on quantum radiation in 1916–1917, as Snow implies, but rather that he was continually preoccupied with the quantum nature of light in those years. Third, physicists as well as historians will be amused by Snow's remark that the "new mathematical tool" of group theory was first introduced into physics by Murray Gell-Mann. These and many other errors might have been corrected if Snow had lived to revise his draft; as it is, they weaken the book. What is special and valuable about Snow's *The Physicists*, however, is its portrait of scientists as human beings. Human passions and squabbles, foolishness and wisdom, acts of pettiness and of grandeur, are woven into accounts of discoveries and reflections on the problems of our scientific age. For this reason, *The Physicists* is an excellent book to hand, with suitable cautions, to undergraduate students of physics and history.

The publisher has enriched the book with a large number of striking and pertinent photographs, an introduction by Snow's friend William Cooper, and three appendices. The third appendix, Snow's 1960 speech, "The moral unneutrality of science," is welcome for what it tells the reader about Snow's background, literary style and attitudes towards scientists; it is particularly timely as an early call for physicists to work for disarmament.

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Gauge Theory and Variational Principles

David Bleecker

179 pp. Addison-Wesley, Reading, Mass., 1981. $17.50

Concepts and methods from differential geometry have been extensively used in the theory of general relativity for several decades. More recently, following the advent of gauge theories, this branch of modern mathematics has found important applications also in quantum field theory. This is just one instance of a general trend in contemporary mathematics, which has accumulated a very impressive record of applications to all areas of the physical sciences.

It is fortunate that several good textbooks are now available, providing an easy access to the basic geometric tools (for example, *Analysis, Manifolds and Physics* by Y. Choquet-Bruhat, C. De Witt-Morette and M. Dillard-Bleick and *Differential Forms in Mathematical Physics* by C. Von Westenholtz). However, the need remains for more purpose-oriented publications to bring readers in contact with the current frontiers of research in mathematical physics. The new series on global analysis, edited by Ralph Abraham, Jerrold E. Marsden and Philip J. Holmes, is intended to fulfill this need for reports from the research frontier.

The book *Gauge Theory and Variational Principles*, by David Bleecker, is the first volume of this series. It is unfortunate that this book falls short of reasonable expectations for a publication on geometric aspects of gauge theories: The treatment of the physics, which should motivate the deployment of the heavy mathematical artillery, is disappointingly shallow; the discussion often lacks in clarity and incisiveness; and overall the presentation is incomplete and out-of-date. In short, this book cannot be a valid substitute for the original papers and existing review articles in the field.

Chapters 0, 1 and 2 contain a discussion of the basic mathematical tools: differentiable manifolds, differential forms, connections on principal fiber bundles and curvature forms. The definitions are often too lengthy and sometimes clumsy; examples and intuitive considerations are scarce; and one feels the need for a clearer and more extensive presentation.

Chapters 3, 4 and 5 deal with particle fields, Lagrangians and field equations. Elaborate definitions are given without an appropriate motivation, to the point that it becomes difficult to recognize familiar concepts. For example, a rather involved definition of "current" is given without explaining how it relates to the corresponding notion in everyday physics. The gauge-covariant equation of continuity is written in differential and in integral form, but there is no discussion of the problem of defining a conserved invariant total charge in the non-Abelian theory.

Chapters 6 and 7 deal with spinor fields and their gauge interactions. Contact with the physicist's approach to Yang–Mills couplings is made only at the end of Chapter 7 and only for the group SU(2). Chapter 8 contains topics on tensor calculus on manifolds. The Cartan calculus and structure equations are not discussed, and torsion is only accidentally mentioned. (The name Levi-Civita is frequently misspelled.)

Chapter 9 and part of Chapter 10 deal with the Kaluza–Klein theory and its non-Abelian generalizations. The discussion is needlessly complicated and physical motivations are omitted. There is no mention of the 40-year-old criticism by Albert Einstein and Wolfgang Pauli, who pointed out the reasons why the Kaluza–Klein proposal failed to provide a genuine unification. The difficulties due to the group-induced cosmological term, which occurs in the non-Abelian theory, are also omitted, as are the Jordan–Thyry generalizations of the theory. The book ends with some remarks on monopoles and instantons, but their possible role in the quantum theory is not appraised.

The choice of papers mentioned in the "selected bibliography" is not only too limited and out-of-date, but is also largely arbitrary; a list of recent review articles would have been more helpful and appropriate.

In conclusion, I hope that, in future volumes of the series on global analysis, authors will avoid the mistakes of neglecting the physics and of creating artificial formal complications; a good blending of rigorous mathematical notions and techniques with physical intuition and applications is needed in order to make such books useful to applied mathematicians and to theoretical physicists.

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Electronics and Instrumentation for Scientists

H. Malmstadt, C. Enke, S. Crouch

543 pp., Benjamin/Cummings, Reading, Mass., 1981. $26.95

Experiments in Electronics, Instrumentation, and Microcomputers

F. Holler, J. Avery, S. Crouch, C. Enke

326 pp., Benjamin/Cummings, Reading, Mass., 1982. $13.95

Throughout our present solid-state revolution, basic electronics has remained true to a traditional theoretical framework. The change from vacuum tubes to semiconductors, for example, has been in many ways conceptually superficial. Yet, electronic circuits do not spring from concepts alone. When components change, the thousands of little details that distinguish the working knowledge of a practicing designer from that of an electronic philosopher must all be incorporated in the educational process. Textbooks must change—and so we find the popular 1962 textbook *Electronics for Scientists* by Howard Malmstadt, Christie Enke, and E. Clifford Toren now replaced by the newly written *Electronics and Instrumentation for Scientists* by Malmstadt, Enke and Stanley Crouch.

Though similar in title and authors, the new text is not derived from the old. It has been designed to be more effective for course use, having 14 chapters of essentially equivalent length. Each chapter ends with about 20 problems that range from numerical applications to straightforward design. Chapter 1 initiates a discussion of physical mea-