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the virtuoso touch with which he plays it will rivet the attention of any reader with a lively curiosity.

Any one of these three short volumes can be read in one sitting. In fact, for anyone who can spare the required few hours, it might prove hard to put one down. The first book in the trilogy begins on a beach, the second on a mountain trail, and the third at a spectacular winter sunset.

Trefil makes no pretense of offering a comprehensive view of any area of science. His style is to latch on to a phenomenon, coyly suggest a hidden link to another that seems unrelated, and explain the connection persuasively. Then before the reader's interest can flag, he is off on another startling leap.

For example, watching the destruction of a sand castle by a rising tide serves as an entrée into the dynamics of the Earth-Moon system, and in one jump we are at the discovery of the outer planets, the fruits of a well-placed faith in the law of gravity. A pump burned out by a lightning strike leads to sound advice on lightning safety, to speculation about the origins of life and, via Benjamin Franklin's lightning rod, to some cogent observations on the links among science, technology and society.

Although most of the phenomena discussed are commonplace, the science they lead to is hardly naive. Such central mysteries (and fashionable topics) as spontaneous symmetry breaking and chaos get their due.

While this sort of random walk necessarily leaves most of the intervening landscape unexplored, it certainly conveys a vivid impression of the interconnectedness of things. Along the way, Trefil manages to make the scientific world view look like just the ticket for any sensitive human being with a zest for life. To achieve such an end a writer must meet the popular understanding on its own ground. Thus Trefil defends scientific skepticism concerning UFOs without ever lapsing into condescension.

Trefil harbors a particular sympathy for some of the unsung heroes of science. A traverse across a mountain glacier brings to mind Milutin Milankovitch, whose model of the ice ages based on long-term orbital effects has become more respectable in our lifetimes than it ever was in his own.

A popularizer of science should convey some sense of its limitations as well as its powers, and Trefil does not shirk this responsibility. A child on the beach with a few hours to kill can become quite expert in skipping

stones. Simple hydrodynamics and the conservation of angular momentum explain the virtues of a flat trajectory and rapid spin. But exactly what happens at impact remains a bit of a mystery.

The public deserves to know how easily scientists can succumb to the lure of a bandwagon. Trefil relates the "polywater" fiasco of the 1970s, a particularly amusing and embarrassing example. I must, however, take exception to his classification of the recent and ongoing "nuclear winter" studies in the same category.

Anyone with the curiosity to pull these books off the shelf should have little difficulty understanding them. At the other extreme, a professional scientist could find them insightful as well as entertaining. These are truly books for every reader.

ROBERT H. MARCH
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The Hunting of the Quark: A True Story of Modern Physics

Michael Riordan

*Touchstone (Simon and
Schuster), New York, 1987.*

399 pp.

\$21.95 hc ISBN 0-671-50466-5;

\$9.95 pb ISBN 0-671-64884-5

Michael Riordan has taken the title of his book from Lewis Carroll's poem, "The Hunting of the Snark." In the last line of Carroll's poem we learn that the identity of the snark has been disguised. Similarly, according to current ideas, the quark is the first particle in the history of physics that cannot be observed directly by experimental physics: It remains confined to the interior of hadrons by the strong color force of quantum chromodynamics. This confinement has created major difficulties for experimenters trying to find the necessarily indirect evidence for the existence of quarks and has also resurrected ancient philosophical arguments about the nature of reality and the nature of scientific measurement.

Riordan tells of the gradual accumulation of experimental evidence and the sudden shifts in theoretical ideas that led to the current "standard model," in which the fundamental particles of matter are three generations of colored quarks matched by three generations of leptons, and in which the photon, the $W^\pm$ and Z^0 bosons and the eight colored gluons are the carriers of the electromagnetic, weak and strong forces, respectively. However, this book is not a general

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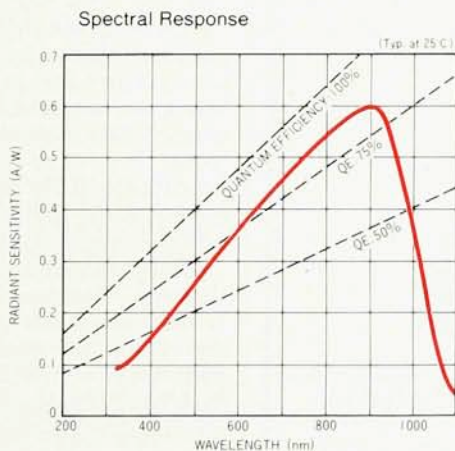
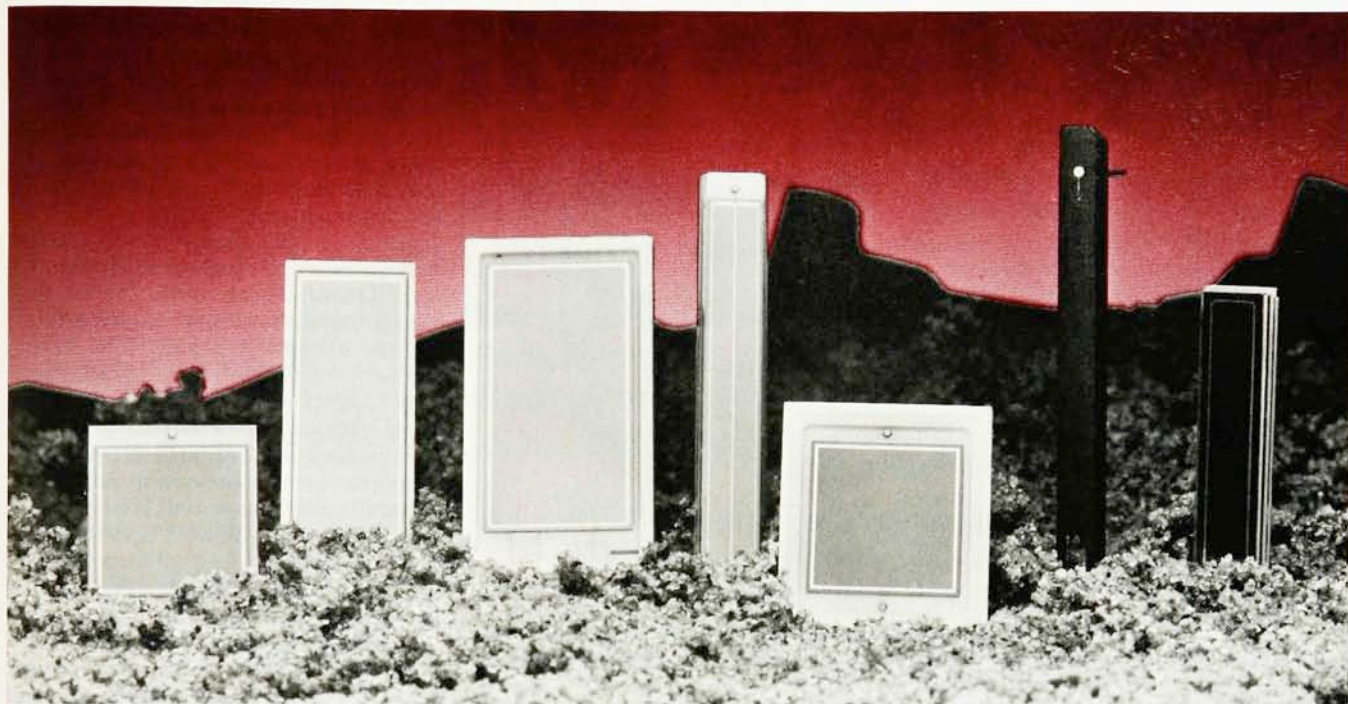
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history of the development of modern physics. The focus is narrowly on the quark; earlier theoretical and experimental developments are discussed only to give the general reader a sense of how radical a departure the quark concept was from previous ideas. Thus the canvas is much narrower than that of, say, Robert Crease and Charles Mann's *The Second Creation* (Macmillan, New York, 1986; reviewed in *PHYSICS TODAY*, November, page 92), which presented the development of the contemporary ideas of physics in a broad philosophical context and provided a much more complete intellectual history of some of the most important developments of the 20th century. Furthermore, *The Hunting of the Quark* concentrates heavily on developments at the Stanford Linear Accelerator Center, in which the author either played a role or was a close observer. (The deep inelastic electron-hadron scattering experiments at end station A receive particular emphasis.)

This book is not just an experimenter's memoir, but also attempts to be intellectual history. It is here that the book is weakest. Specifically, many of the intellectual arguments for the existence of quarks, which come directly from the SLAC deep inelastic electron-hadron scattering data, are probably not clear enough for the general reader. This is largely because much of the intellectual milieu has been neglected. Certainly, the great philosophical break with the past necessitated by the quark model, which is probably as important as the break necessitated by quantum mechanics, gets short shrift in this treatment. It isn't enough to assert the importance of the break; the general reader needs particular examples of how it changed our thinking.

There are many positive features of the book. Riordan navigates skillfully between Scylla and Charybdis in describing the nearly simultaneous discoveries of the J/ψ resonance at SLAC and Brookhaven and the subsequent battle for recognition. He also does an excellent job of describing events after the November revolution of 1975: the discoveries of particles with naked charm, the tau lepton and gluon jets, for example. But he says almost nothing about the fifth, or bottom, quark, which emerged with the discovery of the upsilon resonance at Fermilab, nor about the $W^\pm$ and Z^0 resonances discovered at CERN, both of which are essential to the standard model. This emphasis is consistent with Riordan's narrow focus on the discovery of the quark and not on the development of the entire standard

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Modern Problems in Condensed Matter Sciences, Volume 20

Semimetals

1. Graphite and its Compounds

by N.B. Brandt, S.M. Chudinov and Ya.G. Ponomarev

Translated from the Russian by O.A. Zilbert

1988 x + 495 pages

Price: US \$168.50/Dfl. 320.00

Subscription Price: US \$144.75/Dfl. 275.00

ISBN 0-444-87049-0

This volume presents, for the first time in the literature, a consistent and unifying treatment of semimetals (As, Bi, Sb, Bi-Sb alloys, graphite and its compounds). It describes their structural features and their electric, magnetic, galvanomagnetic, thermoelectric, optical, magneto-optical, acoustic, thermal, and mechanical properties on the basis of modern concepts of the electron and phonon energy spectra.

The book discusses in detail the character of the changes in the energy spectrum and properties of semimetals due to temperature variations, application of a magnetic field, pressure, anisotropic strain, doping by donor, acceptor and neutral impurities, which indicate how the above properties may be altered and how materials with preassigned parameters can be produced. Furthermore, it discusses specific phenomena associated with low dimensionality and the very low carrier density, such as quantum oscillations and magnetoplasma behaviour.

In this first part of volume 20, graphite and related materials are treated. Their layered structure and highly anisotropic properties distinguish these materials from the group V elements As, Sb and Bi. In describing the electron energy spectrum and properties of layered materials, it is expedient to proceed from the analysis of these characteristics for a single layer, which represents a two-dimensional system, and only then pass to the quasi-two-dimensional and (highly anisotropic) quasi-three-dimensional systems by taking into account the interaction between the layers. This way of presenting the material is especially convenient and methodologically fruitful when dealing with questions concerning graphite, pyrocarbons and graphite intercalation compounds.

A different approach, starting from three-dimensional concepts, will be used in part two of volume 20, which will deal with the group V elements and their alloys.

Contents: Preface to the series. Introduction. 1. General properties of carbon materials. 2. Crystal lattice of graphite and synthetic carbons. 3. Mechanical properties of graphite and carbon materials. 4. The energy spectrum of electrons and holes in graphite. 5. Galvanomagnetic effects in graphite and carbon materials. 6. Quantum oscillation effects. 7. Optical and magneto-optical effects. 8. The effects of hydrostatic pressure on the electronic properties and energy spectrum of graphite and pyrocarbon materials. 9. Magnetic susceptibility of graphite and carbon materials. 10. Graphite intercalation compounds (GIC). 11. Lattice vibrations and the phonon spectrum in graphite and graphite-based compounds. 12. Unsolved problems and applications. Author index. Subject index. Cumulative index.

Handbook on Synchrotron Radiation, Volume 2

edited by Geoffrey V. Marr

1987 xii + 834 pages

Price: US \$236.75/Dfl. 450.00

ISBN 0-444-87046-6

Volume 2 of this series concentrates on the use of synchrotron radiation which covers that region of the electromagnetic spectrum which extends from about 10eV to 3keV in photon energy and is essentially the region where the radiation is strongly absorbed by atmospheric gases. It therefore has to make extensive use of a high vacuum to transport the radiation to the workstation where the presence of hard X-rays can cause extensive damage to both the optics and the targets used in the experimental rigs. The topics chosen for this volume have been limited to the disciplines of physics and chemistry.

The first three chapters are concerned with the synchrotron radiation source and its beam lines, with attendant facilities of data collection needed to exploit the VUV to soft X-ray radiation. The following three chapters concentrate on the problems of free atom and molecule studies, while the final five chapters cover surface and solid state phenomena. It is hoped that this material will be of interest to the research student or newcomer to the techniques of exploiting the radiation from a large multi-user facility, as well as providing material of use to the researcher who wishes to consider new developments or the use of techniques, as yet unexplored, where synchrotron radiation may be significant.

Contents: Preface. 1. Synchrotron radiation sources (I.H. Munro and G.V. Marr). 2. Optical engineering (J.B. West and A.A. Padmore). 3. Data acquisition and analysis systems (P.A. Ridley). 4. High resolution spectroscopy of atoms and molecules including Faraday

rotation effects (J.B. Connerade and M.A. Baig). 5. Resonances in molecular photoionization (J.L. Dehmer, A.C. Parr and S.H. Southworth). 6. Molecular photodissociation and photoionization (I. Nenner and J.A. Beswick). 7. Surface science with synchrotron radiation (I.T. McGovern, D. Norman and R.H. Williams). 8. Metal-semiconductor interface studies by synchrotron radiation techniques (L.J. Brillson). 9. Inner shell photoelectron processes in solids (A. Kotani). 10. Surface core level shift (Y. Jugnet, G. Grenet and T.M. Duc). 11. Optical constants (D.W. Lynch). Bibliography. Author index. Subject index.

Enrico Fermi International Summer School of Physics, Volume 92

Elementary Particles

edited by N. Cabibbo

1987 xiii + 502 pages

Price: US \$158.00/Dfl. 300.00

Subscription Price: US \$134.25/Dfl. 255.00

ISBN 0-444-87075-x

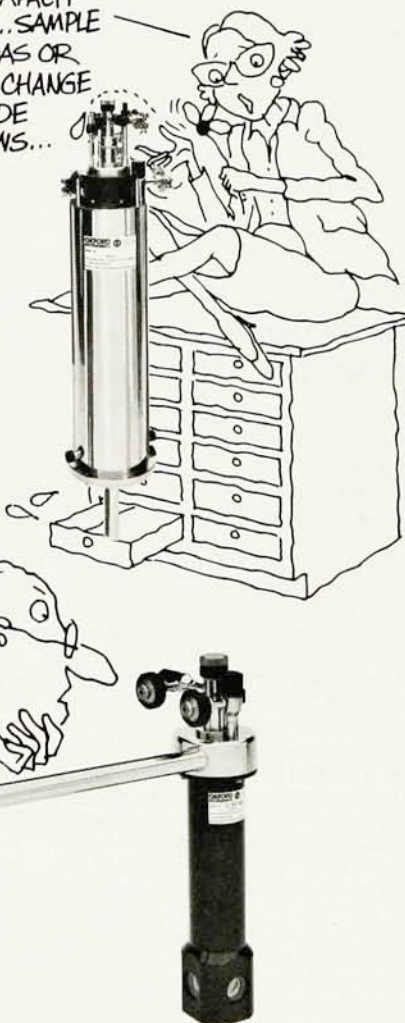
This volume contains the lectures given at the Enrico Fermi School of Physics in the summer of 1984. The course was organized with the aim of giving a comprehensive panorama of the more recent developments in theoretical and experimental high-energy physics. Among the many subjects covered during the school were the phenomenology of the standard model, with particular emphasis on the latest experimental results from the CERN Sp $\bar{p}$ S collider, neutrino physics, supersymmetry, supergravity, composite models and cosmology. Some of the lectures were dedicated to fields other than high-energy physics such as spin glasses, a new and very rapidly developing subject, and to specialized computers in theoretical physics. The basic working principles of e^+e^- storage rings and hadron colliders were also reviewed.

Contents: Introduction (N. Cabibbo). Results from the UA1 and UA2 experiments (P. Hansen). Experimental test and theoretical predictions for electroweak processes (G. Martinelli). Weak decays of heavy quark states (R. Rückl). Compositeness (R. Petronzio). Some aspects of supersymmetric composite models of quarks and leptons (W. Buchmüller). Neutrino masses 1984 (M. Roncadelli). Dark matter, galaxies and large-scale structure in the Universe (J.R. Primack). Supersymmetry and supergravity (S. Ferrara). Ultraviolet divergences and supersymmetric theories (A. Sagnotti). From asymptotic freedom to fermion computer simulations: lectures in lattice gauge theory (J.B. Kogut). The deconfinement transition in finite temperature lattice gauge theory (F. Karsch). Spin glasses (G. Parisi). Computers and theoretical physics (A.E. Terrano). Selected topics in detector physics (G. Charpak). Introduction to accelerator physics (K. Johnsen).

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model. In summary, this is an enjoyable book with enough good explanations and clear discussions to make it well worth reading both for the expert in modern high energy physics and for the general reader.

ALEXANDER FIRESTONE
Iowa State University

Einstein's Legacy: The Unity of Space and Time

Julian Schwinger

Scientific American Books (Freeman), New York, 1986.

250 pp. \$32.95 hc

ISBN 0-7167-5011-2

Albert Einstein's legacy: Ask the typical layman what it was and you're likely to hear " $E = mc^2$," "everything is relative," "the atom bomb" or "the space-time continuum." If the layman has read anything about the renaissance of general relativity over the past 25 years, you might hear "black holes," "the Big Bang" or even "gravity waves."

But unless he or she has studied physics at the high school or college level (and remembers any of it), the average layman is unlikely to have any real understanding of the foundations of the concepts mentioned above. Nor is the layman likely to appreciate how Einstein and his work fit into the three-century-long continuum of physics, stretching roughly from Isaac Newton to the present. These gaps in the understanding of the nonphysicist are admirably filled by Julian Schwinger in *Einstein's Legacy*.

Schwinger, of course, is no stranger to relativistic physics, his Nobel Prize in 1965 (shared with Richard Feynman and Sin-itiro Tomonaga) for quantum electrodynamics being but one recognition of his many achievements during a 50-year career in physics. Nor is he a stranger to the popularization of science. In fact, this book started out as part of a BBC television series written in collaboration with astronomer George Abell. Unfortunately, the series never saw the light of prime-time television, at least in the United States.

The "legacy" of the title actually carries a double meaning. First is the legacy left by Einstein's scientific forebears: Newton, James Clerk Maxwell, Michael Faraday, G. F. B. Riemann and Ernst Mach, to name a few. The book includes numerous historical and biographical sketches of physicists and mathematicians of the 18th and 19th centuries. These not only illustrate the human side of science, an important ingredient in