

chapters with such titles as "Nobel Physics" and "A Century of Physics in Retrospection." There are charts and tables but no equations and no photographs. About a fourth of the contents concerns the sociology and politics of physics—such topics as "personnel and resources," "physics in industry and war," "physics and the new dictatorships," and, concerning more recent times, "science under attack."

Many subjects of historical importance are of necessity merely mentioned or treated very briefly. Henry Mosely's work leading to atomic number and the Franck-Hertz experiment showing discrete atomic energy levels are together mentioned in a single paragraph, while Stern-Gerlach space quantization seems to have been omitted altogether. Experiments are not described in any detail. Theoretical comparisons are fair, though too brief, and fail to make clear why, for example, Henri Poincaré's was "a relativity theory indeed, but not the theory of relativity," or why John Nicholson's 1911 atomic theory, with its quantized atomic angular momentum, "was not really a quantum theory of the atom."

While some subjects are hard to take in from the sheer density of discoveries, discoverers, and their dates, others are discussed in a more readable, discursive fashion. Not surprisingly, these usually turn out to be the subjects in which Kragh himself has done original historical research and published. Among the more interesting discussions, I found those on the Thomson atom, low temperature physics (in Leiden), the electromagnetic world view ("A Revolution that Failed"), telegraphy, "Eddington's Dream and Other Heterodoxies," and physics in the Weimar Republic to be particularly engrossing. On the last topic, Kragh says Paul Forman has argued that the Weimar Zeitgeist "craved for a crisis in the existing semimechanical atomic theory" and encouraged acausal quantum mechanics. Kragh concludes, however, that "adaptation to the Weimar Zeitgeist was of no particular importance." (I say: Amen!)

There are a few historical points on which I differ with Kragh. He credits Robert Marshak with producing (with Hans Bethe) a "proper two-meson theory" in 1947 and mentions a "proposal somewhat similar" made independently by Shoichi Sakata and Takesi Inoue. In fact, while Bethe and Marshak proposed that the high-altitude, strongly interacting mesons were fermions (interacting in pairs) and the

daughter sea-level "cosmic ray meson" was a boson, the Japanese theorists (correctly) made the opposite assignments—and five years earlier. In discussing quark "color," Kragh mentions Oscar Greenberg and Yoichiro Nambu as independently proposing an additional quantum number for quarks. Actually, what Greenberg proposed is called parastatistics; Nambu did propose a new quantum number in 1966, which he called "charm" (the word was later used differently). Much more important: Nambu made quarks the sources of an SU(3) octet of massless gauge gluons as the carriers of force between quarks, an idea adopted by Murray Gell-Mann and collaborators only in 1972 and named by them "quantum chromodynamics."

An unusual feature of Kragh's book is that there are no references to original scientific papers. Even on the occasions where quotations are used, the reference is always to a secondary source. This is true even where a physicist's collected papers or letters have been published; one must trace down the original through the secondary source. One fortunate consequence of this is that Kragh provides a rich bibliography of secondary sources at the back of the book. There is also an appendix for each of the chapters that gives advice on further reading.

The book can function, therefore, as an excellent guide to the historical literature on almost any subject in the history of twentieth-century physics. It will be enjoyed in smaller doses by many readers of PHYSICS TODAY and can be a useful primary or supplementary text in history courses for physics students. The book does not contain enough explanation of the physics itself to provide people outside of physics with much enlightenment, except on the sociology of science.

LAURIE M. BROWN
Northwestern University
Evanston, Illinois

Introduction to Superconducting Circuits

▶ Alan M. Kadin
Wiley, New York, 1999. 382 pp.
\$89.95 hc ISBN 0-471-31432-3

As its title indicates, Alan Kadin's *Introduction to Superconducting Circuits* is not a book on the physics of superconductors or even on superconducting devices, but on circuits. So, why a review in PHYSICS TODAY?

I believe a case can be made that physics undergraduates, who learn a lot about the physics of superconductivity, should be offered an opportunity to learn something about the circuit applications of superconductors. The latter are becoming increasingly important, but their coverage in physics-oriented texts is minimal. Normally, this might be considered an electrical engineering subject. Indeed, Kadin's book was written as a textbook for students with an EE background. But it is unlikely that the EE departments at most universities will offer courses on superconductive circuits. Hence, if the physics faculties want to see such a course offered, they might have to do it themselves. Ergo, this review.

Considering the scarcity of alternatives, Kadin's book would be a viable choice as a text for such a course, even under the auspices of a physics department, especially if supplemented with some material from a standard solid-state physics textbook. The minimal level of quantum mechanics employed in Kadin's book matches the background of the majority of engineering students, but most physics undergraduates will already know far more quantum mechanics than this, and some of them (and many instructors) will bemoan the fact that this knowledge is not drawn upon. While there is something to be said for showing just how elementary the subject can be made, physics instructors should have no problem supplementing Kadin's treatment. One obvious choice as a source of still relatively elementary supplementary material would be Charles Kittel's *Introduction to Solid-State Physics* (Wiley, 1996 and earlier editions), but there are others.

As an alternative to Kadin, some instructors might prefer the more advanced text by Theodore van Duzer and Charles W. Turner, *Principles of Superconductive Devices and Circuits* (Prentice Hall, 1999). But I believe that, for a physics undergraduate course, Kadin's text, supplemented with some physics-based material, would be more suitable.

Apart from a long-winded chapter 1, called *Preview*, which goes into far more detail than a reader not already familiar with the material would find useful, Kadin's book is well organized, with a good selection of topics presented in the right order.

The necessary quantum concepts are introduced purely descriptively: energy gap, Cooper pairs, quasiparticle excitations, density-of-states distribution, tunneling, and coherence

length. Given the engineering target audience, this part is necessarily on the level of flat assertions, with no more than handwaving arguments, but with key references, mainly to Michael Tinkham's *Introduction to Superconductivity* (McGraw-Hill, 1996). In a class of physics students, the instructor would probably want to supplement this treatment, not necessarily with material on the Tinkham level; more likely on the Kittel level. There is no formal BCS theory, nor would it serve a useful purpose in an introductory text on circuits.

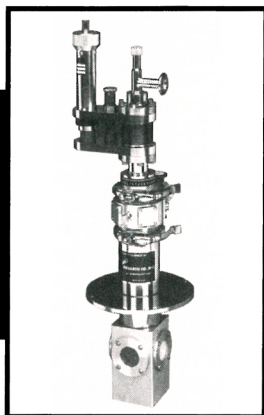
The longest single chapter in the book—and one of the best—is devoted to the magnetic properties of bulk superconductors. The author avoids the traditional excessive emphasis on the Meissner effect and quickly moves on to a very detailed discussion of quantized flux vortices and their numerous consequences. In most books, vortices are typically discussed in terms of the Ginzburg-Landau (GL) theory, a topic clearly beyond the scope of the text. The author handles this dilemma surprisingly well by giving good intuitive physical arguments for the various vortex properties, leading to formal expressions that differ from the exact GL result by some minor numerical factor; the exact GL result is then quoted, with reference—usually—to Tinkham. Still, no matter how unavoidable such a treatment may be in an engineering class, I believe that in a physics class it would be better not to avoid the formal GL equations, but to draw on them on the level of, say, what is found in Kittel. A physics instructor should have no difficulty doing that.

The book treats both conventional and high-temperature superconductors. But with the stage of technology for applications being far more mature for conventional materials, for most applications the emphasis is on the latter. However, useful estimates are given of what might be achievable with high- T_c materials in the future.

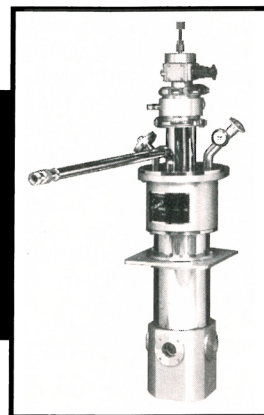
Almost half of the book is devoted to circuits based on Josephson junctions (which is as it should be) split into three distinct chapters. The first of these deals with Josephson junctions in general and with simple SQUIDs, including SQUID magnetometers. The next chapter deals with Josephson-based digital circuits, following the chronological order of their historical evolution.

The last chapter, on radiation detectors, gives a good elementary coverage of the various detector schemes, ranging from an excellent

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discussion of general principles all the way to the scheme for the detection of hypothetical magnetic monopoles.

At the end of each chapter, there is a set of excellent "real-world" problems.

One final criticism: The author has a tendency to make flat assertions without detailed justifications or derivations. This would not be so bad, if there were adequate references given to sources of more detail. Although there are references at the end of each chapter, it is often unclear which reference one should consult, and many questions fall outside the scope of the references given. I believe any instructor assigning Kadin to students should personally have a copy of van Duzer and Turner, which offers very detailed references.

HERBERT KROEMER

*University of California
Santa Barbara, California*

Einstein's German World

Fritz Stern

*Princeton U. P., Princeton, N.J.,
1999. 335 pp. \$24.95 hc
ISBN 0-691-05939-X*

The title—and the author—of Fritz Stern's *Einstein's German World* might lead a reader to expect an authoritative, exhaustive account of the topic, similar to well-known books like Allan Janik and Stephen Toulmin's *Wittgenstein's Vienna* (Touchstone, 1974). Yet, German-born Fritz Stern, a recent winner of the German publishers' prestigious Peace Prize, approaches the topic with far less ambition. Rather than giving the detailed facets of an enormously rich period of middle European culture in the first decades of the twentieth century, he assembles a small series of fine, mostly previously published essays on eminent personalities surrounding Albert Einstein in pre-Hitler Germany, and some considerations illuminating the changes that followed each of the two world wars. Einstein serves as the central point of reference.

To characterize Einstein's Germany, the author profiled Paul Ehrlich, the founder of chemotherapy, and four of Einstein's special friends: Max Planck, the senior colleague and first active supporter; Fritz Haber, the chemist; Walther Rathenau, the industrialist and politician; and Chaim Weizmann, Zionist, scientist and politician and the only non-German treated. The strength of these portraits does not lie so much in

revealing new features in the professional biographies, but rather in bringing out personal attitudes of the portrayed, their relations to friends and colleagues, and their social embedding. So, while we learn nothing about Planck's physics in the epoch considered, Stern does tell us how he dealt with delicate situations in the Germany of World War I and the Nazi epoch.

In the longest (and strongest) chapter, on Haber and Einstein, the author draws on new material to depict sympathetically his (Stern's) godfather, Haber, the scientist who organized both civil and military efforts in Germany during World War I. By contrast, Stern takes the information on Einstein's life and science from known sources. In the case of the social revolutionary Rathenau and the Zionist Weizmann, he restricts himself to describing their political motivations.

Stern emphasizes the role of World War I as the turning point from "the promise [for Einstein] of German life" to "the consequent terrors." Thus he argues that the responses of some German historians prepare the later Nazi ideology. The final chapters dealing with post-World War II Germany (problems of reunification of the two Germanys, the Goldhagen controversy—whether all Germans were Hitler's obedient helpers—and the German-Polish reconciliation) depict a Germany quite different from Einstein's. Still, in spite of all the troubles and miseries, the period of Einstein in Germany maintains the gloriole of a great epoch of the human spirit.

HELMUT RECHENBERG

*Max-Planck-Institut für Physik
Munich, Germany*

Quasars and Active Galactic Nuclei: An Introduction

Ajit K. Kembhavi

and Jayant V. Narlikar

*Cambridge, U. P., New York, 1999.
463 pp. \$80.00 hc (\$34.95 pb)
ISBN 0-521-47477-9 hc
(0-521-47989-4 pb)*

A quiet revolution has been occurring in the field of extragalactic astronomy. Extraordinary images from the Hubble Space Telescope and data from such high-energy astrophysics missions as the Advanced Satellite for Cosmology and Astrophysics (ASCA) and the Chandra X-ray telescope are changing the way we view the central

engines that power quasars and active galactic nuclei (AGN). At the hearts of these objects are supermassive black holes that convert matter into energy and help form enormous, galaxy-sized jets that expand outward at amazing speeds.

As researchers gain increased access to data from across the electromagnetic spectrum, some basic truths are emerging, such as the existence of massive accretion disks that store the matter needed to fuel the AGN. Yet these objects are still enigmatic; challenging puzzles include the way energy is actually extracted from accretion disks. The field is ripe for insight into what may be the ultimate physics—extreme gravity near the event horizon of a black hole.

Following these strides in AGN research, new books that seek to summarize the state of current research are welcome. Ajit Kembhavi and Jayant Narlikar's *Quasars and Active Galactic Nuclei* is one such book. It is written more from an observer's than a theorist's perspective, although the authors handle both equally well. Intended as an introduction to quasars and AGN, this book is targeted at the advanced undergraduate or beginning graduate student seeking a basic knowledge of the field. As such, it is more advanced than Bradley Peterson's *An Introduction to Active Galactic Nuclei* (Cambridge, 1999) but does not contain the rigid mathematics of more advanced texts such as Julian Krolik's *Active Galactic Nuclei: From the Central Black Hole to the Galactic Environment* (Princeton, 1999). The first third of *Quasars and Active Galactic Nuclei* easily meets its authors' objectives. Within a historical background and cosmological framework, and with an easy-to-read style, the authors state their ideas clearly, introduce important physical and astronomical concepts, and explain their relevance to AGN. In particular, I found the discussion of radiative processes refreshing.

The rest of the book is written in review style, with its primary emphasis on quasars and secondary emphasis on other AGN. The authors present a detailed discussion of quasar surveys, multiwavelength properties, and recent observational results.

The book succeeds as a comprehensive account of quasars, but misses its mark as an up-to-date account of active galaxies. In particular, the section on x-ray astronomy does not accurately reflect the state of the field. A minor problem is that some subjects are covered in almost grueling detail