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specifically in the study of phenomena related to turbulence.

Mandelbrot, not ignoring the aesthetic pleasure, wrote *Fractals: Form, Chance, and Dimension* to stimulate interest and open new avenues of thought, rather than to provide a solid and complete grasp of the subject or teach hard analytical tools. The explanations that he seeks at this point are *structural* rather than *dynamical*.

As is often the case with consciousness raisers, the book is somewhat overwritten and suffers from a degree of repetitiveness, especially in its second chapter. However, as a remedy, which is also one of the causes of the problem, Mandelbrot organized the material in a way that facilitates skipping. I urge the reader who loses interest to follow Mandelbrot's advice and to proceed to the next or another section. It is hard to repress the thought that Mandelbrot, following his developed perception, has replaced the line by a fractal in the design of his book.

The unique commitment of Mandelbrot to the subject, or rather to its discipline, is reflected throughout the book and in particular in the very personal chapter devoted to biographical and historical sketches. This chapter is fascinating by itself. Writing about his masters, he gives us his perspective on science and on the scientist's life and toil.

In summary, this work aims effectively at enriching our collection of the most basic tools of analysis; thus exposure to this book may produce unforeseeable consequences. It is highly recommended to every natural scientist.

* * *

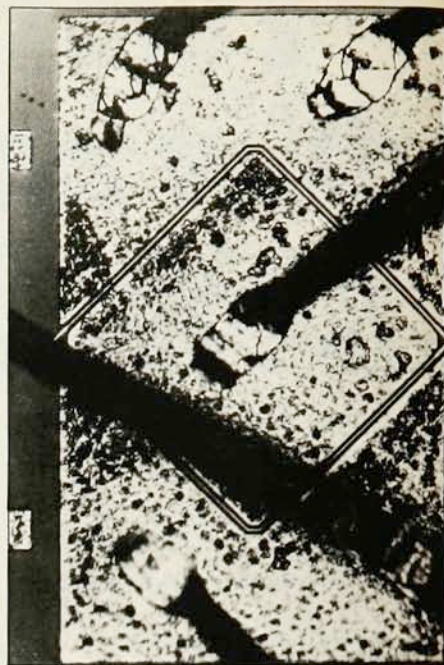
Michael Aizenman is an assistant professor of physics at Princeton University. His research interest is in mathematical physics with a focus on statistical mechanics and dynamical systems.

Metal-Semiconductor Contacts

E. H. Rhoderick

201 pp. Clarendon (Oxford U.P.), New York, 1978. \$18.50

The field of metal-semiconductor contacts (called Schottky barriers or Schottky diodes) is of importance in applications to practical devices as well as a test of our fundamental understanding of semiconductor physics. Device work related to metal-semiconductor contacts include metal-oxide-semiconductor diodes, metal-insulator-semiconductor diodes, switches, transistors and solar cells. Fundamental studies have treated the role of interface states and attempted to replace the traditional descriptions involving work function and electron affinity with a more basic approach in terms



Microwave field-effect transistor developed in 1968 by the IBM Research Laboratory, Zurich and now widely used. The theory behind such applications of metal-semiconductor contacts are described in E. H. Rhoderick's book.

of electronegativity, pseudopotentials and the band structure of the composite system.

Emlyn Huw Rhoderick, as professor of solid-state electronics at the University of Manchester Institute of Science and Technology, has made significant contributions to the metal-semiconductor field through his experimental work. His *Metal-Semiconductor Contacts*, which he frankly states in the preface is meant to update H. K. Henisch's *Rectifying Semiconductor Contacts* (Oxford U.P., 1957), contains many important experimental details not readily available elsewhere. It does not contain any significant accounts of practical devices nor recent theoretical work of a basic nature. Treatment of such work can be found in such texts as S. M. Sze, *Physics of Semiconductor Devices* (Wiley, New York, 1969) and A. L. Milnes and D. L. Feucht, *Heterojunctions and Metal-Semiconductor Junctions* (Academic Press, 1972). Both of these contain more comprehensive treatments and more extensive bibliographies than Rhoderick's book.

Rhoderick's treatment is a very readable account of the standard theory of metal-semiconductor contacts. He has treated the various cases in detail, separating out those features that control barrier height, such as surface state, image forces, oxide layers and tunnelling mechanisms, from the basic current-limiting mechanisms of diffusion and thermionic emission. At each stage of the presentation he uses experimental results and details of the sample preparation to support the theory or reveal its shortcomings.

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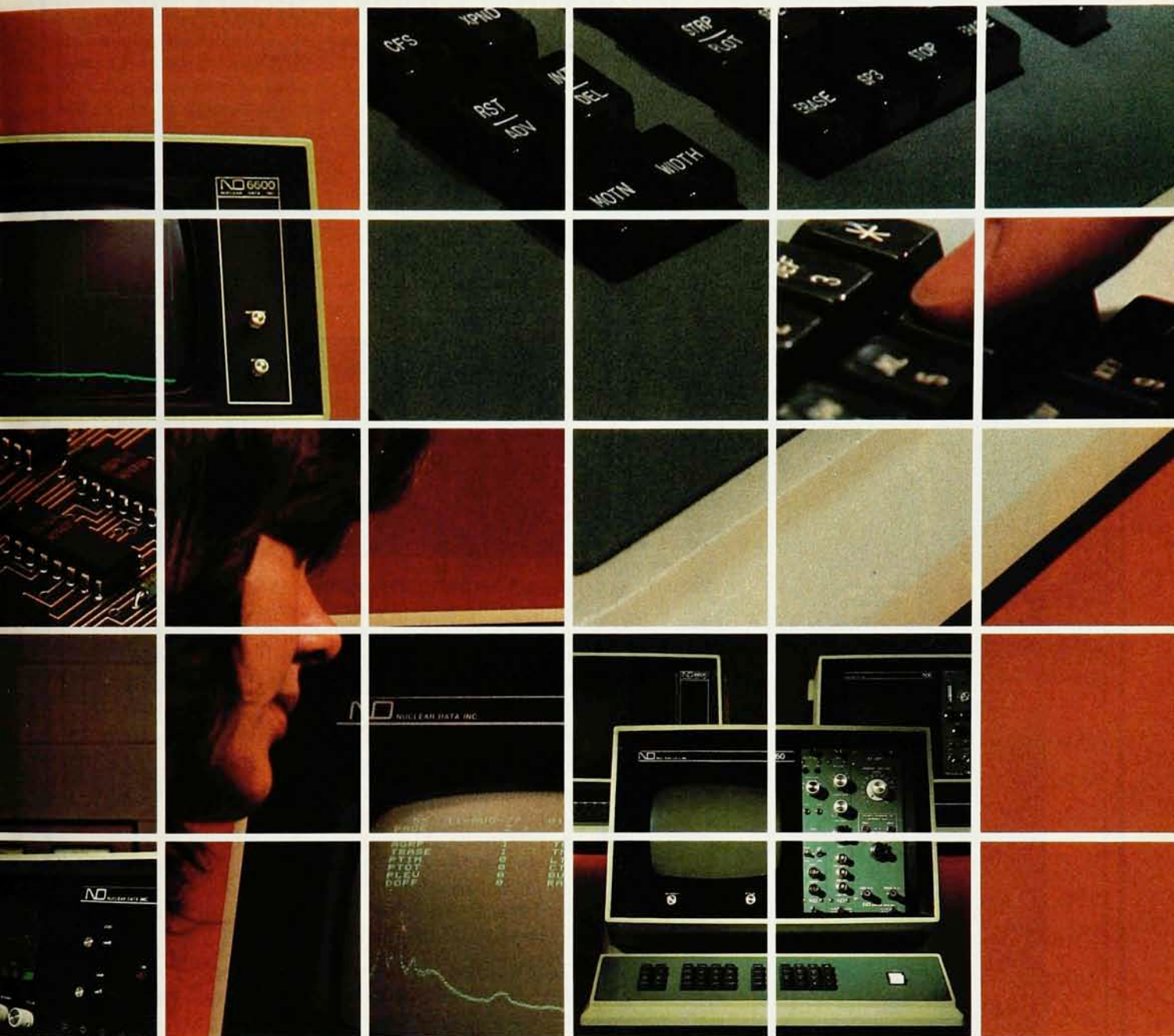
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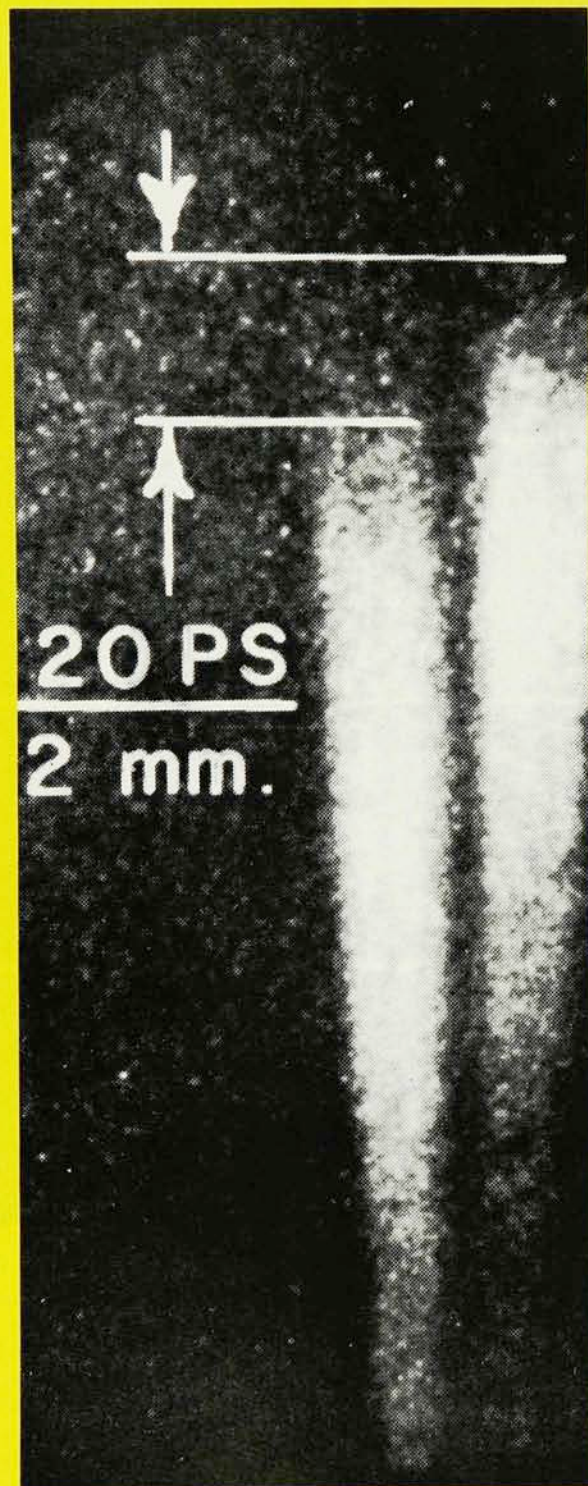


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Rhoderick clearly points out that the experimental situation is beset by problems associated with the metallurgical nature of the interface, the existence of chemical contamination, the presence of interface states, and oxide layers that may be present between the metal and semiconductor. The theoretical situation is also far from adequate because most efforts are directed at explaining ideal Schottky diodes, and even here the analytic problems are formidable. Treatments of real contacts seem to be far off. Despite this state of affairs, Rhoderick's assessment, with which I concur, is that "... we have a reasonably good working picture of metal-semiconductor contacts that serves as a basis for interpreting experimental results and also enables us to 'design' contacts to a limited extent to obtain particular electrical characteristics."

The text contains an account of the theory of Schottky-barrier capacitance, including the effects of deep levels in the semiconductor and nonuniform doping profiles. A discussion of how to form "practical" contacts, and an excellent appendix comparing Schottky diodes and p-n junctions, round out the text.

The book is excellent as an in-depth introduction to the field from both the theoretical and experimental points of view. Graduate students, undergraduates and researchers will find the book quite valuable.

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General Relativity from A to B

R. Geroch
225 pp. Univ. of Chicago, Chicago, 1978.
\$11.95

Many books for non-specialists treat a subject from "A to Z" and try to give answers to all the questions one either has been "afraid to ask" or has not thought to ask. Frequently one ends up with a collection of facts, but with little understanding. By the title of his book, *General Relativity from A to B*, Robert Geroch, a professor of physics and mathematics at the University of Chicago, signals that he does not intend to be all inclusive. Rather, he set himself the modest task of having his readers understand the revolution in thinking that was required by Albert Einstein's theory.

The whole discussion focusses on what is meant by a "space-time," a subject to which Geroch himself has contributed. He moves quickly from an absolute space and an absolute time to the Galilean view, where only time remains absolute. From the observation that the orbits of double stars are elliptical, one concludes that the

velocity of light is independent of the speed of its source. From measurements, one finds that it is also independent of the speed of the observer. From the observation that muons produced in the upper atmosphere reach the Earth, one deduces that elapsed time may depend on the speed of the clock. These deductions are incompatible with the Galilean view.

In what is the most difficult step in the book, Geroch defines the *interval* between nearby events and assumes it to be an invariant for all observers. Armed with this definition, he uses example after example to develop the modern notions of a relativistic space-time in which neither space nor time is absolute. The culmination is a beautiful chapter in which Geroch describes the essential features of a black hole. He draws on astrophysical evidence to support the existence of black holes, but properly cautions that the identifications are tentative.

All of this is done with a minimum of mathematics, although some knowledge of analytical geometry is helpful. Simple examples are used: observers moving in space-time and signals being exchanged between them. Geroch makes the basic arguments and explanations in terms of space-time diagrams. Over 100 such elementary line drawings appear in this book of 225 pages. The language is simple; the structure, direct. Throughout, the discussion is punctuated with comments that illuminate the nature of physics: What is real? What is true? What is an explanation? Where does observation enter? Why is prediction important?

This beautiful little book is certainly suitable for anyone who has had an introductory course in physics and even for some who have not. Moreover, it contains enough substance so that a modern physicist may find that he can learn something—perhaps only that a difficult topic can be presented to a general audience. The whole succeeds so well because Geroch believes that "physics is a human activity..." and wants to share some of its joys with others.

The layout of the book is good and the publisher has clearly reproduced the diagrams. With a little more care by the editor, however, about a half-dozen split infinitives could easily have been eliminated.

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Department of Physics
Syracuse University
Syracuse, New York

Physics of Thin Films

L. Eckertova
254 pp. Plenum, New York, 1977. \$27.50

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