

versibility in the real universe depends ultimately on gravitation. Any gravitating universe that can exist and contains more than one type of interaction material *must* be asymmetric in time, both globally in its motion, and locally in its thermodynamics." In this chapter black holes are discussed briefly and clearly though the subject has undergone new developments since the book

Many people now incline to the opposite point of view, i.e. that the present state of the cosmos is a *typical* one, which would almost certainly result from a very wide range of initial conditions. As a conclusion to this book, it is interesting to see how the subject of time asymmetry has provided material for both these points of view. The precise, clear, exposition of this

conductor, like copper, for thermal and magnetic stability.

The book by A. M. Campbell and J. E. Evetts, of the department of metallurgy and materials science, University of Cambridge, is a reprint of their article originally titled "Flux Vortices and Transport Currents in Type II Superconductors" [Adv. in Physics 21, 199 (1972)]. It reviews the authors' own work as well as that of others on the subject of vortex pinning, its relationship to metallurgical defects and the underlying physics of the homogeneous case. This subject does not lend itself to a general theoretical treatment, largely because of the varied ways in which a pinning effect can be realized. Moreover, conflicting theoretical viewpoints that often lead to similar results have not been resolved experimentally because of questionable applicability to specific experiments. Indeed, the technologically most interesting and useful materials have been the hardest ones to deal with theoretically.

Campbell and Evetts have detailed phenomenological models that consider the role of the elastic properties of the vortex lattice and local pinning forces of various kinds. These are well introduced by a rather complete review of relevant studies of the mixed state in the 1960's. Their book should be of particular interest to researchers active in this field, who presumably are already familiar with much of its content, both as a reference and as a presentation of the views of the authors on certain cases.

The short book by Boris Geilikman, of the Kurchatov Atomic Institute, and Vladimir Kresin, of the Moscow State Extension Pedagogic Institute, is in part a tutorial review of the theory of thermal conductivity and sound absorption in superconductors, the field of the authors' own contributions. Of the problems first tackled by the BCS theory, sound absorption got much attention because of the information on the electronic spectrum and the temperature dependence of the energy gap such studies provide. The book includes topics such as the effects of impurities, strong coupling, gap anisotropy and the intermediate state structure in varying detail. Mixed-state effects are treated briefly, and the more recent developments are omitted.

There is a short chapter on so-called thermal effects, reviewing theoretical speculations on unusual transport properties due to normal excitations, believed to occur near the transition temperature. As an example, a weak magnetic field can be produced by applying a temperature gradient to a uniaxial, pure superconductor.

A chapter on the influence of rf electromagnetic fields includes a discussion of non-linear effects. The authors



went to press, not least in the new evidence that Cygnus X-1 is a black hole and in the revolutionary arguments of Bekenstein and Hawking that a black hole is endowed with a temperature and a "quantum radiance."

Chapter 5 deals with electromagnetic waves, retarded and advanced fields, preacceleration and the absorber theory of radiation. Chapter 6 takes up time asymmetry in quantum mechanics and includes a brief and clear discussion of T violation in elementary-particle physics. The final chapter is concerned with the old idea of the "heat death of the universe" and more recent cosmological models, including the steady-state theory, the oscillating universe, and time-symmetric cosmologies.

The book contains a most thoughtful brief discussion of the pioneering experiment of R. B. Partridge aimed at looking for reduced radiation reaction when a source of radiation is directed out into a region of space where absorption can be imagined to take place only so late in time that the universe is then contracting [Nature, 244, (363) 1973]. As an indication of the balanced judgment of the author and his attempt to give absolutely fair treatment to varied points of view, it is appropriate to quote this paragraph from the conclusion:

Philosophers will distinguish two prevailing schools of thought regarding the creation event (setting aside for the moment the models which do not have one). Traditionally, the present condition of the universe has been regarded as a highly specific one, requiring the creation to have been of a very particular nature to ensure the appropriate subsequent structure. In recent years, developments in modern cosmology have had a profound impact on this question.

book, its breadth of vision, its up-to-dateness and the list of references to the literature and annotated notes on books for further reading, taken altogether make it a text for the undergraduate or graduate student and fascinating reading for every physicist concerned with the "arrow of time."

* * *

John Archibald Wheeler is Joseph Henry Professor of Physics at Princeton University. His recent books include Gravitation (written together with Charles Misner and Kip Thorne) and Black Holes, Gravitational Waves and Cosmology (with Martin Rees and Remo Ruffini).

Kinetic and Nonsteady-State Effects in Superconductors

B. T. Geilikman, V. Z. Kresin
155 pp. Wiley, New York,
1974. \$19.75

Critical Currents in Superconductors

A. M. Campbell, J. E. Evetts
243 pp. Barnes & Noble, New York,
1973. \$12.75

Developments in the technology of high current capacity wires using type II superconductors are quite innovative considering the lag in a good quantitative theoretical understanding in the crucial area of pinning of flux vortices. It is now well known that one needs to suppress dissipative flux movement by introducing pinning sites in the superconductor and by the addition of a normal

present some theoretical highlights of the particularly interesting stimulated superconducting state, whereby a strong microwave field may increase the magnitude of the energy gap, but omit any reference to experiment. This book is a translation of the 1972 Russian edition.

Both books are highly specialized, of limited scope in the field of superconductivity, and for the most part are intended for the advanced reader.

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Weather and Climate Modification

W. N. Hess, ed.
842 pp. Wiley, New York, 1974, \$29.95

This book is written by 32 selected experts in some aspect of weather or climate modification and edited by Wilmot N. Hess assisted by an editorial review committee consisting of three well known meteorologists, George Benton, Eugene Bollay and Patrick Squires. It is aimed at the level of an educated layman or college student in allied fields. As the editor comments in the preface, the treatment of the various subjects, written by the selected experts, is uneven; however, the editor and his editorial review committee have done an excellent job in bringing the various chapters together. In some instances the material covered is repetitious, but this allows each one of the contributions to be read independently of the others. Each of the contributions contains an excellent bibliography, and the book is adequately cross-referenced.

There are very valuable and stimulating reviews in the book containing les-

sons, not only for the educated layman, but for the experts in weather modification and allied fields as well. Because of the complexity of the subject, specialists in one field of weather modification will find useful reading in areas outside their speciality. The book contains reminders of the important interactions of one subfield with respect to another.

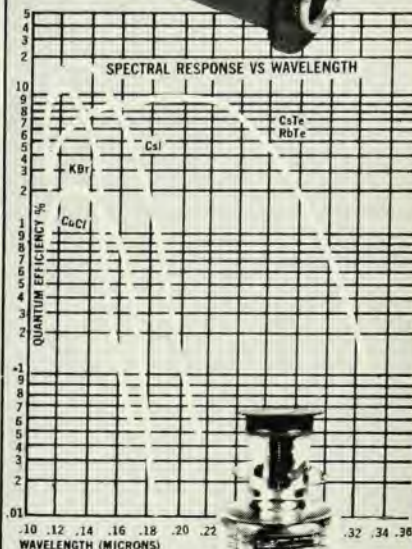
To all potential readers, I especially recommend the contributions by Horace R. Byers on the "History of Weather Modification," by Morris Neiburger and Helmut K. Weickmann on "The Meteorological Background for Weather Modification," by Joanne Simpson and Arnett Dennis on "Cumulus Clouds and Their Modification," by Joseph Smagorinsky on "Global Atmospheric Modeling and the Numerical Simulation of Climate," by Lester Machta and Kosta Telegadas on "Inadvertent Large-Scale Weather Modification" and by Helmut Landsberg on "Inadvertent Atmospheric Modification Through Urbanization."

It is very difficult to give a concise summary of the many different subjects covered in this book, however, I can list a few useful conclusions one could draw from reading it. First, in attempts at weather modification, one must be aware of the controlling role that the existing atmospheric circulation and stability, on all scales, play in defining those situations when weather modification is possible. Simpson and Dennis stress this point by specifying atmospheric conditions with seeding potential for modifying precipitation and cloud dynamics. They conclude that by limiting seeding operations to days with high seeding potential, Florida cumulus clouds can be modified to produce more vigorous growth and additional rainfall. Second, it is firmly established that adding more ice nuclei or ice nuclei active at warmer temperatures, a supercooled cloud mass (temperature less than 0°C) can be very rapidly converted to ice crystals. In this way supercooled fogs and stratus clouds can be dissipated operationally. Under favorable atmospheric conditions precipitation from orographic clouds can be increased by adding artificial nuclei. Third, our general circulation models are not ready to be used for long-range predictions of climate. Also, models of cloud dynamics and precipitation processes can be used to assess the modification potential on a day-by-day, hour-by-hour basis but they must be continuously verified and upgraded with field observations.

A fifth useful conclusion from the book is that man's activities already are changing the local climate especially in and near urban areas. Sixth, man's opportunity to interfere with nature rests in his ability to interfere with cloud mi-



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