his ideas and those of his colleagues for understanding some earlier critical times such as the first 10^{-23} second and even the first 10^{-44} second, when quantum gravity comes into its own. I can imagine no better guide to such developments than Weinberg, and I am looking forward impatiently to his next popular book on cosmology.

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Solid State: A New Exposition

Solid State Physics. NEIL W. ASHCROFT and N. DAVID MERMIN. Holt, Rinehart and Winston, New York, 1976. xxii, 826 pp., illus. $19.95.

The past few years have seen a proliferation of textbooks of solid state physics. The near vacuum that existed before the publication of the first edition of Kittel's *Introduction to Solid State Physics* in 1953 has now become comfortably filled. Prior to 1953, to be sure, there were a few very important monographs and treatises, among them Sommerfeld and Bethe's article in the *Handbuch der Physik* (1933), Mott and Jones's *Theory and Properties of Metals and Alloys* (1936), and Seitz's *Modern Theory of Solids* (1940). These served to define the subject matter of the field, but they were not really textbooks. As Ziman has pointed out in a preface to his own excellent book *Principles of the Theory of Solids*, "A treatise expounds; a textbook explains." Kittel, Ziman, and now Ashcroft and Mermin have written important textbooks, each with its own pedagogical style, that delineate and explain the mainstream content of the field.

Some cynics have argued that the term "solid state physics" was coined in order to make it clear to government funding agencies, after World War II, that there were activities other than nuclear physics that deserved federal support. Traditional solid state physics, however codified, is largely concerned with experiments and theories pertaining to perfect (or nearly perfect) crystals and is directed toward microscopic description of physical phenomena on the basis of quantum and statistical mechanical ideas. Its range of subjects includes crystal structures, electron energy levels in solids, electronic conduction and other transport properties, surface effects, cohesive energy, lattice vibrations, magnetism, superconductivity, defects in crystals, and the special place of these phenomena in insulators, semiconductors, and metals. These are the subjects of primary concern in Ashcroft and Mermin's book. Superfluids, liquid crystals, polymers, and phase transitions, which belong to a larger field generally termed condensed matter physics, are not included, nor, for the most part, are metallurgically oriented matters having to do with atomistic and structural properties such as dislocations and alloy phase diagrams, which are now generally subsumed under the rubric of materials science.

Ashcroft and Mermin present the hues and nuances of solid state physics faithfully. Important approximations in theoretical expositions are characterized even when a full explanation would require a level of sophistication greater than the book presupposes. Detailed arguments that would interrupt the narrative flow are relegated to appendixes that are self-contained and that have been prepared as carefully as the text itself. This format (which has found its ultimate fulfillment in Nabokov's *Pale Fire*) is very useful here. The appendixes, together with well-constructed problems that probe the material discussed in each chapter somewhat more deeply, allow the book to be adapted for more advanced courses or more sophisticated applications.

The arrangement of the subject matter for a book such as this is far from fixed. For example, it is as logical to begin with a discussion of crystal structures and lattice vibrations as it is to begin with the free electron theory of metals. The former subject was the preferred beginning in the earlier textbooks, most likely because it did not require knowledge of quantum mechanics, which was not standard in a beginning solid state physics student's repertoire until fairly recently. It is more satisfactory historically and pedagogically for a book concerned primarily with the electronic properties of solids to begin with the Drude theory of metals as Ashcroft and Mermin do. Regrettably, the truly germinal 1926 paper by Pauli concerning paramagnetism is overlooked in their discussion of this theory, as it is in most others, and is relegated to the much later chapter on magnetism. At any rate, the authors neatly sidestep the problem connected with any linear arrangement of material by inserting a table listing the chapters that are prerequisite to any given part of the book, thereby leaving the instructor or reader with a special interest free to order the material to suit his or her needs. This feature should be particularly useful to those whose contact with the field and "need to know" are occasional.

Despite its diversity, the book is not fragmented, but flows smoothly from subject to subject. Its style is pleasant, its explanations are clear, and the choice of examples is tasteful. Its blemishes are minor and mostly of a technical character (in view of its importance, for example, k·p perturbation theory could have been presented more adequately). References to important papers and reviews could have been somewhat more copious and could certainly have been more accurate.

The basic concepts of solid state physics have found a wide variety of applications in chemistry, geology, and biology. An important new elementary textbook that provides a thorough, lucid, and well-balanced exposition and a means for self-education will surely enjoy a wide appeal. At the same time, however, Kittel's book, now in its fifth edition and on roughly the same introductory level (Ziman's being somewhat more advanced) should not be forgotten. It retains a starring role among beginning texts. Perhaps the top billing will now have to be shared.

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Chinese Artifacts

Metallurgical Remains of Ancient China. NOEL BARNARD and SATŌ TAMOTSU. Nichiōsha, Tokyo, 1975. xxx, 344 pp., illus. $99.50.

In his book *Bronze Casting and Bronze Alloys in Ancient China* (1961) Noel Barnard first presented his views on "the autochthonous nature of the discovery of metallurgy in China." Thinking that it would be useful "to explore the situation more fully" and in particular that "a comprehensive listing of sites yielding metal artifacts—prepared with typological and chronological arrangement of the data—should, when plotted in an appropriate manner onto base maps of China, demonstrate significant distribution patterns," Barnard enlisted the cooperation of Satō Tamotsu to compile the relevant data. The book under review presents the results of the research.

The book begins with a long and technical essay by Barnard, entitled "Origins of bronze casting in ancient China," that summarizes much essential information on such matters as alloy constitu-

ents and ore distribution; pottery kilns and bronze casting furnaces; crucibles; master patterns, models, and molds; iron foundries and forges; and techniques and metals.

The essay is followed by a 132-page table of sites and remains and 23 distribution maps.

The table, which is printed in Chinese, provides "a classified index to the sources consulted of all sites [in China] that have yielded metal artifacts . . . of Han [206 B.C.–A.D. 220] or of earlier date" (p. xxi). It presents all the data the authors found in a search of Chinese archeological publications up to mid-1966. There are three indexes to the table. For those who can use it, the table furnishes the most comprehensive source to date of information on the metal objects found in China that can be dated earlier than A.D. 220.

Much essential information in the table also appears in the distribution maps, which are fully explained in English. The maps show the distribution of bronze artifacts (on separate maps according to such periods as Shang, Western Chou, Spring-and-Autumn, Warring-States, Western Han, and Eastern Han); of gold, silver, lead, and iron artifacts; and of types of artifacts such as horse-and-chariot fittings, swords, crossbow mechanisms, bronze ko halberds, belt hooks, mirrors, seals, and various bronze vessels. The maps are clearly drawn and fully explained. They supplement the table, and they can also stand on their own.

The distribution patterns that appear in the maps lend additional support to Barnard's original view. As he writes in his essay:

> It will be seen from the Distribution Maps that 50 years of archaeological discovery in China covering nearly 440 site-areas which have yielded metal artifacts, results in distinct centrifugal patterns. . . . The metallurgical culture of ancient China has its earliest production centres grouped very closely together and datable probably from around 1850 B.C. From this nucleus the spread of the art of metallurgy and the dispersal of metal artifacts proceeded gradually over the period of two millennia embraced by our survey reaching the northern, western, and southern limits of modern China during Han times. . . . As to the source of stimulation which led to the commencement of metallurgy some time prior to Early Shang, there is no evidence, within the confines of modern China, which may be claimed to point towards an alien metallurgical civilization as the contributing party. On the contrary, all relevant data indicate, without any ambiguity, the presence of a highly advanced ceramic civilization in the Nuclear Area which sometime, and somehow, during the third millennium B.C. was to discover copper and tin and to produce bronze [p. 85].

This is a strong statement; however, it is based upon meticulous scholarship and generally impeccable data. There are still many unknowns and uncertainties in Barnard's story. He is aware of them, but he is not afraid of cautious speculation. For example, he suggests that, according to the patterns of change that can be inferred from the available bronze and pottery data, "the earliest casting of receptacles in bronze took the shapes that were later to evolve into the *Chüeh-* and *Chia*-wine-cups" (p. 7). The thesis is already beginning to be supported by new archeological evidence: two *chüeh*-cups of bronze were reportedly found at an Early Shang site in Yen-shih in the past year. Perhaps no student of the past can count on the good fortune of having every prediction proved true. But in the face of the mass of data painstakingly assembled by Barnard and Satō, one would be surprised indeed if archeological finds in the next decade or two were to fundamentally alter Barnard's thesis about the autochthonous origins of metallurgy in China.

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