he grew increasingly intolerant of any form of criticism. His relations with the public and with some of his scientific colleagues deteriorated markedly and his attitude became more and more defensive. Honest and dispassionate criticism was interpreted by Kinsey as having been "animated by deep emotional conflicts rather than by scientific evaluation of the material." In actuality more than 60 percent of the reviews of the female volume were favorable; but Kinsey paid attention to the adverse reactions, which he blamed variously on the sexual morality of the church or misguided motivation of fellow scientists who objected on "philosophic grounds."

It was tragic that Kinsey died during a period when the outlook for the Institute was so bleak, because better times lay ahead. At first the University of Indiana assumed as much of the financial burden as it could bear, at the same time reorganizing the Institute with Paul Gebhard as Executive Director and Pomeroy as Director of Field Research. Somewhat later the National Institutes of Health began a series of grants, which eventually reached a total of one-quarter to one-third of a million dollars a year.

Several of the volumes envisaged by Kinsey were published, incorporating data collected prior to his death, but the character and direction of the research program have undergone significant alterations. No longer does the entire staff concentrate upon a single objective for long periods; instead several projects are pursued simultaneously and different individuals are responsible for separate research problems or areas. For some projects professional interviewers are engaged to collect data, and polling or survey organizations are occasionally employed.

During Kinsey's lifetime the research program was an extension of his own ego and scientific aspirations. He dominated the entire operation, determined its objectives, and guided its destiny. He was a complex and in many ways admirable human being, but most of all he was a dedicated scientist who devoted his every effort to the achievement of his chosen goal, which was to increase our understanding of human sexual life. Pomeroy's book is a fitting tribute to him.

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Aspects of a Revolution

The Genesis of Quantum Theory (1899–1913). ARMIN HERMANN. Translated from the German edition (Mosbach/Baden) by Claude W. Nash. M.I.T. Press, Cambridge, Mass., 1971. x, 166 pp. $8.95.

The creation of quantum physics in the first three decades of this century is one of the great subjects for the historian of science. There are few periods that have seen such profound changes in the extent and the depth of our understanding of the natural world, accompanied by such searching debate on the meaning of the new approach to nature. This revolution in thought—brought about, as Niels Bohr always insisted, "through a singularly fruitful cooperation of a whole generation of physicists"—has a richness and complexity that demand the highest level of historical scholarship if it is to be treated adequately. The history of the quantum revolution will be a subject of study for years to come, and we can look forward to a variety of treatments and a diversity of interpretations. This is only to say that there is a wealth of material here to attract historians of science of many interests.

One of the historians already at work on this 20th-century material is Armin Hermann, professor of the history of science at the University of Stuttgart. Hermann has previously edited the correspondence between Albert Einstein and Arnold Sommerfeld, as well as a valuable series of reprints of early papers on quantum physics. The book under review here is a translation of his *Habilitationsschrift* which appeared originally in 1969 as *Frühgeschichte der Quantentheorie*. It consists of a series of eight short essays each of which concentrates on the contribution of one man to the quantum theory during the years from 1899 to 1913—from Max Planck's work on the spectrum of blackbody radiation to Bohr's first papers on the quantum theory of the atom. In addition to his two great boundary figures and Einstein, Hermann discusses H. A. Lorentz, Johannes Stark, Arthur Haas, Walther Nernst, and Sommerfeld, each of whom played a very particular role in this early period.

Hermann's book provides an interesting series of sketches of some major aspects of the early quantum theory. For a physicist who has read only the myths and distortions that are still widely repeated in physics textbooks, Hermann will offer a valuable corrective. But his book is too thin in every sense of the word even to suggest the full historical interest of his subject. In the essay on Planck, for example, Hermann gives no indication that Planck's research in the years 1895 to 1901 was originally directed toward an understanding of irreversibility and the second law of thermodynamics, that he tried to construct a fundamental theory of irreversibility based on electrodynamics without any statistical assumptions (in intentional opposition to Boltzmann's approach), that his attitudes were closely related to attempts to construct an electromagnetic world view that would replace the old mechanical world view, and that the "Boltzmann method" which Planck adopted in the fall of 1900 is itself a subject requiring further historical analysis. One could make an even longer list of omissions for the chapter on Bohr, where Hermann's dozen or so pages give an inadequate picture of Bohr's concerns, his methods, or even what it was about his ideas that made them so startling, not to say shocking, to his contemporaries.

I mention these gaps in some of Hermann's discussions, not because the ideas, facts, and relationships he leaves out are individually important (although many of them are), but because these omissions indicate a basic deficiency in his approach to history. The historian must strive, not to seize the essence of a phenomenon in the way the theoretical scientist does, but rather to recapture the past in all its relevant complexity. This means, as Herbert Butterfield put it, that "genuine historical study is bound to be intensive, taking us away from our abridgments, not upwards to vague speculation, but downwards to concrete detail." It is just the absence of the detail that establishes the texture of the past that bothers me about Hermann's book.

Hermann is at his best in dealing with some of the less central aspects of his story, where he uses his sources to greater effect. His discussion of the correspondence between Planck and Lorentz in 1908, and of Willy Wien's adverse comments on Lorentz's lecture in Rome that same year, gives a lively picture of some of the difficulties that even the best older physicists had with the new ideas. Hermann's discussion of Stark's views on quanta, culminating in his angry reaction when Sommerfeld corrected a basic error of his, gives a fresh view of that very difficult but very imaginative man. Since so many

historians of physics (including Hermann) began as physicists, it is especially interesting to read his account of Haas, who is probably the only one to have made the inverse transformation.

Despite its merits Hermann's book is not adequate as history. It does not begin to reconstruct the science of the early 20th century in the kind of depth and detail that we need in order to understand what happened in the crucial first decade of the quantum revolution.

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Archeometry

Dating Techniques for the Archaeologist. HENRY N. MICHAEL and ELIZABETH K. RALPH, Eds. M.I.T. Press, Cambridge, Mass., 1971. xii, 228 pp., illus. $12.50.

This collection of papers, which inaugurates a series of handbooks to be produced under the auspices of the University of Pennsylvania Museum Applied Science Center for Archaeology, joins a collection of volumes that have appeared over the last three years dealing with the various technical and analytical specialties that can be grouped together under the heading archeometry. The other recent works include *Radiocarbon Variations and Absolute Chronology*, edited by Olsson; *Science and Archaeology*, edited by Brill; *The Impact of the Natural Sciences on Archaeology*, edited by Allibone; *Scientific Methods in Medieval Archaeology*, edited by Berger; and the second edition of *Science in Archaeology*, edited by Brothwell and Higgs. With the appearance of these works, archeometry can be said to have come of age, although the actual number of people engaged in it is relatively small. It has been, and presumably will continue to be, a contributory factor in nudging archeological research in the direction of more rigorously built strategies and methodologies modeled on those of the physical sciences. Although the so-called "new archeology" has a number of tangled roots, certainly the advent and increasing precision and accuracy of chronometric—"dating"—methods now in use must not be overlooked in any explanation of its origins.

The volume under review brings together contributions by eight authors, with four of the seven chapters—on dating by means of radiocarbon (Ralph), archeomagnetics (Bucha), thermoluminescence (Winter), and obsidian hydration (Michels and Bebrich)—providing extended discussions that include outlines of laboratory procedures. The other chapters—on dendrochronology (Michael), fission-track dating (Faul and Wagner), and potassium-argon dating (Faul)—although brief and selective, are valuable for those who wish to understand or review the basic elements of these techniques. The chapters on the two techniques with which most archeologists have had the most contact—radiocarbon and obsidian hydration—should be commented on specifically.

The chapter on radiocarbon is one of the most complete summaries of the technique available. Especially pertinent is the discussion of sample types suitable for radiocarbon work and of problems connected with their utilization. Very valuable also is a concise outline of the laboratory procedures, including the specific basis of statistical manipulations of counting data and the significance of $^{13}C/^{12}C$ ratios in fractionation determinations. Some, however, may be puzzled to find that a discussion of the basic assumptions of radiocarbon dating has been alloted only about twice the space of a section devoted to the McBee edge-punched retrieval cards for radiocarbon dates, especially in view of the fact that a project to provide a computer-based data-retrieval system is now well under way. Ralph's discussion of the relation of radiocarbon years to calendar or "true" years, in other words the secular variation or De Vries effect, apparently does not completely utilize the data published by Suess, and Ralph specifically notes some concern about the use of some radiocarbon data in magnetic intensity studies in Bucha's chapter in the volume. Ralph accepts the validity, *on the average*, of the long-term cycles identified by Suess, but does not agree on the existence of short-term oscillations. The occurrence of at least some of these short-term perturbations has been supported by carbon-14 data from European medieval samples (see the Berger volume). Those concerned with the problem of correcting carbon-14 data for secular variation may wish to use the "MASCA Correction Factors" in conjunction with the Suess values published in *Radiocarbon Variations and Absolute Chronology*.

The chapter on obsidian hydration provides a complete historical survey of the development of the technique, noting the lack of immediate acceptance of it as a time-placement method. Although the grounds are not specifically stated, the reluctance to accept the technique can be attributed to the simple fact that, on the average, 60 to 70 percent of the early obsidian hydration "dates" did not agree with the age of the obsidian sample as determined by other criteria. It was not until about five years ago that other workers began to investigate the chemical and physical nature of the hydration phenomena and the effect of compositional variability on hydration rates. Although the chapter notes the chemical problems in obsidian hydration work, it does not bring into clear focus the trends of the current research, in particular the realization that all hydration rates cannot be assumed to follow a simple diffusion formula. Evidence available by 1968 called into question, at least for one area, the use of a simple diffusion formula, and subsequent geochemical evidence confirms the extremely complex nature of obsidian hydration chemistry.

One trusts that, as the editors intend, this handbook will be regularly updated.

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Metropolitan Expansion

Suburban Land Conversion in the United States. An Economic and Governmental Process. MARION CLAWSON. Published for Resources for the Future by Johns Hopkins Press, Baltimore, 1971. xviii, 406 pp., illus. $12.50.

This comprehensive and careful study characterizes the broad results of America's century-long process of urbanization and illuminates the subtle and complex mechanisms that produce those results. Although the primary focus is on the land conversion process as it operates at the growing suburban fringe of our cities, its scope reaches into the slums and city halls of the metropolitan centers and the vast remaining rural areas of the nation. Based primarily on the last two decades, this study tells as much about our future as an urban nation as it does about our past.

The principal contribution of Clawson's book, in my view, is provided by the well-documented, analytic overview of the process of urban expansion in the United States in the period since World