hazards likely to be encountered from the large-scale development of nuclear power." As a record of his public assertions this is appropriate enough, but the authors do not address the considerations that underlay such statements or attempt to weigh their effects, if any, on the debate about the dangers of continued nuclear testing or the subsequent introduction of large-scale nuclear power. Of course Cockcroft had played a central role in British decisions leading to the first nuclear reactors and also in the British rejection of the American pressurized water reactor. Interestingly, according to the authors, even in the early '50's it was believed by Cockcroft and others in the British program "that a water-cooled reactor, similar to that which the Americans had designed at Hanford, would be prone to runaway instability if the coolant water flow failed; the neutron flux would increase rapidly, overheating might ensue particularly if the shutdown mechanism failed, and then the atmosphere would be polluted by radioactive products."

PAUL K. HOCH
Technology Policy Unit,
University of Aston, Gosta Green,
Birmingham B4 7ET, England

Physics 1905–1939

Otto Hahn and the Rise of Nuclear Physics. WILLIAM R. SHEA, Ed. Reidel, Boston, 1983 (distributor, Kluwer Boston, Hingham, Mass.). x, 254 pp., illus. $49.95. University of Western Ontario Series in Philosophy of Science, vol. 22.

This book contains a variety of papers to do with radioactivity and nuclear physics before the Second World War. The papers cover a period that begins in 1905 with Hahn's discovery of radiothorium and his trip soon afterwards to work with Rutherford in Montreal. It ends with the painstaking experiments of Hahn, Strassmann, and Meitner leading to the discovery of nuclear fission in the winter of 1938–39.

A lengthy paper by Roger Stuewer traces views about the structure of the nucleus from 1911 when Rutherford suggested its existence. Stuewer shows the prevalence of the view in the 1920's that there were electrons contained inside the nucleus alongside protons, the only other particle then known. The mysteries of these nuclear electrons deepened with the development of quantum mechanics and as new experimental data became available. These electrons did not seem to have their expected spin or magnetic moment inside the nucleus, and, most puzzling of all, they could be emitted in beta decay with a continuous range of energies, unlike the products of other radioactive decays. The discovery of the neutron in 1932 seemed only to exacerbate some of these problems and led to a debate about the neutron and whether it was a simple or complex particle. This question was only resolved with the help of another particle, the neutrino, suggested by Pauli and named by Fermi.

Many of the twists and turns in this complex story are followed by Stuewer. However, as he himself points out, the hypothesis of nuclear electrons was only one of the ingredients of the history of nuclear physics in those years. Other factors, for example the introduction of particle accelerators—the first seeds of "big physics"—were important, particularly during the work on the first atomic weapons a few years later.

Some of the ramifications come into the papers by Spencer Weart and Fritz Krafft on the discovery of fission. Weart points out that, though fission did have important consequences for the human race, it had few for nuclear theory. This leads Weart to try to identify a paradigm (a word he uses very cautiously) for the study of nuclear physics, which he does by examining the work of the groups in Rome, Paris, and Berlin who were bombarding uranium with neutrons in the 1930's. Part of this paradigm was the idea of transmutation, a concept with a long history. Consequently, Weart argues that there is continuity between the expectations of Hahn and his contemporaries and the end results of their research today. Baldly stated that conclusion is hardly contentious, but Weart hopes that further research into this and other paradigms will illustrate the myriad connections between an individual scientist and the society that supports him or her.

By contrast, Krafft focuses more closely on the personal histories of Hahn, Meitner, and Strassmann to explain both the policies and the accidental factors that led to the Berlin group's discovery that barium, rather than nuclei close to uranium, was produced when uranium was bombarded with neutrons. In Krafft's view, the long collaboration of the Berlin group (despite Meitner's having to seek refuge in Sweden) and the contribution of the analytical chemist, Strassmann, were decisive in their success.

Altogether, this is an interesting collection of papers. Some of the shorter ones, though deserving, cannot be discussed here. The differences of approach used by the various authors suggest that there are many arguments still to come, especially with the large number of publications on the history of fission we are likely to see by the end of 1988, the 50th anniversary of its discovery.

ALAN Q. MORTON
Science Museum,
London SW7 2DD, England

Climate

The Global Climate. JOHN T. HOUGHTON, Ed. Cambridge University Press, New York, 1984. vi, 233 pp., illus. $49.50.

Throughout the 1970's atmospheric scientists from many nations were heavily involved in the Global Atmospheric Research Program (GARP), whose primary practical objectives were the development of global systems for the acquisition and processing of atmospheric weather data as well as the improvement of global weather forecast models. As GARP has been phased out over the last few years, opportunity has been provided by the formation of the World Climate Program (WCP) for the scientific community to attempt a similar degree of international cooperation in the study of global climate.

The World Climate Research Program (WCRP) is the component of the WCP directed at promoting research on the physical processes of the climate system. *The Global Climate* contains comprehensive, and generally up-to-date and well-written, papers reviewing the research areas that make up the WCRP. The editor of the book is the chairman of the committee of scientists responsible for the design and oversight of the WCRP. The first chapter, by Houghton and Pierre Morel, gives an overview of the whole program, which has as its objectives to determine the extent to which climate can be predicted and the extent of human influence on climate. The program is divided into three "streams" of research according to time scale. The first "stream" is concerned with the physical basis for long-range weather forecasting, the second with interannual variability, and the third with long-term climatic trends and climate sensitivity.

Dividing the research according to time scale serves primarily to highlight the different degrees to which changes in ocean heat storage and transport may influence the rest of the climate system. Because the interior of the ocean has a relatively large capacity for the storage of heat, its temperature can only change significantly by interaction with the atmosphere on a time scale of a decade or longer. However, ocean surface temperatures and near-surface heat storage are thought to be important components of shorter-term climate variability.

The second chapter of the book is concerned with global climate research, and the subjects of the 11 subsequent chapters are climate variability, atmospheric general circulation models, cloud-radiation interactions, land-surface boundary conditions, deserts, the cryosphere, air-sea interaction and the upper ocean, the overall ocean circulation, ocean monitoring, biogeochemical processes, and the role of carbon dioxide and other trace gases in the atmospheric radiation budget.

I found of considerable interest a paper by Yale Mintz that reviews all the general circulation model studies that had previously been carried out to explore the sensitivity of simulated climates to surface soil moisture and surface albedo. Because realistic and surface descriptions have not yet become available, the modeling studies serve to establish the sensitivity of model climates to generally large and unrealistic changes. Thus, they provide no basis for quantitative estimates of the impact of future land-use changes on climate. However, the climate changes revealed by the studies are sufficiently dramatic to promote considerable effort to improve the parameterization of land-surface processes in global models.

The most lengthy paper is one by J. D. Woods entitled "The upper ocean and air-sea interactions in global climate." An especially intriguing subsection on the boundary layer of the upper ocean conveys a sense that we are rapidly developing an understanding of the processes by which heat is exchanged between the atmosphere and ocean through the upper layer of the ocean. Yet the deeper layers of the ocean must also be recognized as important, a perspective defended by Carl Wunsch in the next chapter, which is devoted to "the problem of determining and understanding the climate state of the ocean itself—not its superficial role in forcing the atmosphere." A paper by Peter J. Webster and Graeme L. Stephens on cloud radiation interactions treats especially the autors' own contributions to this topic, which make up about a quarter of the reference list. The conclusion by K. Ya. Kondratyev and N. I. Moskalenko that background tropospheric aerosol warms climate by about 3°C is at odds with a recently published study by Coakley, Cess, and Yurevich which found that background tropospheric aërosol cools climate by about 3°C. The difference in the findings appears to result primarily from differences in the assumed optical properties of background aerosols and may reflect the present level of uncertainty about these properties.

Each chapter contains a comprehensive reference list, which is increased in value by the use of asterisks to indicate which referenced articles in turn have extensive reference lists. The book is recommended reading for anyone concerned about current research on global climate.

ROBERT E. DICKINSON
National Center for Atmospheric Research, Boulder, Colorado 80307

Visual Cortical Function

Neuronal Operations in the Visual Cortex. GUY A. ORBAN. Springer-Verlag, New York, 1984. xvi, 367 pp., illus. $38. Studies of Brain Function, vol. 11.

Neuronal Operations in the Visual Contex is dedicated to P. O. Bishop, and that it is immediately suggests much of its content and flavor. Orban is one of a score or so of scientists, now scattered across the world, who have worked in Bishop's laboratory in Canberra and have come to value his quantitative approach toward investigating the physiological properties of single neurons in the visual system. Studies by these scientists have largely depended on technically sophisticated neurophysiological techniques and computer control of stimuli and data processing and display. Because publications by these scientists have been numerous, often technically complex, and sometimes narrowly focused, those of us who are not directly involved in such research will find the book extremely useful as a review, synthesis, and source of references. The book concentrates on the results of the last 20 years of research on the electrophysiological characteristics of neurons in the three major subdivisions of visual cortex in cats, areas 17, 18, and 19, and it nicely complements recent reviews of visual processing pathways from retina to cortex.

Much is written about the classification of cortical cells into basic types and the distribution of cell types according to cortical field, retinotopic position within a cortical field, and cortical layer. Orban concludes that the pioneering classification scheme for cortical cells of Hubel and Wiesel (1962) requires modification, and he replaces the simple to complex to hypercomplex cell sequence of serial processing with an A, B, C, S scheme that does not imply serial processing. Though Orban considers A and B cells as intermediate between simple (S) and complex (C) cells, A cells appear to be a type of simple cell and B cells appear to be complex. In this scheme the hypercomplex class is eliminated and the class property of a reduced response to elongated stimuli is regarded as a variable feature of all cell classes. A helpful table compares the A, B, C, S scheme with other classification schemes and shows that both A and B types have been considered both as simple and as complex by different investigators.

Given the evident importance of classifying neurons, it is unfortunate that there is no discussion of the goals and purposes of classification. Such a discussion would allow the reader to better understand the strengths and weaknesses of the A, B, C, S scheme and give him or her a feel for the types of modifications that will undoubtedly occur. A discussion of the problems of transposing a classification scheme based on cats to other mammals would also have been valuable. In this regard, Orban avoids the current debate over what cells in the lateral geniculate nucleus of monkeys are homologous to Y cells of the lateral geniculate nucleus of cats and presents one point of view without mentioning the other.

Orban goes on to discuss cortical cells as filters for different parameters of visual stimuli, including orientation, length, width, spatial frequency, velocity, and direction of movement. Cortical neurons characteristically respond over a limited range of values of a parameter, and the usual assumption is that by differing individually in selectivity groups of neurons code various stimulus parameters. Orban uses the different properties of cells and the different distributions of types of cells across the three cortical areas to speculate on the functions of classes of cells and cortical areas in vision. Though he argues that areas 17, 18, and 19 operate essentially in parallel, the anatomical connections of these fields indicate that cortical processing across these areas has both serial and parallel components.

Other parts of the book are designed to put the studies of visual cortex in the cat into a broader perspective. Thus, the basic visual systems of cats and monkeys are described and compared, the many cortical visual areas of cats are described, and the complicated connec-