range of chemical reactions and describes how electronic structure governs the dynamics of the reaction. He then discusses the way to orient a pendular molecule and the importance of vector correlations in obtaining more information from the experimental measurements of reaction dynamics. In his conclusion, he discusses his new approach to the electronic structure of atoms and molecules with a few electrons based on dimensionality and scaling arguments. That this area of research arose from his desire to design a homework problem for a first-year graduate course in quantum mechanics shows the important coupling between teaching and research.

The last chapter covers real-time laser femtochemistry and is something of a disappointment as it is a reprint of a 1988 review published in *Chemical and Engineering News* by Zewail and Richard Bernstein, who died in 1990. Zewail merely provides two pages of additional comments (despite his note that over 400 articles have been published in the area of femtochemistry during the past five years) and ten pages of references.

It would have been nice to include chapters on modern electronic structure theory and modern theoretical dynamics studies. These would have helped to tie the structural aspects of Pauling's work to the dynamics discussed in the second half of the book, and the editor would not have had to look far among Pauling's students or his own Caltech colleagues to find those who could cover these areas.

Still, the book is enjoyable, and the quality of the production is excellent, with significant use of color. The biographies and often informal photographs of these world-class scientists at the end help to place them in a historical perspective and provide some insight into the character of these unique individuals. The perspectives provided by their essays can give us all hints about how to think about problems and come up with ingenious solutions. Although much of the book is inherently technical, there is also an underlying aspect of scientific philosophy that is worth learning.

David Dixon
DuPont Central Research and Development Experimental Station, Wilmington, DE 19880–0328

Axons, Ions, and Dons

Chance and Design. Reminiscences of Science in Peace and War. ALAN HODGKIN. Cambridge University Press, New York, 1992. xii, 412 pp., illus. $59.95.

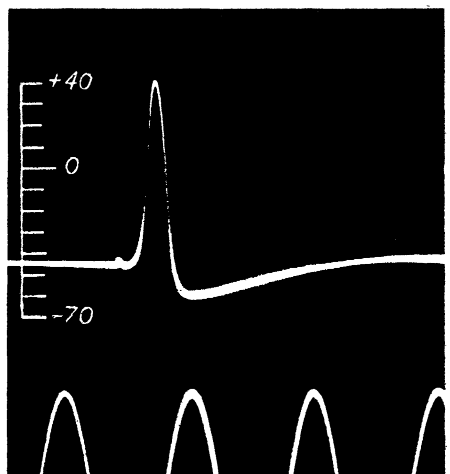
All students of excitable membranes know that Hodgkin and Huxley discovered voltage-dependent sodium and potassium permeability changes in the membrane of squid giant axons and showed how their properties explain propagation of action potentials. This fundamental biophysical work dominates an early chapter of every textbook of neurobiology. It set the tone for all subsequent voltage-clamp studies on ionic channels and, although now 40 years old, still receives hundreds of citations each year and inspires the most challenging questions of channel molecular biology.

Alan Hodgkin's autobiography has three contrasting sections. The first moves from a gentle English childhood to life as a university student and starting as a fellow at Trinity College, Cambridge. In the second, England is thrown into war. Scientists turn every energy to technical projects in a tense climate of austerity and urgency. The third blends discoveries, holidays, and meetings in postwar years until Hodgkin and Andrew Huxley go to Stockholm to share the 1963 Nobel Prize in Physiology or Medicine. There is neither the competition and intrigue of Watson's *Double Helix* nor the sharp commentary of Medawar's *Memoirs of a Thinking Radish*. Rather we sample the flavor of private life and the climate of science in Cambridge. Drive and ambition and even the science itself move to the back seat as a quieter recollection takes over, bolstered by quotations from personal letters—friends, romances, holidays, and arts as well as science. Throughout, vignettes of ordinary and extraordinary people, their habits, oddities, and opinions, are sketched with dry humor. These light impressions suggest the theme that life flows through sequences of odd encounters and as much depends on chance as on design.

Childhood is a period piece of peaceful opportunity. Visits to many Quaker aunts, grandmothers, and other relations abound with children playing in ample gardens flowing down to rivers. Insects, flowers, and birds are early attractions. An eager naturalist, the young Hodgkin takes up ornithology more seriously, and holidays of rock-climbing and adventure in remote places become important. A 1932 stay in Germany reveals dangers of Nazism, and student days in Cambridge promote political debate, particularly about Communism.

Research students are on their own in Cambridge. At the age of 20, Hodgkin personally buys parts to assemble an oscilloscope and, without a supervisor, embarks on successful and significant research, proving the local-circuit theory of nerve impulse conduction with frog nerve. His work eventually earns him a teaching fellowship at Trinity College and a Rockefeller Foundation fellowship for a year with Herbert Gasser in America. A few weeks in the summer of 1938 with Kenneth Cole and Howard Curtis are notable both for the chance to use the squid giant axon and because Hodgkin discovers that collaboration is more fun than working alone. Additional money from the Rockefeller Foundation allows him to build up his own equipment in Cambridge, and the next summer he and Huxley try their hand at intracellular recording from squid giant axons. Almost at once they obtain the quite unexpected and very important result that the action potential overshoots zero potential by many tens of millivolts.

Within three weeks of this great discovery, Hitler invades Poland, the Plymouth squid boat is commandeered for mine sweeping, and a darker era begins. Hodgkin becomes part of a team developing 10-centimeter airborne interception radar. We read about design of magnetrons, aerials, scanning systems, and displays as the group is shuttled from one unlikely location to another, working exposed in winter without heat and flying hazardously in quickly outfitted aircraft to test and refine each concept. Much depends also on the quality of components and on the ability of the wartime industry to deliver and install hundreds of sets. There are many details of dates, ideas, successes, and failures. The seven-days-a-week effort is physically and



"Action potential and resting potential recorded between inside and outside of axon with capillary filled with sea water. Time marker 500 Hz. The vertical scale indicates the potential of the internal electrode in millivolts, the sea water outside being taken as zero potential." [From *Chance and Design*; Hodgkin and Huxley, *Nature* **144**, 710–711 (1939)] mentally draining, the only bright spot being Hodgkin's marriage, to Peyton Rous's daughter Marion.

The postwar years bring houses, four children, friends, holidays, and the classical research discoveries. Shortages of equipment and funds and rationing of food and fuel are gradually relieved. Vegetables in France, Renaissance paintings in Italy, and chances to relax on remote British isles are savored. The Physiological Laboratory under Lord Adrian finally hires its first secretary, and grant support is assembled. Collaborations with Katz, Huxley, Keynes, Baker, and visitors lead to the sodium theory, the Hodgkin-Huxley model, long-pore theory, ionic and metabolic requirements of the sodium pump, resting and action potentials of muscle, perfusion of axons, and—a trip to Stockholm.

This book is a gentle glimpse of an earlier English scientific era that required independence and saw great discoveries made with small and frugal methods. It gives unexpected insights into the more private thinking and experiences of a scientific giant.

Bertil Hille
*Department of Physiology and Biophysics,
University of Washington
School of Medicine,
Seattle, WA 98195*

Astronomical Objects

Variability of Blazars. ESKO VALTAOJA and MAURI VALTONEN, Eds. Cambridge University Press, New York, 1992. xiv, 465 pp., illus. $59.95. From a conference, Jan. 1991.

Astronomers like to give colorful names to newly discovered, or thought to be newly discovered, unusual phenomena. The term "blazar" was coined by Edward Spiegel during a memorable after-dinner speech at the 1978 "Pittsburgh Conference on BL Lac Objects." BL Lac objects are named after their prototype "BL Lacertae," which is one of a class of galactic stars known as Lacertids. However, after such objects were identified with a rapidly varying radio source in 1968, it was realized that BL Lacertae itself was a distant galaxy, not a galactic star. The name "BL Lac object" is now applied to the general class of extragalactic objects that are similar to quasars but are characterized by rapid variability, high polarization of optical and radio emission, and the absence or near absence of the strong optical-emission lines that characterize quasars.

Related to blazars and BL Lac objects are objects variously called active galactic nuclei, highly polarized quasars, or optically violent variables and commonly referred to as AGNs, HPQs, and OVVs, respectively. Often, as the name implies, the term "blazar" is used to describe the most luminous BL Lacs, although as a class BL Lacs are less luminous than quasars and not all blazars are BL Lacs.

Many of the properties that were originally used to define the class of objects called BL Lacs, such as the absence of emission lines, are not always found in objects that are included in papers and conferences on BL Lac objects, and indeed there is little agreement now on just what defines a BL Lac object or blazar.

Variability of Blazars is the proceedings of an international conference of the same title held in the Baltic coastal city of Turku, Finland, at which more than 60 astronomers gathered to present new data and to discuss their theoretical implications. The volume contains 61 papers that vary in length and depth of discussion.

As reflected by the topics of a number of contributions, the central problem of blazars and related objects has been to understand how such prodigious amounts of energy can be radiated from such small volumes in the nuclei of galaxies. The most widely discussed model involves highly anisotropic radiation, at least at radio but probably also at optical and x-ray wavelengths. The anisotropy is thought to result from focusing along the direction of motion by a relativistically moving plasma. It is argued that the observed differences in properties of blazars, AGNs, quasars, BL Lacs, HPQs, and OVVs depend more on the viewing angle than on differences in their intrinsic properties. When viewed along the direction of motion, the galactic nucleus appears unusually bright and is referred to as an AGN, BL Lac, quasar, or blazar.

One consequence of the bulk relativistic motion is so-called "superluminal motion." When a radiating source is moving at velocities near the velocity of light along a direction close to the line of sight, the source nearly catches up with its own radiation. As a result the differential time scale for a distant observer is compressed, giving the illusion of motion that can exceed the velocity of light.

When examined in sufficient detail nearly all blazar radio sources show superluminal motion, so bulk relativistic motion must be common. Indeed it is too common, since only about 1 percent of relativistic beams are expected to be sufficiently aligned to show enhanced radiation and superluminal motion. The outstanding problems are to identify the much more common (unbeamed) parent object and the

Vignettes: Clothing and Unclothing

The corporate style of dress can be quite formal. I made a trip with some university executives one day to the corporate headquarters of a large consumer appliance firm. Every executive in the room was wearing a dark navy pinstriped suit, a gleaming white starched shirt, a conservative silk rep tie, and highly polished black shoes. Our vice-president for research had on a soft brown tweed suit and brown shoes . . . . But at least we were wearing suits. Then the corporate people all took off their jackets and worked in their shirtsleeves during the meeting. We academics kept our jackets on.

—*Dorin Schumacher, in Get Funded! A Practical Guide for Scholars Seeking Research Support from Business* (Sage Publications)

There was a well known Cambridge physicist called Dr. G F Searle, who ran the practical classes for undergraduates during the famous Rutherford era. . . . I felt thankful that I had not had to start my physics studies under him—particularly as he had a reputation for being prejudiced against women students. He is said to have come up to an unfortunate female in one of his practical classes and to have said, aggressively: "Are you wearing corsets? You cannot work in a physics lab, with its magnetic instruments, if you are wearing steel-boned corsets. Go and take them off."

—*Joan Freeman, in A Passion for Physics: The Story of a Woman Physicist* (Hilger)