sight, and historical sensitivity. The book he has produced is not always easy to read, but the time devoted to working out the implications of his ideas will be well spent for anyone seriously interested in the epistemology of mathematics and its historical development.

JOSEPH W. DAUBEN
Department of History, Herbert H. Lehman College, and *Ph.D. Program in History, Graduate Center, City University of New York, New York 10468*

The Magellanic Clouds

Structure and Evolution of the Magellanic Clouds. SIDNEY VAN DEN BERGH and KLAAS S. DE BOER, Eds. Reidel, Boston, 1984 (distributor, Kluwer Boston, Hingham, Mass.). xviii, 425 pp., illus. $47.50; paper, $24.75. International Astronomical Union Symposium no. 108. From a symposium, Tübingen, Germany, Sept. 1983.

The Large and Small Magellanic Clouds appear to the naked eye of an observer in the Southern Hemisphere as two luminous patches that resemble detached sections of the Milky Way. In fact, the Magellanic Clouds are the nearest major galaxies and have played a central role in the development of our understanding of extragalactic systems and their constituent stellar populations. The significance of the Magellanic Clouds in these regards was especially emphasized by the late Bart Bok, to whose memory this volume of proceedings is appropriately dedicated.

The book is well organized. The papers are divided into seven groups, within each of which there are several reviews and more numerous brief contributed papers. Summaries of panel discussions also are included and cover some of the more controversial topics. The book provides a balanced overview of the present status of research on the Magellanic Clouds.

This certainly was not an easy task. During the decade that has elapsed since the last major meeting on the Magellanic Clouds there has been an information explosion fueled by the construction and instrumentation of ground-based observatories in the Southern Hemisphere and by the advent of sensitive observatories in space. Thus we now have data on very faint stars obtained with large optical telescopes that allow the histories of the Magellanic Clouds to be probed over time scales of billions of years, as well as a variety of x-ray measurements from the Einstein satellite that yield insight into properties of massive, short-lived stars and their violent interactions with interstellar gas. Both topics are well covered in review papers. Some of the newer observational possibilities are still being exploited, but early results are contained in many of the contributed papers. Examples include the important molecular studies that are being carried out in Australia and in Chile by the Columbia-Chile group or the discussions of the nature of a star named R136a, a possible "superstar" or star-cluster powerhouse containing thousands of solar masses in the core of the gigantic 30 Doradus ionized gas cloud. The contributed papers also present interesting new interpretative ideas, such as a study of the spatial distributions of star-forming regions in the Large Cloud by means of pattern recognition analysis.

Do we then have a nearly complete picture of the evolutionary and structural properties of the Magellanic Clouds? The answer is clearly no, although from this symposium it is also evident that we now know where more of the difficulties lie. In principle the evolution of a given galaxy involves a rather straightforward conversion of a gravitationally bound primordial gaseous system into stars, but in reality the processes are anything but simple to diagnose or model. The new studies of the Magellanic Clouds, galaxies that are rather different from our own Milky Way, serve to reinforce this point. As one illustration, recent investigations of microwave line emission from the molecule CO indicate that there might be fewer molecular cloud sites of star formation in the Magellanic Clouds than in the Milky Way, and yet optical and ultraviolet observations leave no doubt that the Clouds are producing many young stars. There is an interesting debate about the degree to which the numerous young stars are due to effects associated with the close passage of the Clouds by the Milky Way rather than to intrinsic variations in modes of star formation between different types of galaxies (the galactic version of the "environment vs. genetics" issue). Similarly, we find that even the well-developed topic of stellar evolution can be a subject for surprises in the attempt to understand the extensive stellar populations of young and intermediate age in the Magellanic Clouds. We also have yet to determine such fundamental points as whether the Magellanic Clouds consist only of normal stars and gas or whether they, like the massive spirals, are embedded in invisible envelopes of dark matter.

We should not be discouraged by these and other loose ends that were brought up throughout the symposium. Rather, we should recognize that the Magellanic Clouds are fulfilling their traditional role as laboratories for advanced studies of normal galaxies and look forward to the next symposium on the subject.

JOHN S. GALLAGHER, III
National Optical Astronomy Observatories, Kitt Peak National Observatory, Tucson, Arizona 85726

Invertebrate Vision

Photoreception and Vision in Invertebrates. M. A. ALI, Ed. Plenum, New York, 1984. x, 858 pp., illus. $115. NATO ASI Series A, vol. 74. From an institute, Lennoxville, Quebec, July 1982.

The topics covered in this book range from photoreception by eye spots of single-celled protozoans to vision by 20 million receptor cells of the octopus eye. A third of the book is devoted to the simplest invertebrates, such as protozoans, metazoans, rotifers, and nematodes. Half is devoted to animals that have compound eyes, such as insects and crustaceans. The remainder includes papers on invertebrates that have multiple ocelli, such as spiders and myriapods.

Given its origin in a two-week tutorial workshop, one might expect the volume to be a handbook of papers that survey the field of invertebrate vision. It is not, according to the editor, who faced an unusual problem in organizing the book. Autrum's three volumes of the definitive *Handbook of Sensory Physiology* had recently appeared. Not only do the topics in the two books overlap, a third of the authors who contributed to this book also contributed to the *Handbook*. Ali's response to this challenge was to create not a handbook but a "glorified text-book" meant to be more easily accessible to a larger number of persons. Success in this venture is mixed. Half of the authors wrote tutorial papers that would be useful in a college course. Others wrote for the specialist or limited discussion to their own research. The inflated price of the book limits its utility as a textbook. The quality of the printing is below the standards required by electron micrographs.

The coverage of the lower invertebrate groups includes much comparative description of photoreceptor and pigment

cells. Not much is said about their visually mediated behavior because there is not much to say. A discussion of that topic by Burr deals with terminology more than with substance.

The arthropods have attracted much attention as models for studying visual information processing because they have sufficiently complex behavior to be interesting and because they can be studied with many techniques. But which is the best model for discovering fundamental principles? Laughlin argues that the fly is rapidly superseding *Limulus* as the best invertebrate model and supports his claim with an excellent physiological discussion of signal processing by monopolar cells of the lamina. Perception of movement by tethered flies has been studied extensively and quantitatively for many years by the group from Tübingen, five of whom contribute here. The fly retina, which is described by Franceschini, is well understood but not simple, for it contains six distinct spectral types of central receptor cells the behavioral functions of which are a mystery. Understanding of the neuroanatomy of the fly's optic neuropils has been advanced considerably by Strausfeld, who in this volume discusses columnar neurons, including giant neurons of the lobula plate. Hausen describes well the physiological properties of those giant neurons and their role in movement detection. Buchner and Buchner show how the deoxyglucose technique can be used to label movement-specific activity in the medulla and lobula. E. Buchner describes and evaluates mathematical models for detection of position and movement.

The fly is not the only candidate for "best model." I cast my vote for the social Hymenoptera. The honey bee *Apis* and the desert ant *Cataglyphis* have a much more interesting and well-characterized repertoire of visually mediated behavior than flies. Their retinas are spectrally simple compared with those of flies and are just as well understood anatomically and physiologically. Their neuroanatomy, however, is not nearly as well described as is that of flies. A problem with Ali's volume as a textbook is that discussions of the Hymenoptera are sparse and poor. Autrum's volumes cover this subject well.

Five of the chapters should delight the layperson as well as the specialist. These chapters are well illustrated and written in lively style in language that should be understandable to readers who have some background in biology. There is a chapter on protozoans by Couillard, one on rotifers by Clément and Wurdak, and one on spiders and myriapods by Muñoz-Cuevas. The jewels of the volume are two sparkling chapters by Land, one on the optical inventiveness of crustaceans and the other on the unique eyes of molluscs.

GARY D. BERNARD
Yale University, Department of Ophthalmology and Visual Science, New Haven, Connecticut 06510

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