Galaxies and the Universe consists of 19 chapters, ranging in length from 16 to 100 pages. The first five chapters deal with galaxy properties that are studied chiefly by optical means, and the next four deal with radio emission from galaxies and quasars. Two chapters then discuss the formation and dynamics of galaxies. After a chapter on the distance scale, three chapters cover multiple galaxies and clusters, and two more deal with the general phenomenon of clustering. The final two chapters are devoted to the radio and optical observations that bear on cosmology.

As one might expect of such a varied collection, the individual chapters differ greatly in tone and in level. They range from flat empiricism to abstruse theory, and the point of view is often broadly ecumenical but occasionally so narrowly personal as to be of dubious general value. The overall coverage was good when the volume was planned, but a survey planned today would probably direct more attention to quasars (which get one brief chapter) and other high-energy phenomena, and it would include a chapter on the astrophysics of the big bang. In any case, the book would have been more valuable if it had included a chapter discussing cosmological models explicitly and systematically.

In spite of these shortcomings, *Galaxies and the Universe* is a valuable book. It belongs in every library that includes advanced astronomy.

More than half of the individual chapters fall in the range from quite good to uniquely valuable. I would single out several for particular mention. Allan Sandage updates his and Hubble's scheme of classification. Alan T. Moffet presents a comprehensive discussion of emission mechanisms in radio galaxies, followed by a good survey of observed properties. K. C. Freeman's chapter begins with a clear, concise summary of the stellar dynamics of the Milky Way and other galaxies and continues with the best existing survey of observations and theory concerning the structure of galaxies. Sidney van den Bergh discusses distance criteria and the distances of nearby galaxies. His discussion of methods is excellent, even though his 1969 evaluation of the Hubble constant does not give as much weight as one might give today to correlations between distance criteria and galaxy luminosity. Peter A. G. Scheuer not only summarizes the radio data that bear on cosmology, he adds some excellent insights and clarifications of his own.

In addition, there are valuable discussions of the content of galaxies (H. Spinrad and M. Peimbert), of methods of mass determination (E. M. and G. R. Burbidge), of energy curves and K-corrections (A. E. Whitford), of radio-source identifications (R. Minkowski and J. Kristian), of 21-centimeter studies (M. S. Roberts), and of optical observations and cosmology (A. Sandage).

The remaining eight chapters are not particularly to be recommended, either because they are intrinsically of lower quality or because the rush of extragalactic astronomy has left them behind. It is indeed a pity that George Field's excellently written chapter on galaxy formation is now out of date, and it is ironic that Maarten Schmidt's chapter on quasars is incomplete because it does not cover his own more recent work (although that work is in fact mentioned in Scheuer's chapter).

Publication of this volume completes the monumental series Stars and Stellar Systems, eight of whose nine projected volumes have appeared. The missing volume (volume 4, *Clusters and Binaries*) has not been produced, though the University of Chicago Press continues to list it. Even so, the astronomical community owes a great debt to the dozens of individuals who have labored to produce this series.

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Normal Motor Behavior

Motor Control. Issues and Trends. GEORGE E. STELMACH, Ed. Academic Press, New York, 1976. x, 232 pp. $17.50.

Since Sherrington's and Hughlings Jackson's studies beginning almost a century ago, the most widely known work on movement control by the brain has been carried out by physicians or medically trained physiologists. In the past few decades, however, increasingly important contributions in this field have come from "sports science," a discipline whose experimental subjects are for the most part healthy young adults, and whose goal is to understand normal motor behavior. There is a *Journal of Motor Behavior* devoted to studies arising from this group, and annual conferences devoted to sports science are now held in a number of countries throughout the world. Many members of this new scientific discipline had their original training in psychology, but the field also includes physiologists, biomedical engineers, clinicians, and cyberneticists.

With its increasingly interdisciplinary makeup, the field of sports science has become more and more concerned with bridging the gap between traditional descriptive studies of normal motor behavior and traditional physiological or clinical studies of brain organization. Stelmach's book brings together a series of papers that succeed in giving an excellent picture of the work being done in this new field.

A major topic dealt with by the contributors is the relation between afferent feedback arising during movement and the "central motor program" that sets the movement off. As Adams points out in his chapter on a "closed-loop theory of motor learning," Lashley brought the notion of the motor program to its current level of high esteem by his 1917 paper showing that a man with traumatic deafferentation could make reasonably accurate movements of his anesthetic lower limb. But what of normal subjects whose afferents are intact? It is to the role of afferent input in normal motor behavior that this book addresses itself. One contributor, Richard A. Schmidt, presents a strong array of evidence that "a motor program that produces movement without the involvement of peripheral feedback probably does not exist in human behavior." But Schmidt does not deny the value of the central motor program concept; instead, he provides an excellent definition of the central motor program as:

> . . . a set of prestructured alpha and gamma motor commands that, when activated, result in movement oriented toward a given goal, with these movements being unaffected by peripheral feedback indicating that the goal should be changed.

A major contribution of many of the chapters in this volume is their integration of literature from kinesiology, neurophysiology, and physiology. As Paul Weiss wrote many years ago,

> Nobody in his senses would think of questioning the importance of sensory control of movement. But just what is the precise scope of that control? Is the sensory influx a constructive agent, instrumental in building up the motor patterns, or is it a regulative agent, merely controlling the expression of autonomous patterns without contributing to their differentiation?

The experimental results presented in Stelmach's book go a long way to providing answers to Weiss's questions.

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