Astrophysical Phenomena

Atoms and Molecules in Astrophysics. Proceedings of the Scottish Universities Summer School (a NATO Advanced Study Institute), Stirling, Aug. 1971. T. R. CARSON and M. J. ROBERTS, Eds. Academic Press, New York, 1972. xiv, 368 pp., illus. $23.50.

Most of the material of astrophysics is provided by spectroscopic observations. Given thermodynamic equilibrium, the construction of quantitative models that reproduce the observed radiation involves only data on spectral line positions and radiative transition probabilities. To astrophysicists atomic physics once was in effect atomic spectroscopy. The discovery of numerous stellar and more particularly interstellar molecules extended the required background in atomic and molecular physics to include the spectroscopy of diatomic and polyatomic molecules, but more significant has been the recognition that few objects in the universe exist in conditions of thermal equilibrium, and that a detailed understanding of atomic and molecular processes of excitation and deactivation, of formation and destruction, is consequently needed if the correct physical content is to be extracted from the observations.

The range of physical processes is very broad, and the breadth creates a demand for abbreviated presentations of the basic material that can rarely be satisfied without loss of precision and clarity in the exposition of the underlying concepts. *Atoms and Molecules in Astrophysics* is a brave attempt to provide a brief account of some of the more immediately relevant areas. The lectures include a survey of atomic scattering theory by P. G. Burke, an introduction to molecular spectroscopy by H. Foley, a summary of collision theories for highly excited atoms by I. C. Percival, and a very brief description of theoretical studies of line broadening by H. Van Regemorter. The article by Foley is particularly lucid, but they are all well organized and economical in presentation. Greater reference to experimental aspects would have provided a more satisfactory description of the discipline, but for those who need a rapid reminder of the content of the subjects treated in the lectures the book has value. Clearly much of the physics of atoms and molecules involved in astrophysics today is omitted, and the book is in no sense comprehensive.

The book also contains two lectures on astrophysical phenomena whose interpretation demands a particular knowledge of atomic and molecular processes. M. J. Seaton presents a clear and instructive discussion of the present theory of gaseous nebulae which includes the question of the widths of the radio recombination lines from H-I regions. The lecture by M. Litvak deals with interstellar molecules with particular reference to the physical conditions and processes leading to interstellar masers. It is more complex than Seaton's elegant account, but so perhaps is the subject.

The book concludes with several summaries on related topics, all of which have already been more adequately discussed by the authors in the journal literature.

Finally, then, the book has some good parts but the whole is no more than a sum of its parts. It is in fact a typical summer school.

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Marine Studies

The Biology of the Indian Ocean. Proceedings of a symposium, Kiel, Germany, Mar. 1971. BERNT ZEITZSCHEL, Ed. Springer-Verlag, New York, 1973. xiv, 550 pp., illus. $55.40. Ecological Studies, vol. 3.

The International Indian Ocean Expedition (1959–65), unlike the early expeditions, was not a voyage by one ship with a defined purpose but resulted from a decision of the oceanographic community to concentrate activity for a number of years in the relatively unexplored waters of the Indian Ocean. This volume contains the proceedings of a symposium devoted to the biological investigations. The majority of the 44 papers describe the distribution of plankton, fish, and benthos in the area. These will be essential for anyone working in the region and valuable to those concerned with general oceanic distributions of plankton. Many of these papers are based on the collections at the Indian Ocean Biological Centre.

The geographical distribution of effort and the types of investigation depended on the interests of the participants. A unique feature of the Indian Ocean is the reversal of the surface circulation in the tropical belt produced by the change from northeasterly to southwesterly monsoons. In turn this plays an important role in the upwelling along the Arabian coast. In consequence, much of the effort was concentrated in the Arabian Sea and results are much sparser for the southern parts of the ocean. The general features of the physical environment, including nutrient distribution, are described in papers by Dietrich, Wyrtki, and Currie, Fisher, and Hargreaves. These provide a necessary background for the understanding of the distribution of organisms. At the basic level of primary production, there is good agreement between measured areas of high productivity and those expected on the basis of physical and nutrient distributions. At the highest trophic level discussed here, tuna, it is apparent that there is no simple correspondence between abundance of tuna and physical factors or basic productivity. Thus, as well as displaying relations between different features of the area, these papers also indicate unresolved problems.

The strengths and weaknesses of this international, interdisciplinary study of a large area are revealed in the paper by Cushing, which attempts to estimate the energy flow at the lower levels of the food chain. Presumably Cushing uses the same basic data to derive primary production (grams of carbon per square meter per day) as Krey (in another paper in the book) uses, yet there are considerable quantitative differences between the presentations which are not explained. For secondary production there is the advantage that all collections for zooplankton biomass were taken with the same type of net hauled in the same way (vertically 200 meters to surface), but these data expressed as displacement volume (milliliters per square meter) have to be converted first to grams of carbon per square meter. Then a "growth" rate is obtained by calculating the duration of each generation as a function of temperature from data on *Calanus* from the west of Scotland. (The calculations are given too briefly and appear to contain errors in presentation.) No account is taken of the effects of predation in determining the production-biomass ratio. These estimates, combined with primary production data, allow Cushing to calculate transfer efficiency from phytoplankton