are all animal-like characteristics. But it also requires lipoate, which other animals can synthesize; it makes a vitamin $B_{12}$-like compound whereas other animals need $B_{12}$; it has a bacteria-type cytochrome c and an operative glyoxalate cycle like plants; it contains a pentacyclic triterpenoid which has not been found in other animals; and it lacks all urea cycle enzymes.

Hill summarizes what we know about the biochemistry of *Tetrahymena*, but many biochemical questions remain to be answered about it and other protozoa. Perhaps when biochemists tire of vertebrate breis and bacteria they will come to realize that these organisms can be used to good advantage and that much can be learned from them.

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## The Submillimeter Region

**Far-Infrared Spectroscopy.** KARL DIETER MÖLLER and WALTER G. ROTHSCHILD. Wiley-Interscience, New York, 1971. xx, 798 pp., illus. $29.95. Wiley Series in Pure and Applied Optics.

**Far-Infrared Properties of Solids.** Proceedings of a NATO Advanced Study Institute, Delft, The Netherlands, Aug. 1968. S. S. MITRA and S. NUDELMAN, Eds. Plenum, New York, 1970. viii, 606 pp., illus. $25. Optical Physics and Engineering.

The far-infrared or submillimeter region of the electromagnetic spectrum, extending over the wavelength range from roughly 10 microns to 1000 microns, continues to be a uniquely challenging frontier of spectroscopy. Although richly endowed with phenomena of fundamental and analytical importance in physics, chemistry, and life sciences, it has historically attracted fewer workers owing to the lack of sources and detectors of quality comparable to those available at either longer microwave or shorter optical wavelengths. Despite recent vast improvements in instrumentation, as well as significant fundamental experimental results, the far infrared is still largely unexplored.

*Far-Infrared Spectroscopy* represents an admirable attempt by the authors to compile in one volume a summary of both instrumentation and fundamental phenomena associated with this spectral region. Within the context of classical spectroscopy they have succeeded in their attempt. The reader will find many useful tutorial details concerning grating and Fourier transform instruments and their accessories, as well as an overview of the theory of far-infrared spectra of vapors and liquids. In these areas the text is augmented by an extensive bibliography.

The main body of the book, however, seems to lack a unifying sense of direction, or any clear statement summarizing and relating the abundant details. Far-infrared spectroscopy as it existed in 1969 when the book was finished is not the final chapter, but in reality the setting of the stage. The authors miss the opportunity to place their work in this historical perspective and to convey the excitement and challenge of opening up the far-infrared frontier with the use of improved laser sources, detectors, and techniques whose development was already reported at that time.

This oversight is partially remedied by the inclusion of a number of appendices written by other researchers dealing with topics of current interest in solid-state spectroscopy including impurity effects, ferroelectrics, magnetism, superconductivity, and semiconductors.

The thrust into new frontiers is the main emphasis of *Far-Infrared Properties of Solids*, which is a collection of graduate-level lectures from a 1968 advanced study institute. In a sense the title is a misnomer, for many of the lectures deal with instrumentation and techniques not restricted to the study of solids. The inclusion of these, however, gives the book balance and extends its usefulness as a reference source, although some of this advantage is negated by rapid technological developments since 1968 and the unfortunate fact that the volume was not published until two years later. The coverage of research areas parallels to a great extent that of the appendices in the Möller-Rothschild book, but individual problems are treated in somewhat greater depth.

When viewed in proper perspective the two books together provide useful introductory and reference material for the serious adventurer into far-infrared spectroscopy, combining the classical with the new.

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## Astronomical Objects

**The Physics of Pulsars.** ALLEN M. LENCHEK, Ed. Gordon and Breach, New York, 1972. x, 174 pp., illus. $14.50. Topics in Astrophysics and Space Physics.

Allen Lenchek has made a great effort to provide a much-needed compilation of pulsar observations and theories. The result is a rather rich pulsar stew, but the kind that is mixed up for better or worse from nothing but leftovers. In this case, the ingredients are recordings of a series of colloquia given at the University of Maryland in late 1969; most of these are surprisingly unspoiled, but are not those of a proper recipe but rather what was available. Some very important elements are missing entirely, others reappear almost as reliably as pulsar pulses.

Since the contributors in most cases were giving talks describing their own work, few of them attempt to give a balanced view of work in the areas discussed. The list of contributors is distinguished, and the result is very, very good when it is good, and when bad it is horrid.

Following a brief introduction, the book is divided about evenly between observational and theoretical material. There is but one colloquium, by G. R. Huguenin, on the radio properties of pulsars, so important omissions are inevitable. One can find almost nothing on the pulse shapes of pulsars; in a later chapter a few poor-quality pulse shapes are given. There is no mention of the strong microsecond time-scale modulation of pulsars, a matter of crucial importance to the theory. And none of the recent superb work on systematic effects in pulsar pulse sequences by such people as D. C. Backer is mentioned. The chapter by G. S. Downs on pulsar timing is quite good, except that because Downs cannot measure the timing of the most revealing Crab Nebula pulsar, this crucial object does not appear in his discussion. The chapters on optical and x-ray observations are both complete and still up-to-date. There are two chapters, by R. M. Hjellming and Y. Terzian, on dispersion measures, interstellar clouds, and distances, which are both very good but of course greatly overlapping.

The best part of the book is the theoretical chapters. All the leading protagonists of pulsar theory appear on stage and succeed in giving articulate and still timely descriptions of their theories. These include T. Gold, H. Y.

Chiu, F. Pacini, P. Goldreich, and J. Ostriker. Since most of these chapters were given to an audience where the goal was immediate clarity, there is an abundance of good explanation which gets the ideas across far more effectively than is often the case with a succinct written paper. No doubt this is an excellent place to absorb the essentials of the pulsar theories, although the reader, along with the writers, will come away repeating the final question put plaintively to Goldreich, "Well, what makes your pulsars pulse?"

This book is a good place to start on pulsars, but the newcomer should beware of some very massive black holes lurking in it. Any pulsar book which has only one sentence about solid crusts in neutron stars and no sentences about the extensive work on the timing of pulses from the Crab pulsar can't be all good.

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## Books Received

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