pers published therein were received by the editor as far back as 1967. A lapse of five years between the reception and the publication of a scientific paper, particularly a review paper, may very appreciably reduce the value of the work. Being another editor, I make this complaint with commiseration and understanding.

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Chemical Processes

Ions and Ion Pairs in Organic Reactions. Vol. 1. MICHAEL SZWARC, Ed. Wiley-Interscience, New York, 1972. xii, 400 pp., illus. $17.95.

In this, the first of two projected volumes, the editor has collected chapters which, in his own words, deal "with the physical techniques fruitful in unraveling the problems of structure, energetics, and dynamics of ions and ion pairs." And, in large part, it seems to this reviewer that this objective has been met.

The physical techniques that are treated, largely spectral, include mass spectrometry (P. Kebarle), spectrophotometry (a particularly informative and interesting chapter by J. Smid), infrared and Raman spectroscopy (W. F. Edgell), electron spin resonance spectrometry (J. H. Sharp and M. C. R. Symons), and nuclear magnetic resonance spectrometry (three separate chapters by L. D. McKeever, by E. de Boer and J. L. Sommerdijk, and by M. Szwarc).

Although, as the title implies, the emphasis is on organic chemistry, the chapters by Kebarle and Edgell deal largely or entirely with inorganic systems. This being the case I find it unfortunate that no discussion of the elegant physical relaxation techniques developed by Eigen and utilized by him for the study of (largely inorganic) ion-pair phenomena is included.

The reader should be cautioned that the emphasis throughout this volume is on ion pairs, not free ions. Except in the extremely interesting chapter by Kebarle free ions are discussed only tangentially. Another limitation of this first volume is that attention is restricted almost entirely to organic ion pairs composed of an organic carbanionic component (frequently a radical anion) and an inorganic component, $R^{\ominus}M^{\oplus}$. The complementary combination of an organic carbonium ion portion electrostatically associated with an inorganic anionic component ($R^{\oplus}X^{\ominus}$) is not discussed, presumably because spectral techniques have not yet been developed to investigate these generally unstable species. It is hoped that volume 2 will deal with these species. Incidentally, about this second volume Szwarc has written that it "is devoted to the role of ions and ion pairs in chemical reactions such as proton transfer, electron transfer, or ionic polymerization."

This reader at least was left with two overwhelming impressions after reading this volume: (i) that the traditional textbook definitions of chemical bonds as resonance hybrids of two distinct types, ionic and covalent, must be reexamined; it is increasingly obvious that the fundamental difference is one of degree, not kind; and (ii) that the potential for obtaining information about the nature of bonding by means of spectral techniques is great indeed.

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Space-Time Problems

General Relativity. Papers in Honour of J. L. Synge. L. O'RAIFEARTAIGH, Ed. Clarendon (Oxford University Press), New York, 1972. x, 278 pp., illus. $24.

This festschrift honors Synge's 75th birthday. Although there is hardly an area of mathematical physics that has not benefited from Synge's work, the present volume is confined to general relativity, to which Synge made and continues to make many important contributions. Perhaps the hallmark of Synge's work in relativity has been his consistent emphasis on the geometrical point of view; it must be gratifying to him that a number of the papers share this geometrical spirit.

Weyl showed in the 1920's that a Riemannian structure of Minkowski signature generated conformal and projective structures on a manifold which could be identified by studying the paths of massless and massive test particles, respectively; the use of test rods and clocks to determine the metrical structure could thereby be eliminated. In their paper "The geometry of free fall and light propagation," Ehlers, Pirani, and Schild solve the reverse problem. Compatible conformal and projective structures on a manifold are defined, and additional conditions yielding a unique Riemannian structure are derived. The existence of such a structure need not therefore be assumed beforehand in order to construct it from the behavior of null and massive test particles. Since this method of test particles has recently come into favor, it is very satisfying to see it fully developed. Of course, each of the three methods currently proposed for explicating the significance of the metric structure of space-time (rods and clocks, paths of massive particles and clocks, and paths of massless and massive particles) has advantages and drawbacks. Thus, it is perhaps better to regard them as alternative ways of looking at the implications of a metrical structure for space-time than to claim absolute superiority for one.

Trautman's paper "Invariance of Lagrangian systems" is a geometrical treatment of invariance properties of Lagrangians and related conservation laws using the methods of fiber bundle theory. The geometrical content of symmetries, which tends to get lost in the usual treatments involving local coordinate systems, is thereby elegantly brought out.

Penrose's paper "The geometry of impulsive gravitational waves" takes up the question of the propagation of discontinuities in the curvature tensor on null hypersurfaces. Detailed attention is devoted to the study of intrinsic geometric structures which a null hypersurface inherits from the Riemannian structure of the manifold. This study of intrinsic null geometry could well find further useful applications.

"Global and non-global problems in cosmology" by Ellis and Sciama shows "that some cosmological problems are more global than others"; and indeed which properties are truly global varies from model to model. Their very thorough survey of this question only reinforces the residual uneasiness that all cosmological discussions provoke in me. Their paper provokes the question, If local observations cannot determine certain global properties of *some* model universes, how can we ever be sure of the applicability of *any* model?

Two historical papers survey "Einstein's path from special to general relativity" (Lanczos), a topic all too little studied as yet by historians of science, and "The acceptability of physical theories: Poincaré versus Einstein" (Balazs). The latter briefly investigates why it is wrong to attribute the discovery of special relativity to Poincaré (as Whittaker does in *A History of the Theories of Aether and Electricity*). Anyone interested in pursuing this question should look at the recent detailed study by Arthur I. Miller, in the *Archive for the History of Exact Sciences* (in press).

The volume also includes: "The relativistic Boltzmann equation," by W. Israel; "A limiting case of relativistic equilibrium," by S. Chandrasekhar; "The self-consistent test-particle approach to relativistic kinetic theory," by W. B. Thompson; "Exact solutions of the Einstein-Maxwell equations for an accelerated charge," by W. B. Bonnor and P. C. Vaidya; "Plane-symmetric similarity solutions for self-gravitating fluids," by A. H. Taub; "Equations of motion in the linear approximation," by I. Robinson and J. R. Robinson; and "Rotating bodies in general relativity," by P. S. Florides.

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(Continued on page 330)