of a relatively timeless quality or suggest ideas that are still stimulating, for example, John A. Hannah on "Motives for the participation of American universities in international education," Robert M. Macy on "The need for guidelines to political development," and Jerome Bruner on "Educational assistance for developing nations: techniques and technology." But in general one is impressed that the pace of change in this field, as in others, is so rapid that mimeographed documents prepared for conferences and committees should be put into print quickly or not at all.

EUGENE STALEY
School of Education, Stanford University, Stanford, California

Techniques in Chemistry

High Resolution Nuclear Magnetic Resonance Spectroscopy, by J. W. Emsley, J. Feeney, and L. H. Sutcliffe (Pergamon, New York, 1965. vol. 1, 733 pp., illus.; vol. 2, 542 pp., illus. $17.50 each), is a bold attempt "to provide a detailed account of the basic theory underlying high resolution nuclear magnetic resonance (nmr) spectroscopy and also to present a survey of the major applications in physics and chemistry." That it succeeds in its purpose to a remarkable degree is testimony to the abilities and thoroughness of the authors. That it is less than definitive and falls short of being truly comprehensive reflects the ever-increasing vastness of the subject and the heterogeneous interests and backgrounds of the practitioners of the art.

Twenty years ago two communications reported the first observations of nuclear magnetic resonance in bulk matter. Useful applications of the new techniques to physics and chemistry soon followed, as did the discovery and characterization of new nmr phenomena, such as the "chemical shift" in 1949, the electron coupling of nuclear spins or indirect spin-spin interaction in 1951, and the spectral averaging effects of chemical exchange in 1953. These three phenomena were found to govern the detailed fine structure which appears in the high-resolution nmr spectra of liquids and gases and which is a very sensitive indicator of molecular structure, including some of the most subtle conformational changes and differences. Thus it soon became clear that nmr was a field of great promise for chemical research.

The promise has been realized during the past 10 years by the design and commercial availability of nmr spectrometers of increasingly higher sensitivity and resolution and by their successful application to an astonishing range and number of chemical problems. The success of nmr as an aid to research is shown in quantitative terms by the present publication rate, greater than 450 per month, of papers referring in a more than incidental way to some aspect of nmr. Most of the current papers involve the use of high-resolution nmr to solve structural problems in chemistry. Many of these applications are empirical in nature and require little more than comparing the spectra for compounds of known and unknown structure. Others require detailed analysis and understanding of the spectra, and some even need to use or extend the basic theory relating the spectral parameters to molecular structure.

The first volume of Emsley, Feeney, and Sutcliffe's book is directed toward the latter needs. It treats the basic theory of nmr, especially of the phenomena governing high-resolution spectra and the relation of these phenomena to molecular electronic structure. The practical aspects are covered in a chapter on instrumentation principles and another on the operating procedures and lore employed to obtain usable spectra. Strong emphasis is placed upon the analysis of a complex spectrum to obtain the chemical shifts and scalar coupling constants which, after all, are the basic spectral parameters related to molecular structure. Initially the authors planned a single volume, but the exponential increase in nmr determinations of molecular structures led to the publication of their survey of such applications as a second volume. This volume includes separate chapters on proton and fluorine resonance and a third on other nuclei. Many useful tabulations of chemical shifts and coupling constants are given and many typical spectra are reproduced.

It is not surprising that there is some unevenness in such a lengthy monograph by several authors, and each reader will no doubt find his own points to carp about. In my case, although Erwin Hahn's studies of the indirect spin-spin coupling were by spin-echo rather than high-resolution methods, I feel that his contributions to this area should have been cited, as should have been his addition of chemical exchange terms to the Bloch equations. Moreover, with the general availability of high-speed computers, I believe that a 5-page discussion of computer methods for analyzing spectra would have been much more useful than 25 pages of appendices listing frequencies and intensities of A_mB_n spectra. Also, I wish that volume 1, besides being a comprehensive reference for the theory and practice of high-resolution nmr, were more critical or were better suited for students. But in any case, the authors are to be congratulated for having fitted such a large and diverse field into one book. Practitioners of the art will find that the usefulness of the monograph makes it well worth its high price.

H. S. GUTOWSKY
W. A. Noyes Laboratory of Chemistry, University of Illinois, Urbana

Ratios and the Celestial Spheres

Nicole Oresme, speculative mathematician and natural philosopher, translator of Aristotle's *Ethics* and *De coelo* into French, friend and protégé of the King of France, opponent of astrology, schoolman extraordinary, was without question one of the most original thinkers of the 14th century. His **De proportionibus proportionum** and **Ad pauca respicientes**, now published together in a definitive edition (University of Wisconsin Press, Madison, 1966. 488 pp., illus. $10.75), with English translation, commentary, and notes by Edward Grant, set forth one of his most original pieces of thought: an analysis of the quantitative relations of ratios that is equivalent to the introduction of fractional and irrational exponents, and an anti-astrological application of this analysis to the motions of the planets.

To understand this achievement of Oresme, one needs to recall the nature of ratio as conceived in Euclid's *Elements*: a relation with respect to size