books

Probing the nucleus with electrons

Electron Scattering from Complex Nuclei, Parts A and B

H. Uberall
Academic, New York, 1971
Part A, 467 pp. $24.00
Part B, 400 pp. $21.00

Reviewed by T. W. Donnelly

In the past two decades the study of nuclei by means of electron scattering has grown from infancy to its present position as one of the most powerful techniques for exploring the nature of the nucleus. This two-volume set is essentially a stocktaking or summary of where we stand in this field at present. To quote the author's intent: "... it was decided to gather all the preceding achievements of elastic and inelastic electron scattering and combine them in the form of a summary monograph of this field." "... It is designed to provide a broad coverage of the entire subject matter—one may realize that at the present point in the progress of electron scattering, this is perhaps the last occasion when such a comprehensive synthesis can still be accomplished." Indeed, at present this is a very large task even for someone such as the author who has made numerous contributions to the subject of electron scattering theory himself. However he appears to a large extent to have succeeded.

This monograph is aimed at everyone involved in the study of electron scattering, graduate students just beginning to work in this field and experienced researchers alike. That, of course, is quite ambitious, and probably everyone will find parts that are somewhat too condensed and others that are too exhaustive. However, on the whole the balance between theory and experimental results or between the details of electron scattering itself and the information learned about nuclear physics is well maintained throughout.

The work is divided into two parts, A and B, the former dealing with some introductory groundwork and focusing mostly on elastic electron scattering, while the latter involves inelastic electron scattering and several special topics. In part A the basic theory is presented, beginning with the first Born approximation and then proceeding to higher Born approximations, the high-energy approximations and the full phase-shift analysis. Within these approximations are covered such topics as polarization effects and scattering from oriented and deformed nuclei and from magnetic moments. The author shows the evolution of elastic-scattering studies from the early low momentum transfer experiments that have given us much of our present knowledge of the shape of nuclear charge distributions to present-day studies at high momentum transfer involving high multipolarity structure in the nucleus, the distribution of magnetic moments and the possibility of short-range correlation effects.

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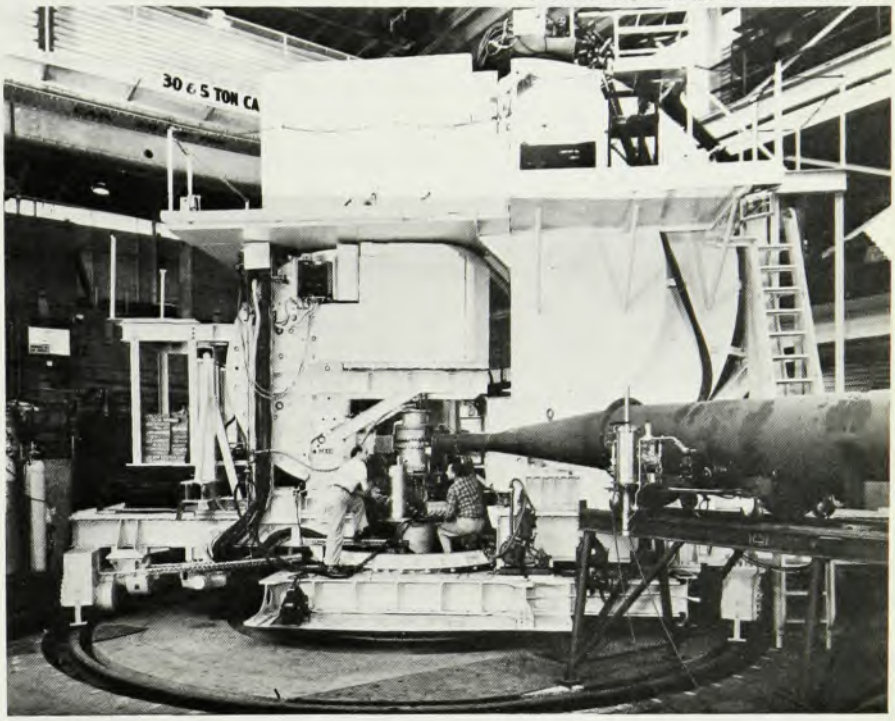

The 72-inch mass spectrometer at Stanford's High Energy Physics Laboratory. Instruments like this provide the basis for much of the experimental and theoretical discussion in Uberall's book, *Electron Scattering from Complex Nuclei, Parts A and B.*

Part B begins with a discussion of radiative corrections to electron scattering, followed by a lengthy treatment of inelastic electron scattering including sections on nuclear models and on the giant resonance. Parts A and B are not intended to be self-contained, at least as far as the development of the theory is concerned, for the treatment of electro-excitation in part B draws on earlier sections in part A. Even so, much of part B can be read independently of part A.

The final sections of the work contain material on scattering to the continuum, particularly coincidence experiments and electrodisintegration and conclude with a brief chapter on special topics: isospin effects, dispersion effects, sum rules and correlations and the effects of mesons.

Uberall has provided a very scholarly work with exhaustive references to the

original literature. In particular the historical development of each topic is followed, emphasizing the major steps that have been taken (and documenting some of the mistakes made as well). On the other hand subjects of current interest have not been neglected. These books live up to the promise of being a status report summarizing where things stand at present.

Indeed if there is a major negative criticism to be made it is that the approach taken is so wide in scope that some, especially the initiate in the field, may have trouble extracting the major conclusions from the wealth of detail. However, for the researcher in the field who desires a monograph that is current and yet includes many of the detailed developments in the subject, Überall's books largely fulfill this need. With the next generation of electron accelerators upon us, bringing with them even more exciting possibilities of studying the nucleus at high momentum transfer, this monograph comes at an opportune time to collect what is known and prepare for the near future.

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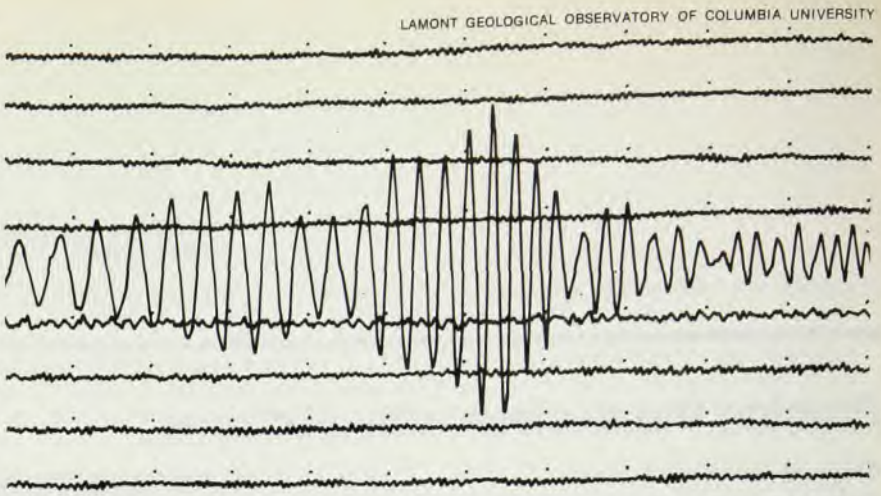
Nuclear-Explosion Seismology

H. C. Rodean
156 pp. US Atomic Energy Commission, Division of Technical Information, Oak Ridge, Tenn., 1971. $3.00

Howard Rodean is the author of several papers and technical reports dealing with aspects of nuclear explosions ranging from chemical and physical properties of rocks in the immediate vicinity of the blast to the seismic hazards of explosion-produced ground motion.

Aside from the purely geophysical interest in seismic wave propagation in the earth, the seismic waves generated by explosions have been of both political and military interest in the last decade or so. This book is meant to be a summary of the unclassified knowledge, both experimental and theoretical, concerning the coupling between underground nuclear explosions and the seismic signals they produce, with an emphasis on the characteristics that distinguish explosions from earthquakes.

Although the book deals mainly with the elastic or seismic region—the region far from the blast—the first few



Seismogram of the Cannikin multimegaton nuclear explosion on 6 November 1971. The equally spaced dots on the trace are minute marks. Differentiating between natural and man-made seismic disturbances is dealt with in *Nuclear Explosion Seismology*.

chapters contain a general description of a nuclear explosion itself, followed by a more quantitative treatment of the inelastic or near source region. Important in understanding how an explosion generates seismic waves are the effects of rock properties on seismic coupling, the dynamic process of stress wave propagation, some thermodynamics and the equations of state for solids. The discussion includes a comparison of porous and nonporous solids under shock compression and ends with the results of a computer simulation study of a 5-kiloton explosion in granite.

Only a fraction of the energy of an explosion is radiated in the form of seismic waves that can be detected, recorded and analyzed. Of the several types of waves produced, the P (compressional) and S (shear) body waves and the R (Rayleigh) surface waves are of primary importance in differentiating between explosions and earthquakes. The physical principles of elastic wave theory for these waves is developed along with a discussion of reflection and refraction of elastic waves, wave propagation in a spherically stratified earth and formation of Rayleigh waves at a free surface. A mathematical approximation for an explosive seismic source is given. Also included is a short discussion of seismic wave attenuation, dispersion and the effects of the characteristics of the recording instrument on the signal.

The various phenomena mentioned above and the complexities involved in the problem of detecting and identifying seismic signals related to underground nuclear test are brought out in an extensive analytic and numeric generation of P-wave solutions which include the effects of the source function, attenuation, dispersion, explosion yield and seismometer response characteristics. Some theoretical amplitude-yield curves are produced and compared to actual experimental amplitude-yield curves obtained from several geologic regions.

The book concludes with a discussion of the possibilities of clandestine nuclear testing by means of seismic decoupling through the technique of detonations carried out in large cavities. There is also a summary of what is known and not known about seismic waves generated by underground nuclear explosions.

Due to the scope of the book, the treatment of each topic is necessarily brief. However the author includes the pertinent mathematics and enough descriptive material to make the book very readable. Well worth mentioning are the many references to technical reports, scientific papers and books throughout the text that would be very helpful to anyone interested in pursuing a given subject further. The book can be recommended to anyone interested in the geophysical effects related to a nuclear explosion.

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The Caloric Theory of Gases: From Lavoisier to Regnault

R. Fox
378 pp. Oxford U. P., New York, 1971. $16.00

Almost all physicists refer to the caloric theory of heat at one time or another, but few know what it involved in detail except that heat is considered to be a material fluid. Up until now it has been difficult to find an accurate and definitive discussion of this theory, which held the attention of physicists for about 150 years. But now we have a scholarly treatise on the subject growing out of a doctoral thesis at the University of