KLYSTRON GALLERY AT SLAC. The two-mile gallery has a 24-MW S-band klystron every 12 meters. On the shelf above and to the right of the first klystron is one of the 120 ion-getter vacuum pumps.

little over a year, a proposal was prepared for a two-mile electron linear accelerator; this proposal was submitted to several Washington agencies. Then began a long waiting period while the proposal was studied and then approved by a National Science Foundation panel, by a panel drawn from the General Advisory Committee of the Atomic Energy Commission and by the President's Science Advisory Committee. Hearings were held before the Joint Congressional Committee on Atomic Energy. In late 1960 a $3 million study contract was awarded to Stanford by the AEC and, finally, in September of 1961 the project was authorized at an estimated cost of $114 million.

In the meantime the Stanford group had been busy with design and model studies of critical machine components and, upon authorization, construction began almost immediately. In May of 1966 a staff, now including about a thousand persons, had completed the main construction and demonstrated a beam of 10-GeV energy. By January of 1967 the beam had reached its design energy of 20 GeV; time and cost estimates had both been met. Composition of this book must already have been under way, for it describes the status of the machine as of July, 1967.

Very few readers will be competent to understand completely all parts of this book. But it includes something of interest for everyone—scientific historians, project administrators, high-energy physicists, accelerator physicists, electronic engineers, mechanical engineers, civil engineers and operating engineers. All will find much of interest and value in their respective fields.

After a brief introduction, the book begins with a very well written statement of aims and purposes, a succinct statement of the "why" and "how" of the accelerator and its experimental program. Chapters follow on SLAC history and administration. Two chapters of general description bring the reader to page 162, where the scientific layman may choose to stop, because now the authors get down to business with a reasonably esoteric chapter on beam dynamics. From this point on, the text deals with one component or discipline after another, and is generally written with clarity and considerable detail.

I found two chapters particularly interesting. The first was on klystrons. As a design goal, it was decided that the accelerator would be powered by 240 klystrons of about 20 MW output at 2856 MHz, and, moreover, that these amplifiers should have useful lives of several thousand hours. Neither of these goals was near realization when the SLAC project was initiated. Intensive development programs initiated at SLAC and in industry continued through many months of frustration and tube failure. Four pages of this chapter show poignant pictures of ceramic output windows that failed for various reasons. But eventually, in time for the final operation, the effort was crowned with success.

The other chapter that particularly fascinated me was on support and alignment. The accelerator was to be aligned over its whole two-mile length to an accuracy of 0.010 inches, a precision better by an order of magnitude than could be achieved using conventional optical methods. Under the personal supervision of SLAC's dynamic director, W.K.H. Panofsky, the survey group developed an alignment system using a laser beam and 277 rectangular Fresnel lenses that achieved an alignment precision well within the requirement. This system is enclosed in a two-mile long 24-inch pipe. Ports in the pipe provide "access for a lean and agile technician to do maintenance."

There is very little to criticize in this book. In a few places, SLAC appears to claim credit for developments not entirely its own. For example, in discussing the administration, the system of involving the same persons in all phases of work associated with a given component, from early design to final test, is widely used in other accelerator centers. The chapter on history and development makes no mention of the important contributions to the linear-accelerator art of John Slater's group at MIT or of W. Walkinshaw, D. W. Fry and their group at Harwell.

There are a few other trifling statements of which a reviewer can be critical. But these fade into insignificance in comparison with the vast quantity of valuable and interesting information that crowds every chapter. This book deserves a place in the library of any physicist interested in accelerators, in high-energy physics, or merely in large, complex and well executed projects.

JOHN P. BLEWETT
Deputy Chairman,
Accelerator Department
Brookhaven National Laboratory

John Dalton and the Progress of Science

D. S. L. Cardwell, *ed.*
(Conf. Proc., Manchester, England, 19–24 Sept. 1966) Manchester Univ. Press (Barnes and Noble), New York, 1968. $9.50

John Dalton would have been proud and pleased by this detailed look into the value and significance of his scientific contributions. Dalton was a man who made mistakes as well as many valid conclusions from the evidence he had at hand. To understand his sig-

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nificance in the history of chemistry, physics, meteorology and physiological optics, one must understand what was happening around him more than what he was doing. This is just where the value of this book lies.

In September of 1966 the Manchester Literary and Philosophical Society and the Manchester University Institute of Science and Technology joined in celebrating the bicentenary of Dalton's birth. They brought together some of the world's leading historians of science to discuss Dalton's work, and the papers presented form the substance of this volume. These papers contribute more than just a detailed historical analysis of Dalton's many activities.

It is apparent that in inviting the speakers, the organizing committee did not ask them to prepare papers on particular aspects of Dalton's life and work, but rather they appear to have asked the question "What comes to your mind when you think of Dalton?"

The result is excellent. We are provided with the kind of insight into Dalton's time that every student of the history of science needs to have, and this collection of essays gives stature and relevance to a man whose scientific ideas in almost every detail have now been displaced and superseded. It is a book that should be widely read and will continue to be useful to students of the history of science for many years to come.

SANBORN C. BROWN
Professor of Physics
MIT

Theory of X-Ray and Thermal Neutron Scattering by Real Crystals

By Mikhail A. Krivoglaz
(Trans. from Russian) 405 pp. Plenum, New York, 1969. $25.00

The complete theory of x-ray diffraction was first described by C. G. Darwin in 1914 in two papers that are remarkable for their comprehensiveness. The theory was rederived in a somewhat more elegant formalism by P. P. Ewald in three papers published in 1916–17. Over 20 years elapsed before amplification in the books written by Max von Laue in 1941, W. H. Zachariasen in 1945 and R. W. James, who wrote the most comprehensive exposition, including detailed discussions of various experimental tests carried out prior to his book's publication in 1948.

There are really two theories of x-ray diffraction, that is a kinematic theory that ignores possible interactions between the incident and diffracted beams and a dynamic theory that does not. Darwin showed how the kinematic formulation can be modified to include dynamic effects; Ewald concentrated on the dynamic theory, and Zachariasen showed how a single formalism could relate the two. The three books deal with the effects of thermal vibrations and other possible defects occurring in crystals.

The burgeoning interest in solid-state sciences during the second half of this century has focused increasingly more attention on the imperfections occurring in crystals and on x-ray methods (and to a lesser extent on neutron methods) for detecting and characterizing them. Although both relatively perfect and imperfect crystals are encountered in nature and in the laboratory, Mikhail Krivoglaz, in his book, uses "real" to denote crystals containing sufficient imperfections to allow him to concentrate on the kinematic theory. The basic relations in this formulation are developed in chapter 4, which also indicates that they are equally applicable to x rays and to thermal neutrons having wavelengths of the order of 0.1 nanometers. In this chapter Krivoglaz classifies defects into two groups, depending on whether they primarily reduce the intensities of sharp Bragg reflections or whether they also distort and displace them. The treatment here is brief; therefore the reader really should study one of the three books mentioned above before undertaking a critical reading of the rest of Krivoglaz's tome.

The first three chapters are devoted to developing a fluctuation theory for crystals and relating it to local fluctuations in composition, order parameters, atomic displacements, lattice constants and forces causing such fluctuations. This is done both for the macroscopic (continuum) and microscopic (lattice dynamics) versions of general-elasticity theory.

Chapters 5–7 then consider the interaction of x rays (or neutrons) with various kinds of defects. Specific equations are derived for a variety of defects ranging from fluctuations in long-range order, through dislocation lines and loops, to point defects, as they occur in solid solutions, ferroelectric crystals, near phase-transition points, and so forth. Krivoglaz deals with a rather large number of phenomena and clearly demonstrates the convenience and power of the fluctuation-theory approach. This is, of course, the author's personal imprint, for he has been actively developing this approach for the past 15 years. *In fact, this feature distinguishes the book from all others and* makes it such a welcome addition to scientific literature.

The last three chapters are grouped together as "Inelastic Scattering of X Rays and Thermal Neutrons in Crystals," and depict the interactions of x rays with phonons. Three short appendixes presenting specialized mathematical relations and a rather extensive bibliography round out the book. The original Russian text was published in 1967, and the English translation includes several insertions by Krivoglaz, updating its comprehensiveness.

In addition to prior familiarity with x-ray diffraction theory, the reader must have a good grounding in modern physics and in mathematics in order to follow the rather succinct developments. The necessary physics is adequately presented but not self-evident without mature reflection. One also may find it desirable to familiarize oneself with other treatments of many of the same topics in books of the current decade by W. A. Wooster, by André Guinier, by J. L. and M. Amorós, and by B. E. Warren.

The English translation is quite good and relatively free of idiomatic difficulties that often plague translators who are not intimately acquainted