

The history of crystal gazing

Early Papers on Diffraction of X-rays by Crystals

J. M. Bijvoet, W. G. Burgers, G. Hägg, eds.
372 pp. A. Oosthoek's Uitgeversmaatschappij N. V., The Netherlands, 1969.
\$13.50

Reviewed by Barbara W. Low

This collection of early papers on the diffraction of x rays by crystals was prepared during the Commission on Crystallographic Teaching of the International Union of Crystallography. It was intended not only as a fundamental source book but also "to make the student aware of the history of his science." The editors, J. M. Bijvoet, W. G. Burgers and G. Hägg, have gathered together 83 papers and abstracts, some very brief, that provide an account of the principal developments in the field of diffraction by crystals extending from the discovery of x-ray diffraction through considerations of geometrical optics, the reciprocal lattice, to the intensity of x-ray diffraction by crystals in both kinematical and dynamical theory. The papers are presented in their original language, and therefore German and English dominate with a few citations in French.

The discovery of x-ray diffraction by crystals in 1912 by W. Friedrich, P. Knipping and M. Laue was not only epochal as seen in retrospect, but its immediate impact was overwhelming. It provoked extraordinarily swift and vigorous developments in theory and experimentation. The first x-ray crystal-structure analysis of zincblende by W. L. Bragg was published one year after Laue, Friedrich and Knipping's research was communicated to the Bavarian Academy of Sciences. The "Bragg Equation" appeared in a paper presented to the Cambridge Philosophical Society in November 1912, and the relationship between the Laue equations and the Bragg equation was established by the end of 1913, the year in which E. Friedel's law was enunciated. There is a paragraph in this collection from a 1915 lecture in which W. H. Bragg outlined the principles of Fourier analysis.

The papers communicate the excitement

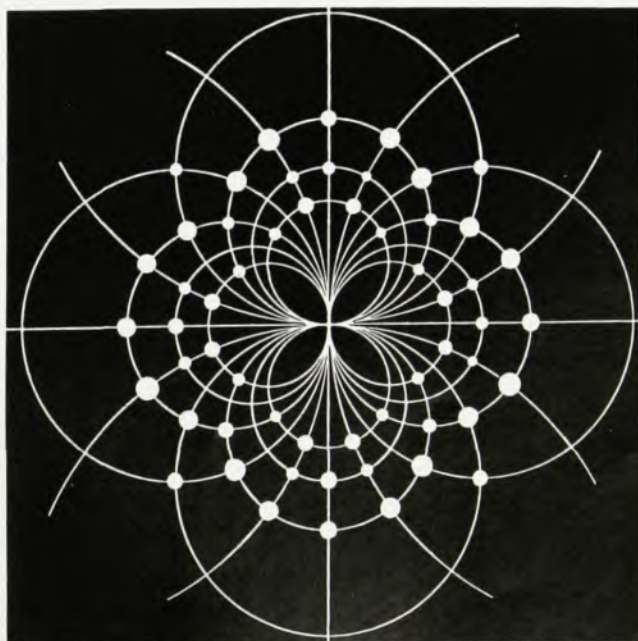
and challenge of disciplined exploration, critical boldness in theory and controlled invention in experimentation. They were obviously written by scientists, for scientists, with the unmistakable passion of involvement of head and hand. Fundamental x-ray diffraction theory is handsomely represented by the papers of Laue, W. H. and W. L. Bragg, Paul P. Ewald, Charles G. Darwin, Peter Debye and many others, a roster of x-ray crystallographic household names. The experimentalist will particularly delight in the paper of W. H. Bragg on the measurement of intensity by the x-ray spectrometer.

Among the papers are two from Japan: the first by T. Terada published in 1913, the second by S. Nishikawa in 1914. They testify to the remarkable manner in which the work of Laue, Friedrich and Knipping excited contemporary interest and research.

In short, it is easy to be grateful for the pleasures and insights of this collection, but it is not "a rather coherent text with little need for introduction or text links." Indeed the editors implicitly recognize this, for they excuse the absence of commentary, not ultimately on the absence of need but on the existence of Ewald's *Fifty Years of*

X-ray Diffraction, "an unsurpassable account of the early period." This absence of commentary is a serious shortcoming especially as the collection is, by editorial decision, not restricted to papers dealing with ideas that are still valid.

Background as provided by Ewald's illuminating comments is not an ornament but a basic necessity if this collection is to fulfill its avowed purpose. Thus, consider the sentences in Ewald's introduction to *Fifty Years of X-ray Crystallography* concerning W. H. Bragg's initial preference for the corpuscular interpretation of x rays. "It is characteristic for W. H. Bragg's unbiased way of thinking, as well as for the impact of Laue's experiment, that it took Bragg only a very short transition period for accepting the pure wave theory. . . . Only in his first letter to *Nature*, dated 18 October 1912, does he make an implicit attempt to save the corpuscular idea. . . . The same idea was expressed at the same time by another famous physicist whose previous work had also stressed the corpuscular aspect of radiation, Johannes Stark. His paper in *Physikalische Zeitschrift* (13, 973, 1912) assumes propagation of the radiation along 'Kristallschächte'—tunnels or pit shafts



Diffraction of x rays in 2.5-mm-thick rock salt, from a 1913 paper of W. L. Bragg. (Reproduced in the book reviewed on this page).

formed by the regularity of the atomic arrangement." These comments sharpen the interest in Bragg's paper and underline the significance of the Stark citation.

The editors themselves are distinguished x-ray crystallographers who have made fundamental contributions in the field. Their own viewpoints would be immensely valuable to the student and of provocative interest to those who know their work. Why did these editors choose these particular papers and abstracts from so many?

Another omission in one sense more grave than the lack of commentary is the absence of any crystallographic background. To appreciate the development of x-ray diffraction theory in crystals the physicist should be aware of the work of A. Bravais and L. Sohncke, of A. Schoenflies and E. von Fedorov, and even more he should know how much knowledge or ignorance of their studies affected the early developments. The reader should be told the significance of P. Groth's presence in Munich and W. J. Pope's in Cambridge.

One of my colleagues has stated (and I agree with him) that for many physicists the solid state is cubic, the rare and atypical acknowledge the existence of hexagonal symmetry. The physicist, therefore, who reads this collection without a crystallographic introduction will be most deprived without being aware of his deprivation.

If we could have had Ewald's comments where appropriate as well as those of the editors, this collection would have been one of the most remarkable scientific treatises of our time.

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Sundials

By Frank W. Cousins

Pica Press, New York, 1970. \$18.50

Managing Editor: What have you got there?

Book-Review Editor: It's a gorgeous book all about sundials.

ME: Sundials? Good grief, who needs 'em? They don't even keep good time, do they?

BRE: J. G. Porter says, in his Introduction here, that a properly made sundial, carefully set up, will give you the time accurate to the nearest minute. Is your watch as good as that? Apparently the eventual limit is set by the finite diameter of the sun's disc, which

gives a slightly blurred edge to the shadow.

ME: OK, but what can there be to say about sundials that's worth 247 pages and \$18.50?

BRE: Oh, there's something in here for everybody. Superb photographs of historic instruments. Quotations in prose and verse—from Ecclesiastes and Plato to T. S. Eliot and W. H. Auden. Geometrical theory of all kinds of sundials—did you know that there are horizontal dials, reclining dials, vertical dials, polar dials, equatorial and armillary dials, cross and star dials, analemmatic dials...

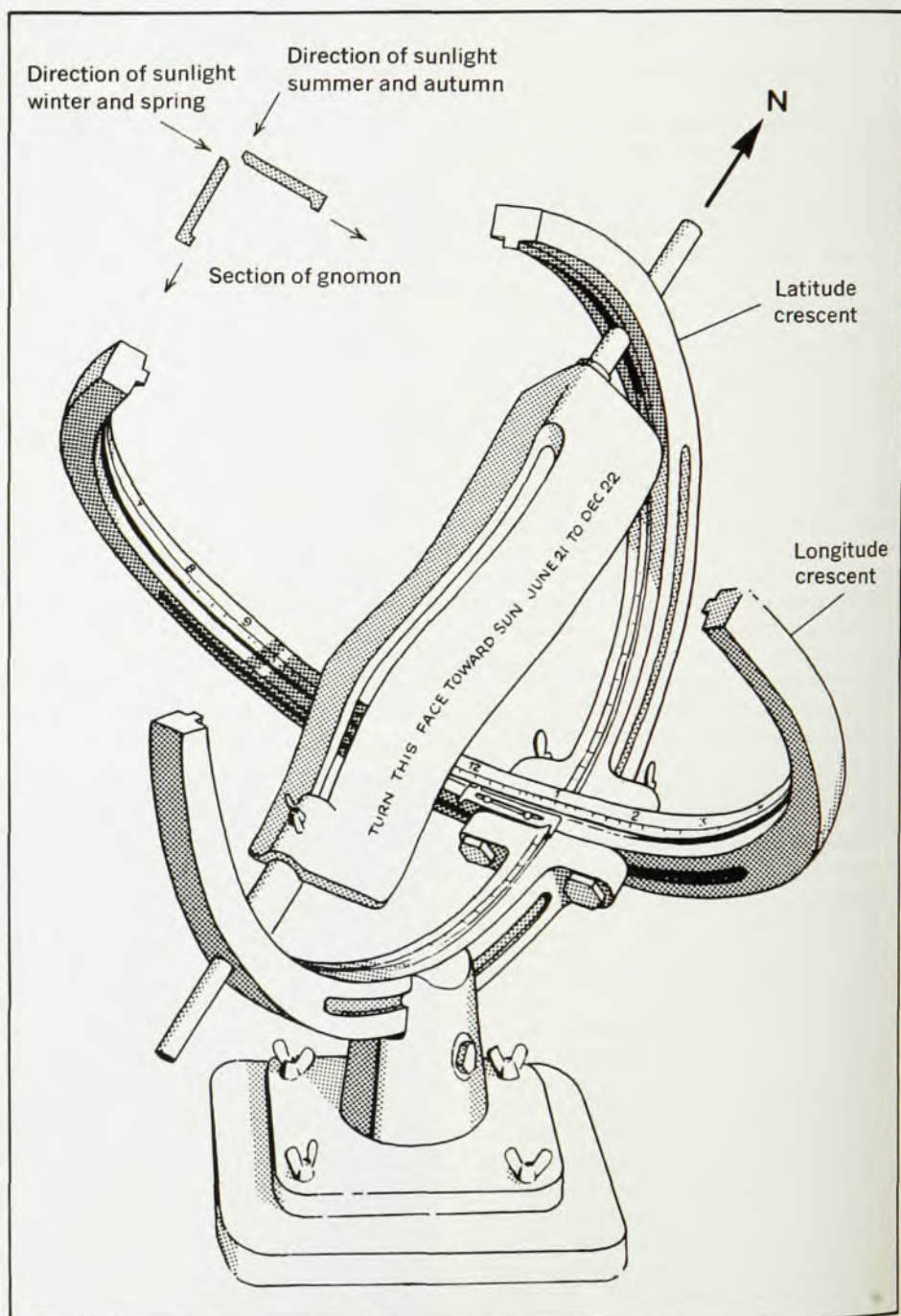
ME: Stop! Stop! But none of them are any good on a cloudy day!

BRE: He has two answers to that. One is poetic: "Horas non numero nisi serenas," which means, you unlettered scientist, "I count only the hours that are serene." Who wants to know the time on a grey day?

The other answer is more scientific. See, here is a very clever sundial invented by Sir Charles Wheatstone, which works by finding the plane of polarization of scattered sunlight. That one works even with an overcast sky.

ME: Yes, that's rather impressive. Is there nothing wrong with the book, then?

BRE: Well, Frank Cousins's writing style is rather rococo. It's fine for the descriptions of early instruments; many



Sundial, designed by R. L. Schmoyer in 1950. The time is read by turning gnomon for the minimum width of sunlight through the slot.