INTRODUCTION

Origin, Scope, and Plan of this Book

In July 1962 the fiftieth anniversary of Max von Laue's discovery of the Diffraction of X-rays by crystals is going to be celebrated in Munich by a large international group of crystallographers, physicists, chemists, spectroscopists, biologists, industrialists, and many others who are employing the methods based on Laue's discovery for their own research. The invitation for this celebration will be issued jointly by the Ludwig Maximilian University of Munich, where the discovery was made, by the Bavarian Academy of Sciences, where it was first made public, and by the International Union of Crystallography, which is the international organization of the National Committees of Crystallography formed in some 30 countries to represent and advance the interests of the 3500 research workers in this field.

The year 1912 also is the birth year of two branches of the physical sciences which developed promptly from Laue's discovery, namely X-ray Crystal Structure Analysis which is most closely linked to the names of W. H. (Sir William) Bragg and W. L. (Sir Lawrence) Bragg, and X-ray Spectroscopy which is associated with the names of W. H. Bragg, H. G. J. Moseley, M. de Broglie and Manne Siegbahn.

Crystal Structure Analysis began in November 1912 with the first papers of W. L. Bragg, then still a student in Cambridge, in which, by analysis of the Laue diagrams of zinc blende, he determined the correct lattice upon which the structure of this crystal is built. Soon afterwards he obtained the first complete structure determinations, namely of NaCl, KCl, KBr and KI, a series of alkali halides having similar structures. By this determination a scale for the measuring of atomic distances in crystals and, simultaneously, of X-ray wave-lengths was obtained. It led to the construction of the powerful instrument devised by W. H. Bragg, the X-ray Spectrometer, with which the majority of the early crystal structures were determined. It ushered in the access to a super-

stereo chemistry, in three dimensions and with quantitative determinations of atomic distances and bond angles such as had been impossible up to then. This finally led to the close link which exists nowadays between X-ray structure analysis and the physical and chemical problems of the chemical bond, problems which dominate nearly every aspect of our scientific and industrial activities, as well as the study of metabolism in man, beast and plant.

X-ray Spectroscopy deals with the emission and absorption of X-rays by and in matter. In particular, Moseley's early work showed that the already vaguely recognized 'characteristic X-rays' were a direct outcome of atomic structure and could be used to identify an atomic species. At a time when modern atomic theory was in its earliest infancy—Niels Bohr's first paper appeared in the same year, 1913, as Moseley's—the spectroscopic data on X-rays, allowing a much simpler interpretation than those on visible light, gave invaluable support and guidance for the development of the principles of the quantum theory of the atom. From this the whole of physics and chemistry profited, and again today, the greatly refined methods of experimentation and discussion bring the research in X-ray spectroscopy very close to the problems of chemical bond and energy band structure of solids.

Among the later consequences of von Laue's discovery should be named the diffraction phenomena obtained in crystals by using beams of electrons and neutrons, instead of X-rays. These two applications of very nearly the same experimental procedures and theory as for X-ray diffraction, are rapidly developing along their own lines. Each of the means of obtaining diffraction—X-rays, electrons, neutrons, and even atoms—has it own peculiarities in interacting with matter. Therefore different information can be gained by using these methods judiciously; but they all spring from the source Laue opened up.

Let us then, after ten lustrums, look back on the discovery, and on the development of Crystal Structure Analysis, of Spectroscopy, and of Crystal Optics in the widest sense. This review forms the first and larger half of this volume.

In the second half, a more personal note will be struck. There is, nowadays, a general demand for more of the human touch in presenting science to the coming generation, for more detail about the men whose memory is handed down by the laws named after them (a few, like Röntgen, even achieve the status of becoming immortalized in a unit!) but whose personality is effaced as the circle of their students

fades out. At which schools did they learn their art when they were young, with whom did they form friendships that lasted throughout their scientific life? What was their own evaluation of their work, what their hopes and their disappointments, their outlook on science and life?

Clearly the desire for a short autobiographical essay of his heroes is legitimate in one about to devote his own life to the continuation of the work they began. Would we older people not appreciate autobiographical essays from Hamilton, Kelvin, Rayleigh, Maxwell, Helmholtz; do we not appreciate those of Poincaré, Planck, Einstein, Hardy, and the popular writings of Boltzmann, Schuster and others?

Let us leave it to the historian of science at a later period to evaluate and weigh the merits of each of the pioneers of a new development with the distant objectiveness that becomes a disciple of Clio, for it would be unbecoming for us, nay, impossible, to be objective judges of our own times. But let us present him with a view, a personal and colourful view, that we have gained in our own experience and according to our own temperament. If the same facts, presented from different sides, appear contradictory, as well they may in independent autobiographical essays, let it be the historian's job to straighten this out. He will be grateful to us for attempting to offer him material and to disclose relations which he would find impossible to glean by combing the journals and books.

Part of this autobiographical collection concerns the main schools in which X-rays crystallography was developed and taught. Since these sections are written by prominent members of these schools, they may well pass as 'autobiographical' in a slightly wider sense. The autobiographical section should be considered only a first attempt of this kind of mosaic synthesis of the making of a science. Some of the main intended contributors died in the course of the preparation of this work—von Laue, Maurice de Broglie, W. T. Astbury, C. Hermann. Others could not be convinced of the usefulness of their contribution, and many who should have been asked to contribute were not approached because of the danger of exceeding limitations of space. It is the Editor's view that if this collection finds an approving response, the present commemoration volume should be enlarged and systematized in a second edition.

This book is not written for the first generation of X-ray crystallographers who grew up together with the subject, but rather for the second and later growth, and for other scientists. The Editor has tried

to keep the presentation at a level so that it can be read by the non-crystallographer who is interested in learning what this 'New Crystallography' is about. Chapters 3–6, describing the setting of the discovery and the first few years of X-ray diffraction, should present no difficulties to a scientifically minded reader. After that, in describing the further development, some technical terms and some factual knowledge of the subject seemed unavoidable. Rather than to interrupt the historical account on every page in order to explain the terms and methods newly introduced, a short account of the whole subject has been given in Chapter 7. In a way this Chapter only aims at giving the reader a condensed course in the language used later; but since for the learning of a vocabulary a background of concepts is a necessity (except for a parrot), the Chapter gives, at the same time, a very condensed and incomplete, but, it is hoped, intelligible factual survey of the field. It should be read carefully and consulted repeatedly as the reader progresses to some of the later parts of the book.