There are countries where science has at its disposal financial endowments vastly greater than those available in Great Britain, both for fundamental and for applied research. The universal tribute to the pre-eminence of British scientists in fundamental research might well remind us that in no other country does the scientist enjoy greater freedom of investigation and communication, despite all the invasions of that freedom by secrecy requirements arising out of considerations of national security, from which Great Britain, as also other countries, is not immune. So at this time the scientist might well reflect further whether there is not some connexion between that liberty and the nature of our whole system of government of which her gracious Majesty is the titular head.

Between systems of government and the spirit of the communities which they serve there is in fact a close, if intangible, connexion. The scientist never had more reason than to-day for appreciating that, while his professional activities are influencing the community more closely than ever, they are in turn conditioned by the spirit and outlook of the society in which he works and upon whom he depends for support. It is not simply that, to an increasing extent, even fundamental science depends upon public funds for support: the fields in which science can advance, and the rate at which the results of scientific advance are applied, are determined increasingly by public opinion. Indeed, in more countries than one it has become evident that there is real danger that scientific advance may be impeded by mass hysteria and misunderstandings amounting to what has been an antagonism which may constitute a definite anti-scientific trend.

It is in such circumstances that the amateur tradition of science is so important. Scientific advance has always owed much to the work of the amateur. That is still true to-day; and particularly science depends upon the help of the amateur in spreading an understanding and appreciation of what science is doing and the benefits it could bring to mankind. For this reason it is appropriate to recall, as Sir Arthur MacNalty does on p. 951 of this issue, the encouragement which the sovereigns of this realm have given to the pursuit of science and its teaching. The interest and understanding which Queen Elizabeth showed earlier this month at the Royal College of Surgeons was only the latest of a number of occasions on which she and her husband, the Duke of Edinburgh, have given encouragement which scientists, and perhaps especially it should be mentioned, the younger scientists, deeply appreciate and will ever remember.

Lastly, with a Sovereign who has herself shown her interest in science by accepting the fellowship of the Royal Society, the comparisons commonly being made between the present time and the first Elizabethan age cannot but stir the imagination of the historically-minded scientist. When the first Elizabeth ascended the throne, the founding of the Royal Society lay a full century in the future. Already, however, the discovery of America and the circumnavigation of the world had widened men's horizons, and the new learning, notably through the work and teaching of the Oxford 'humanists', More, Grocyn, Colet and Linacre, had started a ferment in men's minds which led in due course to Bacon's "New Atlantis" and to Newton.

No more than the first Elizabethans can we yet discern the new age that is waiting to be born. During the past four centuries, the limits of the physical world have been well-nigh explored. Save for Everest and the increasing mastery of the air, the feats of geographical exploration seem to have been accomplished, and it is with the world of the minute that the future seems likely to be most intimately concerned, whether we think in terms of nuclear research leading to the atom bomb or industrial power, or the way in which the electron microscope and other new tools are laying bare the structure of living tissues. Wherever that may take us, it is increasingly clear that not in the physical world will man find the wisdom and understanding that will enable him to face the future with courage and confidence. The foundation of society in the new Elizabethan age is to be found in the same moral and spiritual values that inspired the greatest of our forbears of that earlier age. The solemnity of the Coronation should take our minds back to that central truth, and as we pledge our loyalty to the Queen who is to be crowned on June 2, we should remember also that in such loyalty and in the respect for and clearer understanding of human values lies the condition both of scientific advance and of social well-being and order.

INTERNATIONAL TABLES FOR X-RAY CRYSTALLOGRAPHY

International Tables for X-Ray Crystallography (Published for the International Union of Crystallography.) Vol. 1: Symmetry Groups. Edited by Norman F. M. Henry and Kathleen Lonsdale. Pp. xi+558. (Birmingham: Kynoch Press, 1952.) 105*s*.

At a conference in Zurich in 1929 an international group of X-ray crystallographers met to work out the plans for a standard set of tables on space groups and of functions and data needed in practical crystal-structure analysis. The need for such tables arose in the minds of all those who were authors or prospective authors of books on structure analysis. At that time the application of space-group theory had become an accepted practice; furthermore, experimental methods had been standardized and corrections devised for obtaining the most accurate data. In a text-book, therefore, the author had either to include a great volume of already published tables, or to put up with the fact that his book could not be of practical use. Besides, different formalisms and nomenclatures were likely to spread and become firmly established in the schools of the various countries, and this was apt to lead to a great complication of the international literature. The establishing of a single plan for the tables required some sacrifice of pet ideas on the part of each of those who took part in the planning, but the result of the conference and of the subsequent work of the various schools, the "Internationale Tabellen zur Bestimmung

von Kristallstrukturen" (Borntraeger, Berlin, 1935; referred to later as "Tab.'35"), have fully justified the advantages of the give-and-take then exercised. Not only have these tables in the original edition and in a war-time photo-offset re-issue done great service in all X-ray analysis laboratories as well as in the teaching of students, but they have also led to a great saving of effort by the acceptance of standard symbolism and methods.

In the twenty years that have passed since the preparation of "Tab.'35" enormous progress has been made in the development and application of new methods of crystal-structure determination, such as the development of new instruments (Buerger precession camera, Geiger counter technique), computing techniques (punched card methods) and theoretical methods (phase inequalities, statistical detection of symmetry elements, Fourier refinement methods). It seems natural that a full re-edition of such tables would be preferable to a minor revision. Besides, the ground had meanwhile been prepared for an easier co-ordination on an international scale than was possible by individual initiative in 1929. The International Union of Crystallography at its very foundation (London 1946, Harvard 1948) set up a committee to prepare a modern set of tables, and, thanks to the untiring activity of its chairman, Prof. Kathleen Lonsdale, the committee has now published the first of the three volumes which will form the complete work.

To start by the 'habit', the volume of five hundred pages is beautifully published for the Union of Crystallography by the Kynoch Press. Paper, binding and print are an impressive sample of craftsmanship, and no misprints have been noticed. The layout, especially for the simpler space groups, is lavish, with an impeccably white lower half of the page inviting one to scribble down notes. The price is kept low by subsidies which the Union received from the United Nations Educational, Scientific and Cultural Organization and from United States sources through the United States National Committee for Crystallography.

Vol. 1 of "Tab.'52" presents the symmetry groups in fundamentally the same way as Vol. 1 of "Tab.'35". The bulk of the volume is formed by the description of each of the 230 space groups. Most of the figures of "Tab.'35" have been taken over; changes had to be made in cases where a more extended description was given, for example, in referring rhombohedral groups to hexagonal axes. The figures for cubic space groups have been omitted. Now it is true that in the cubic system figures are necessarily more schematic than in systems where the presence of at least one singular direction facilitates the orientation; yet I must confess that I feel rather lost without the neat figures of "Tab.'35" by which M. Mauguin found an acceptable solution to an intricate problem of spatial representation. Co-ordinates require careful reading, whereas the diagrams give at a glance a vivid impression not only of the equivalent positions but also of the right- or left-handedness of the surroundings of each equivalent atom.

A major change from "Tab.'35" is the partial separation of the space-group descriptions in physical space from the equivalent in Fourier space: the structure factors are collected for all space groups in Table 4.7 (150 pages), whereas the 270 pages of space-group description, forming Table 4.3, after listing the co-ordinates of equivalent points, do not go beyond a listing of the absent reflexions, omitting previously listed information (for example, subgroups) which was considered of minor practical value. While the present separation and curtailment may not inconvenience the practical worker, yet the old arrangement had the unquestionable advantage of offering at one place a complete dual description of each space group in crystal and in Fourier space.

In the monoclinic system the twofold symmetry axis is traditionally taken as the *b*-axis; this orientation is generally accepted throughout the older crystallographic and mineralogical literature. On the other hand, a unique axis is taken as the *c*-direction in all other crystal systems, and the derivation and handling of space groups is slightly more unified if this convention is also adopted in the monoclinic system. The authors of "Tab.'52" have tabulated monoclinic groups in both settings. It is to be hoped that the users of "Tab.'52" will be aware of the recommendation of the Stockholm Assembly (see *Acta Cryst.*, **4**, 569; 1951) that "the use of the *c*-axis as the unique axis is acceptable where there is a special reason for this setting, in which case the reason should be stated". Normally, therefore, the second setting should be used in "Tab.'52" so as to avoid a clash with the very extensive existing literature.

Among the novel material of the space-group tables a list of the symmetry properties of $|F|$ must be mentioned. For $P4_3$, for example, this takes the form:

$$|F(hkl)| = |F(\bar{h}\bar{k}\bar{l})| = |F(h\bar{k}\bar{l})| \neq (F(\bar{h}kl)|;$$
$$|F(\bar{h}kl)| = |F(h\bar{k}l)|.$$

This statement is far from expressing completely the symmetry properties of $|F|$. What about $|F(hkl)| = |F(khl)|$, the result of the fourfold axis? Throughout the reported symmetry relations, the order of the indices (hkl) in the argument of F is preserved; in other words, only the symmetry of $|F|$ which is caused by twofold axes or x, y, or z reflexion planes is listed. On the other hand, the obvious centro-symmetry of $|F|$ is repeated for every single space group. The extensive introductory note of the structure-factor tables offers no help in understanding the principle of this selective listing of the symmetry of $|F|$.

Some tables of "Tab.'35" have been omitted as being of minor practical value: these are mainly the collective tables on lattice complexes, which formerly occupied twenty-six pages, and the list of lattice complexes, non-generating symmetry elements and sub-groups which were provided under the heading of each space group. Part of this material is offered in a condensed form in Table 5.2 (three pages) on sub- and super-groups of the space groups. References in the explanation of this table might well have included "Tab.'35", where a full list is to be found.

The progress in methods of using experimental data is reflected in the inclusion of the expressions for Fourier synthesis, that is, the explicit form of the Fourier series for $\varrho(x, y, z)$ in each space group. This important information was not contained in "Tab.'35" and was first published in Prof. Lonsdale's "Structure Factor Tables" (George Bell and Sons, Ltd., 1936). Also new are Tables 5.3 (space-group determination by methods outside the Friedel law) and 5.4 (inequalities arising from symmetry elements), both occupying about one and a half pages. The latter

lists the special forms of Harker–Kasper inequalities in the presence of symmetry elements; the former section is mainly a description of the statistical treatment of intensities along the lines inaugurated by Dr. A. J. C. Wilson.

Further welcome additions are tables on the space groups of lower dimensionality, namely, the two linear and the seventeen planar groups (that is, the two groups on a line and the seventeen groups in a plane). These are important for the classification of the symmetry of projections of space groups or of sections through space groups, and have been fully tabulated. Of perhaps greater physical importance are the groups with one translation (seven in the plane (borders), thirty-one in space) and the eighty groups (nets) with two translations in which the particles are allowed to lie in three-dimensional space (for example, a woven tissue). These have been mentioned but not tabulated in the note on p. 56; more general knowledge of these groups seems desirable, and inclusion in the present volume would have greatly improved their accessibility.

The text explaining the tables and their use is clearly and carefully written; it offers more explanation than that of "Tab.'35". Altogether, one notes the tendency to facilitate the use of the tables by workers who have little more than a general idea of space groups. This is an acknowledgment of the fact that this rather mathematical tool is being used to an ever-increasing extent by chemists and biologists whose main training cannot include the details of an intricate mathematical theory. Examples of the use of the tables are often given, and I agree wholeheartedly with this; on the other hand, I feel strongly that a volume of tables should not attempt to teach methods, like a text-book. Neither is it the place for a historical article surveying the development of space-group theory and crystal-structure analysis (pp. 1–5). A very welcome innovation, however, is the last table, Table 7 (five pages), which is a dictionary of crystallographic terms in English, French, German, Russian and Spanish; this in a way replaces the trilingual text of "Tab.'35". The rather embryonic dictionary seems to be limited to terms occurring in the text of Vol. 1, but it is a good start for a more general dictionary of terms likely to be encountered in papers on structure analysis. Some rather unusual German terms and others which have been omitted have been noted: for 'Habit' *Tracht* should have been given, since *Habitus* is easily recognizable. The expression *Hydrostatischesmodul* (*sic*) for *Kompressionsmodul* is unlikely to be encountered. The use of *Stab* for line in *Reflexionsstab* and in *Symmetriestab* is new to me, but may be a modern development. Thermal vibration is usually *Wärmeschwingung*, and the correct rendering of 'moving-film method' would be *Goniometermethode* and not the impossible *bewegend-Film-Methode*.

The foregoing criticism of detail should not detract from the fact that the authors and in particular the editors, Dr. N. F. M. Henry and Prof. K. Lonsdale, have performed a splendid and most unselfish service to the large group of crystallographers who benefit by the use of such tables. The new work is an adaptation of the results of theory by experimentalists of long standing for the benefit of experimentalists, and is based on the experience obtained with the older set of tables. Some innovations are obvious improvements, others appear questionable, but only the prolonged use of the tables will bring out fully their virtues and their foibles.

P. P. Ewald

ADVANCES IN AGRONOMY

Advances in Agronomy

Prepared under the auspices of the American Society of Agronomy. Vol. 3. Edited by A. G. Norman. Pp. x+361. (New York: Academic Press, Inc., 1951.) 7.80 dollars.

MANY sciences now have their annual volumes of "Advances", consisting of summaries of particular sections of the subject written by specialists. Agronomy, the study of crop production and soil management, began to be so surveyed in 1949 by the American Society of Agronomy with authors working under Dr. A. G. Norman as editor. The third volume has now appeared. In so wide a field there is abundant choice of material, and almost any subject considered over an area as varied in its conditions as the United States presents a formidable array of data, with the result that most of the contributions are necessarily lengthy and carry numerous references to the literature. Papers such as that on the subsoil, and one dealing with the chemistry of soil potassium, are not, nor are they intended to be, easy reading. The student has to work for his information, but the material is clearly set out to enable him to do so.

In addition to the two papers mentioned above dealing with various aspects of the soil, two deal with legume and herbage plants, two with systems of management of soil conservation and irrigation, and one with a disease problem—the control of soil nematodes. Vol. 3 also contains an excellent survey of recent changes in British agriculture by J. A. McMillan, of the National Agricultural Advisory Service.

In evaluating soil the surface soil commonly receives more attention than the subsoil. It is true that as a seat of soil nutrients the subsoil is generally, though not always, much inferior to the surface, but its properties in respect of root penetration and drainage are of great importance. In the article on this the author deals with the physical properties, clay minerals and fertility-levels of subsoils in the broad soil classes of the United States and discusses at length the characteristics of the various subsoil pans that occur. Interesting sections deal with the difficult and sometimes unsolved problems of the management of subsoils exposed by soil erosion, and the bad effects of subsoil compaction caused by the use of heavy tractors, especially in wet conditions.

A comprehensive paper on soil conservation summarizes the position reached and scientific problems raised by work carried out under the large government schemes that have operated since 1933. The problems are not entirely technical; in fact the most obstinate ones arise from the fact that no farmer takes kindly to alterations in his system which cost money, involve learning fresh skills and may, at the outset at any rate, result in lower returns.

Rather similar treatment is accorded to the subject of irrigation and soil research. The emphasis here is on the need for complete and reliable scientific information derived from both laboratory and pilot farms before a big scheme is launched. This applies to surface irrigation in the arid areas and also to overhead supplemental irrigation in wetter districts. The modern factorial field experiment is essential in studying the inter-relation of fertilizers, water supply and cultivations. The effect of big schemes on the water economy of whole districts needs to be looked into.

A very readable article on chemical treatment of the soil for nematode control shows that soil fumiga-