ones. World-wide comparisons are particularly fruitful in the conservation field, and they show clearly that even government agencies and large undertakings are still clinging to methods equivalent to the bow-and-arrow stage in warfare. Both the International Union and national conservation agencies will need to be strengthened to find the right answers and to see that they are put into practice. The high technical quality of the Edinburgh meeting and the impressive representation of the various professions concerned gives encouragement to believe that they will not fail.

The meeting was accompanied by an international film week, at which a wide range of films was shown from countries as far apart as India, Japan, the U.S.S.R., South Africa and Canada, illustrating the increasing potentialities of colour films for scientific as well as education and propaganda purposes. The effects of fire, erosion, pollution and destruction of plant and animal life were vividly illustrated. One general comment was that in too many cases the skill and thoroughness exhibited in obtaining the pictures was not yet matched when it came to cutting and editing the material. As a result of these comments, progress in this direction can be confidently expected.

About 180 photographs of mammals, reptiles, birds, insects and plants were exhibited from the British National Collection of Nature Photographs, newly formed by the Nature Conservancy, and the Royal Scottish Museum arranged an interesting exhibition on "Man and the Balance of Nature" which included a good deal of material from the recent International Exhibition organized by the International Union for the Conservation of Nature and Natural Resources in Paris.

The papers and discussions of the technical meeting will be published as soon as possible, but in the meantime the Nature Conservancy would be glad to reply to any inquiries, addressed to it at 19 Belgrave Square, London, S.W.1.

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

MEETINGS IN MADRID

THE meetings of the International Union of Crystallography held in Madrid during April 2–7 were a departure from the previous practice of the Union in several ways. For the first time, the main interest of the symposium was not focused on structure on a molecular scale, but on structure on a scale intermediate between molecular and optical-microscopic. Also for the first time, two of the Commissions of the Union organized an extended series of open meetings. The programme was very crowded, and even with the help of colleagues I am able to give only an incomplete account.

Teaching of Crystallography

The Congress of the Union held in Paris in 1954 saw the beginning of the present general interest in the teaching of crystallography and the establishment of a Commission[1] on such teaching. In preparation for the Madrid meetings, this Commission had circulated a questionnaire, and from the replies and the statements given by several national representatives it was obvious that crystallography, though it grew suddenly out of the morphological stage as long ago as 1912 and has made swift progress since, has not received full academic recognition even yet. Full courses in crystallography at the undergraduate level are extremely rare, and most of the undergraduate teaching given elsewhere is slight and incidental to studies in the older sciences. The best opportunity for serious study of, and training in, crystallography is postgraduate, and the prior training in other subjects is a great advantage. For crystallography embraces a field far wider than is often realized—even by those engaged in other sciences—and far wider than its name suggests. In just over forty years we have gained an insight into the variety of structures, perfect and imperfect, and into the structural reasons for the chemical and physical properties of solids, that far outstrips our knowledge of liquids and gases. This new insight is being rapidly exploited by industry, but scarcely any use has been made of it in modern presentations of the established sciences.

It was generally agreed that, instead of trying to squeeze formal courses on crystallography into the already overcrowded degree courses, it would be both easier and more natural to introduce it incidentally and gradually, thus making the student structure-conscious even from his school days. The preciseness of crystal models and the directness of this approach could transform completely much of the teaching of the basic chemical laws, and at the university degree level could simplify the presentation of material in many subjects. In some subjects, such as physics, the emphasis would be less on the diversity of structures and more on the relations between structure and physical properties (especially anisotropic properties), and on diffraction phenomena in two and three dimensions. Mineralogy has had, of course, the closest academic relation with crystallography, but it is remarkable how many departments still concern themselves mainly with morphological and petrological techniques, paying scant attention to structure and its connexions with geochemistry—and (so it would appear from the discussions in Madrid) even less to the techniques of structure analysis. On this point, contributions at the meeting from the U.S.S.R. were especially interesting. The bias of Russia has been traditionally mineralogical, but for the few who undertake the very extensive courses the training is comprehensive and modern. In Europe generally there is great variety in the approach, and the extent of training is dependent on local educational tradition and personal initiative. In North America there are a very few, and very good, schools of crystallographical research and postgraduate teaching, but very little is done at the undergraduate level. Japan is worthy of mention for the scale and quality of its post-war work in crystallography, but it is not clear how far the subject has penetrated into undergraduate teaching.

The ideas exchanged at Madrid on the order of presentation and on teaching aids were valuable, and showed that, despite the variety of contexts in which the subject is introduced, geometrical concepts are the most important and usually the earliest topics treated, with crystal chemistry a close second. Crystal physics, except perhaps for crystal optics, is usually a poor third.

There is no shortage of good text-books for the specialist student, but there is an urgent need for the provision of new or revised text-books for college, school and, indeed, general use. These should rely much more on the structural approach to chemistry, physics, metallurgy, mineralogy and biology.

Apparatus

The papers on crystallographical apparatus were mainly concerned with advances in techniques in powder diffractometry and with the development of X-ray tubes and associated equipment. The properties of the various quantum-counting devices used in diffractometry have now been investigated in detail over the X-ray range of wave-lengths, and it appears that the thallium-activated sodium-iodide scintillation counter, used with a pulse-height analyser, has considerable advantages over the Geiger or the proportional counter[2]. The analyser, when set to accept the proper range of pulse amplitudes, is very effective in reducing background from diffuse scattering of the continuous spectrum, from specimen fluorescence, and from radiation other than X-rays. The high quantum efficiency of the scintillation counter, and its uniform response over the range of X-ray wave-lengths normally used, gives it a uniformly high figure of merit (based on equal weights for observed counting rate and peak-to-background ratio), and makes it very suitable for fluorescence analysis as well as for powder and single-crystal diffraction work.

The application of focusing monochromators to the improvement of powder diffractometry has also received a good deal of attention. In one of the more promising arrangements the specimen is used in transmission with a reflecting monochromator placed in the divergent diffracted beam; a standard diffractometer can readily be adapted for this. Though the peak intensity (for values of 2θ between 15° and 85°) is lowered by a factor of about two, the non-characteristic background is eliminated, and the lines are considerably sharper than with the standard arrangement set for maximum resolution. Since preferred-orientation effects are reversed in transmission, this arrangement, in conjunction with the standard one, provides a sensitive means for detecting preferred orientation in a given specimen. In another arrangement the monochromator is placed between the source of X-rays and the specimen, which is examined in transmission. This method has advantages for low-angle work.

The development of fine-focus X-ray tubes has given rise to new problems in the design of both tubes and auxiliary apparatus. A focal spot of ideal shape and brilliance is difficult to obtain, and when a line focus is required, various aberrations arise very readily. The design of line-focus tubes was discussed, and characteristic examples of aberrations and their correction were illustrated. It was emphasized that, to use these tubes to the best advantage, the tube and the diffraction camera need to be designed as a single instrument. A Weissenberg camera with film radius 1 cm., and an axial retigraph with specimen-to-film distance 1 cm., were noteworthy examples. Improvements in the design of rotating-anode tubes were also described.

Single-crystal counter diffractometry continues to develop, and some account was given of an arrangement in which the mechanical precision required is less than in earlier equipment, so that its construction is practicable in small workshops.

Analysis of biological specimens can be carried out on the electron microscope by taking photographs with three different beam velocities; these photographs are used to produce a composite coloured image of the specimen. The different colours are characteristic of the atomic numbers of the elements present and indicate their distribution in the specimen.

A simple analogue computer[3], based on two d.c. bridges, was described. In its general form the machine will give the product of three sine or cosine terms, so that it can be used for calculations of structure factor, Patterson function or electron density, although the computer that has actually been constructed was specially designed for the calculation of structure factors.

Structure

Individual papers in the symposium on structures on a scale between the atomic and microscopic dimensions were of great interest. Perhaps because it was a first attempt to organize a symposium in this dimensional range, it was a little difficult to discern a 'structure' in their order of presentation, and one was left with a somewhat scrappy impression of the field. The most impressive were the papers on proteins and sub-proteins, investigated both by electron microscopy and by X-ray diffraction. There was an interesting group of papers on the structure of collagen, including a demonstration of the equivalence of the results obtained by the two methods. Another group of papers was devoted to viruses[4]. Consideration of the structure of molecular viruses led to some interesting applications of point-groups, including a cubic point group, 532, possessing a five-fold axis[5].

The papers on metals showed extreme diversity, from surface films through tin whiskers to more conventional structure work on phases with very large unit cells. Work on field-emission microscopy[6] was noteworthy. The investigation of structure and structural imperfections in metals at 5° K. was interesting both for its results and for the ingenuity of the apparatus, which provided for cold-working the specimens in the spectrometer at the low temperature.

The work on proteins and metals formed two reasonably consistent groups, although the arrangement of the programme somewhat obscured this. There were, in addition, a large number of papers difficult to classify, on topics ranging from commercial greases to orientation of cellulose in filamentous algae. One was led to wonder if a number of smaller meetings, more restricted in scope, with a single subject only claiming attention at any one time, would not be more valuable than a large conference with several simultaneous sessions.

A. J. C. Wilson

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