

electron-density map or by differential synthesis (Booth, 1946*b*). For orthorhombic cells (or monoclinic with  $\beta$  nearly  $90^\circ$ ),

$$\sigma_x = \sigma(A_x)/A_{xx}.$$

To these errors the random errors of computational rounding-off must be added. With three-figure computing methods these will be negligible. An analysis, unfortunately not reducible to a simple formula, shows that using two-figure Beevers-Lipson strips the computing error for dibenzyl (Jeffrey, 1945, 1947) is  $\sigma_x = 0.004$  A., roughly half the other random error.

As the number of  $\Delta F$ 's involved is large, the probability distribution for the random errors is Gaussian, so that significance levels are easily obtained from error functions. Suppose that a bond length  $A$  is found to be  $a$ , with s.d.  $\sigma_a$ , and that another bond length  $B$  (in the same or a different structure) is  $b$  ( $<a$ ), with s.d.  $\sigma_b$ , and that it is wished to test whether  $A$  is significantly longer than  $B$ . If  $A$  has the same actual bond length as  $B$  the probability that its observed length should, on account of random errors, exceed that of  $B$  by  $(a-b)$  or more is

$$P = \frac{1}{2} - \frac{1}{\sqrt{\pi}} \int_0^x \exp[-t^2] dt = \frac{1}{2} - \frac{1}{2} \operatorname{erf} x,$$

where

$$\sqrt{2} x = (b-a)/(\sigma_a^2 + \sigma_b^2)^{1/2}.$$

Values of  $P \leq 0.01$  are commonly taken as indicating a significant difference between  $a$  and  $b$ , and  $0.01 < P < 0.05$  as 'possibly significant'.

We illustrate the method by examining the central C-C bonds in dibenzyl. Using punched card methods, similar to those described by Cox, Gross & Jeffrey (1947), but adapted for differential syntheses, the bond lengths after

correction for finite series are found to be  $C'_1-C_1 = 1.510$  A. (across the centre of symmetry), and  $C_1-C_2 = 1.523$  A. The problem is, are these lengths significantly less than the C-C single bond as found in diamond (1.5445 A. with an error which is negligible for our present purpose (Lonsdale, 1947)? The random error was found to be  $\sigma_x = 0.0074$  A.; hence the s.d.'s of the bond lengths are respectively  $2 \times 0.0074$  A. (since the peaks are symmetrically dependent), and  $\sqrt{2} \times 0.0074$  A. Applying significance tests we find  $P = 0.010$  and  $0.020$  respectively. For the difference of the angle  $C'_1-C_1-C_2$  from the normal tetrahedral angle we find  $P = 0.00024$ . Statistical analysis thus gives confirmation to the conclusion (Jeffrey, 1945, 1947) that these bonds are different from C-C single bonds.

The assumptions made in the treatment of errors outlined above may not be universally valid; this and other points will be discussed in a detailed account of accuracy problems now being prepared.

These investigations were made possible by a grant from the Department of Scientific and Industrial Research for which we express our thanks.

## References

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## Notes and News

### International Union of Crystallography

#### *Statutes and By-Laws*

The Statutes and By-Laws of the International Union of Crystallography, as adopted on 31 March 1947, are printed below. Copies of these Statutes and By-Laws may be obtained from the General Secretary (R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England).

#### STATUTES

##### I. *Objects of the Union*

1. The objects of the Union are:
  - (i) To promote international co-operation in crystallography.
  - (ii) To promote international publication of crystallographic research and of crystallographic works.
  - (iii) To facilitate standardization of methods and of units in crystallography.
  - (iv) To form a focus for the relations of crystallography to other sciences.
2. The Union is a member of the International Council of Scientific Unions.

##### II. *Membership*

3. A country adheres to the Union through a National Committee duly recognized by the General Assembly. Each National Committee represents Crystallography in its own country.
4. The term 'country' shall be understood to include Dominions, Colonies, Protectorates and any dependencies which budget independently for scientific purposes.
5. Each country may adhere to the Union in any one of eight Groups I-VIII with corresponding voting powers and contributions as set out in paragraphs 8 and 10.
6. A country may select different Groups for general purposes and for individual special projects. The National Committee of each country shall inform the General Secretary at the beginning of each General Assembly of the Group, or Groups, adopted for the period to the next General Assembly.

##### III. *Administration*

7. The work of the Union shall be directed by the General Assembly of delegates appointed by the National Committees.
8. Voting at General Assemblies shall be by countries,

which shall have votes in accordance with the Group in which they adhere, as follows:

Group	I-III	IV-VI	VII, VIII
Number of votes	1	3	5

The National Committee of each country shall make known to the President the names of the delegates appointed to vote on behalf of that country.

Any adhering country not represented may forward its votes to the President by post, and such votes shall be valid if received before the votes are counted.

9. The General Assembly may formulate By-Laws on any matters not covered by these Statutes.

#### IV. Finance

10. Each adhering country shall pay an annual subscription in accordance with the Group in which it adheres, as follows:

Group	I	II	III	IV
Number of unit contributions	1	2	3	5
Group	V	VI	VII	VIII
Number of unit contributions	7	9	12	15

11. The unit contribution shall be quoted in gold weight.

12. The financing of special projects of the Union may be kept distinct from General Expenditure, and a country adhering to the Union shall be pledged only for the General Contribution.

13. The National Committee shall be responsible for the payment of annual subscriptions according to the Groups adopted. These subscriptions shall be paid during the calendar year to which they apply.

14. Any country which is in arrears with its contribution for two years shall be warned and shall be deprived of its voting power. Any country which is in arrears for four years shall cease to be a member of the Union.

15. In the event of dissolution of the Union its funds shall be made over to scientific organizations nearest in their aims to those of the Union.

#### V. Statutes

16. Changes in the Statutes may be proposed by the Executive Committee of the Union or by any of the National Committees. Notice of such proposed changes shall reach the General Secretary at least three months before a General Assembly. No change shall be made in the Statutes except at a General Assembly and with the approval of two-thirds of the votes of the adhering organizations.

#### VI. Duration of the Union

17. The duration of the Union is not limited.

18. The Union shall not be dissolved except at a General Assembly and with the approval of two-thirds of the votes of the adhering organizations.

#### VII. Authoritative Text

19. The present English text of the Statutes shall be considered the authoritative one.

## BY-LAWS

### I. Administration

1. The General Assembly shall normally meet every three years. If the date and place of the meeting have not been previously decided, they shall be determined by the Executive Committee and notice shall be dispatched to adhering organizations at least six months in advance.

2. Commissions and National Committees of the Union may propose business to be transacted at General Assemblies. Such proposals shall reach the General Secretary at least fourteen weeks before the meeting.

3. The agenda of business to be transacted at General Assemblies shall be determined by the Executive Committee and shall be dispatched to adhering organizations at least ten weeks before the meeting. No question which has not been placed on the agenda shall be discussed or put to the vote unless a proposal to that effect be approved by a majority of the votes of adhering organizations represented at the meeting.

4. The President may invite any scientist to an ordinary meeting of the General Assembly. Such invited guests may take part in the discussions, but shall have no power of voting.

5. The General Assembly shall

- (i) give recognition to the National Committees;
- (ii) elect the Officers of the Union;
- (iii) elect two members of the Finance Committee;
- (iv) elect Commissions of the Union and determine their terms of reference;
- (v) determine the projects which shall be financed independently of general expenditure;
- (vi) receive reports on the activities of the Union and of its Commissions;
- (vii) receive the budget and determine the unit contribution for general expenditure and for special projects;
- (viii) determine the general policy and the timetable for the period to the next General Assembly.

6. The Officers elected by the General Assembly are:

- (i) the President;
- (ii) two Vice-Presidents;
- (iii) the General Secretary;
- (iv) two representatives of the Union on the International Council of Scientific Unions;
- (v) the Chairmen of Commissions of the Union;
- (vi) a representative of the Union from each Joint Commission with other Unions.

These officers are referred to as the Officers of the Union and constitute its Executive Committee. They hold office until the close of the ordinary General Assembly following that of their election. The President and Vice-Presidents are not eligible for re-election to the same office. Other Officers are immediately eligible for re-election.

7. The Executive Committee may fill by co-optation any vacancy occurring in its body. Any persons appointed shall hold office until the close of the next ordinary General Assembly.

8. Any officer unable to attend meetings of the Executive Committee may delegate his powers, including his vote, to a deputy duly nominated by him in writing.

9. The Executive Committee shall present an annual report to each National Committee and shall also report on its activities to the General Assembly. The report to the General Assembly shall be dispatched by the General Secretary to National Committees at least ten weeks before the meeting.

10. The President, on the advice of his fellow Officers, may call Extraordinary General Assemblies; he shall call such Assemblies at the request of not less than half of the adhering organizations.

11. The agenda of business to be transacted at Extraordinary General Assemblies shall be determined by the Executive Committee and shall be dispatched to adhering organizations at least four months before the meeting. No question which has not been placed on the agenda shall be discussed or put to the vote unless a proposal to that effect be approved by a majority of the votes of adhering organizations represented at the meeting.

## II. President

12. The President is Chairman of the General Assembly and of the Executive Committee. He is the legal representative of the Union and its supreme representative in dealing with other bodies. He is an *ex-officio* member of all Commissions of the Union.

13. The President, with the approval of the Executive Committee, may delegate specified parts of his powers and duties to other members of the Executive Committee.

## III. General Secretary

14. The General Secretary is responsible for conducting the ordinary business of the Union and for keeping its records. He is an *ex-officio* member of the Finance Committee and of all Commissions of the Union.

## IV. Commissions of the Union

15. The Commissions of the Union established by the General Assembly may co-opt further members and shall generally have full freedom in arranging their internal structure and work. They may formulate their own Statutes and By-Laws within the framework of the Statutes and By-Laws of the Union. If special funds are provided for their use, they may make their own financial arrangements, subject to the approval of the Finance Committee.

16. The Chairman, or in the case of Joint Commissions one representative, shall forward records of all meetings of the Commissions to the General Secretary and shall report on the activities of the Commissions to the General Assembly. The report to the General Assembly shall reach the General Secretary at least three months before the meeting and shall be dispatched by him to adhering organizations at least ten weeks before the meeting.

## V. Finance

17. The Executive Committee shall prepare an estimate of the budget for each of the years between the next General Assembly and that following it. The Finance Committee shall examine this estimate and also the accounts for the years preceding the last General Assembly, and shall submit separate reports on these two questions

to the General Assembly. These reports shall reach the General Secretary at least three months before the meeting and shall be dispatched by him to adhering organizations at least ten weeks before the meeting.

## VI. Authoritative Text

18. The present English text of the By-Laws shall be considered the authoritative one.

## *Acta Crystallographica*

Since the publication of Part 1 of this *Journal* a further generous contribution towards the cost of production has been received from the North American Philips Co. Inc., Mount Vernon, N.Y., U.S.A.

## Bubble model of a metal

Messrs Kodak Ltd. of Harrow, Middlesex, England, announce the production of a 400 ft. 16 mm. black and white film with the above title. The film has been prepared in collaboration with Sir Lawrence Bragg and J. F. Nye and illustrates a bubble model of the crystal structure of a metal (W. L. Bragg and J. F. Nye, *Proc. Roy. Soc. A* (1947), **190**, 474). It shows the assemblage of small bubbles representing a metal structure and displays the manner in which they simulate such effects as grain boundaries, dislocations and other types of fault, slip, recrystallization, annealing and strains due to foreign atoms.

The price of the film in Great Britain is £8, and it is sold under reference Kodagraph No. 2015. Distribution in the U.S.A. will be through the Eastman Kodak Co., Rochester, N.Y.

## Summer school in metal physics

The Board of Extra-Mural Studies of the University of Cambridge, England, announces that by courtesy of Sir Lawrence Bragg a Summer School in Metal Physics will be held this year in the Cavendish Laboratory.

The School will provide an introduction to the application of physical methods to the examination and utilization of metals, and is intended for those whose researches require a more fundamentally physical approach than is usual in ordinary metallurgical and engineering practice. The lectures and demonstrations will deal with

(A) Applications of X-ray methods in the examination of metals,

(B) Physical and mechanical properties of metals.

Parts (A) and (B) will both be taken by all attending the School, and for Part (A) an elementary knowledge of X-ray diffraction methods and of crystal symmetry will be assumed; during the School it will be possible to provide only a very brief review of these aspects of the subject-matter.

The School will be held from Monday, 23 August, to Friday, 3 September, inclusive. A detailed syllabus and form of application for admission may be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, England, to whom the completed application form should be returned not later than 1 June 1948.