ting up of new international institutes of research, and measures likely to encourage young people devoted to scientific research are to be examined. Then the unification of nomenclature and of standards of measurement in certain sciences is to be attempted; a beginning has already been made with regard to the terms employed in nosology. Another task proposed is the diffusion by means of analytical summaries of scientific work performed by nationals in countries whose language is not widely known. Among the questions referred to the section charged with general affairs is the setting up of an organization for the preparation of youths for international careers. The question had already been considered by the committee on Intellectual Cooperation sitting at Geneva of the establishment of an international university or an institute of international studies under the auspices of the league, and now the Paris institute is to give the question a more detailed examination. A scheme for study tours and exchange of students of all countries has also been approved. Another proposal, from Rumania, is the flotation of an international loan for the restoration of science in certain countries, particularly those which suffered most severely from the war. The information section of the new institute is to examine questions concerning books—for example, the question of introducing uniformity of size and paper measure, and of undertaking a campaign against the use of papers and inks of inferior quality whereby the printed record is likely in course of time to be destroyed. M. Luchaire concluded his address with an eloquent tribute to M. Henri Bergson, who has been chairman of the Committee on Intellectual Cooperation since its foundation, but was unable to go to Geneva this year owing to ill health. He spoke of Bergson as a great citizen of the intellectual world who had devoted all his time during recent years to the work on intellectual cooperation, giving second place even to those philosophical speculations which had been his glory and his delight. A telegram of greeting and homage was sent to M. Bergson from the delegates at Geneva.—*British Medical Journal.*

SCIENTIFIC BOOKS

Introduction to Theoretical Physics. Volume I. By Arthur Haas, professor of physics in the University of Vienna; translated from the third and fourth German editions by T. Verschoyle. Pp. xvi–331, D. Van Nostrand Company, New York, 1924. Price $6.00.

The wonderful progress of physical science in recent years has made an understanding of the fundamentals of theoretical physics increasingly necessary for every physicist or physical chemist. While an introductory course on theoretical physics has been more or less standardized in continental universities since C. Christiansen's "Elements of Theoretical Physics" appeared in German translation in 1894, such a course is hardly yet universal in this country. This has been due, in part, to the lack of a suitable textbook in the English language. In view of this fact the appearance of an English edition of Professor Haas's book must be considered an event of great importance.

The object of this book is to give a survey of the fundamental principles of theoretical physics that will prepare the student for the study of original papers and monographs on modern physics. The first volume is devoted to classical physics and in it no use is made of atomistic hypotheses. It deals with the principles of mechanics, with the general theory of vector fields, of vibrations and of potential, and also with the theory of the electromagnetic field and of light. At the end of the volume is given a very useful summary. The second volume will take up atomistic and non-classical physics.

The ground covered is treated with great clarity and pedagogical skill. Only a minimum of mathematical knowledge is assumed (even the process of differentiation is explained) and no steps are left out in the calculations. This feature makes the book particularly valuable for self-study. By placing the developments of all purely mathematical relations in separate sections their abstract and general character is emphasized and confusion avoided between mathematical form and physical contents. Systematic use is made of vectorial methods throughout the volume. With the thorough and complete development given of the general principles, it has, of course, been necessary to leave out examples and applications to special problems.

The reviewer has found only one real error in the book. On page 160 the stress in a deformable body is assumed to be a vector instead of a tensor, and the proof given for the symmetry of the stress tensor as well as the derivation of the surface-force acting on an arbitrary surface-element are therefore illusory.

A few of the sections on the theory of the electromagnetic field are less satisfactory than the rest of the book. The author, when applying the results from the chapter on potential theory to electromagnetism, has not always kept clearly in mind that these results are purely mathematical. It would also have been more natural to start with Biot and Savart's law, with which the student is already familiar, rather than with the general law for the magnetic field of a closed circuit.

The reviewer has used the first volume of the English translation, together with the second volume of the German edition, in a course for beginning graduate students, and has found it very satisfactory, especially when supplemented with problems and special readings. It is much to be desired that the translation of the second volume be not delayed.

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SPECIAL ARTICLES

THE STRUCTURE OF HIGH- (OR β-) QUARTZ[1]

AT temperatures below 575° C. crystals of quartz have the symmetry of the enantiomorphic hemihedral class of the rhombohedral division of the hexagonal system (point group 3D). An inversion takes place at this temperature, however, and above 575° C. the symmetry is increased to that of one of the truly hexagonal crystal classes. When α- (or low) changes to β-quartz a single crystal of the former becomes transformed into a single and similarly oriented crystal of the latter. This fact permits the investigation of the X-ray diffraction effects from single crystals as well as from crystalline aggregates of β-quartz.

Powder, Laue and spectrum photographs have been made from β-quartz in the course of a series of X-ray diffraction studies of crystals at elevated temperatures. The data from these photographs have been found to be sufficient to yield a unique solution to the problem of the atomic arrangement in this form of silica.

A print has been published of a Laue photograph[2] of quartz above its inversion point. Spectrometer measurements[3] from several simple planes have also been recorded. No structure, however, has been deduced from either of these earlier sets of observations.

Crystallographic measurements have shown β-quartz to have an axial ratio very close to that of α-quartz —$c_\beta = 1.0926$[4] as opposed to $c_\alpha = 1.0999$. The hexagonal unit cell of α-quartz which agrees with all attainable diffraction data has dimensions $a_0 = 4.903$A°,[5] $c_0 = 5.39_3$A° and contains three molecules of SiO_2. The only simple unit cell for β-quartz that can account for the data from powder photographs and from six Laue photographs is a similar one with $a_0 = 5.01$A°, $c_0 = 5.47$A°. Since the density[6] of β-quartz is known to be $\varrho(585°) = 2.518$, its unit cell likewise must contain three molecules of SiO_2.

The hexagonal, rather than trigonal, symmetry of β-quartz is immediately apparent from the Laue photographs taken with the X-rays normal to the base (00·1). Since quartz above its inversion still shows rotary polarization, its class of symmetry must be either 6C or 6D. Crystallographic observations[7] have been supposed to point quite conclusively to the latter. If this selection of crystal class is assumed to be correct, the following deduction leads uniquely to a structure for β-quartz which is in satisfactory accord with experiment.

The X-ray diffraction effects arising from atomic arrangements built upon the space groups isomorphous with 6D differ in the nature of the reflections observed from the plane (00·1). The present powder and spectrum photographs from β-quartz agree with the previous spectrometer measurements in showing only 3rd, 6th, etc., orders from this face. Its corresponding space groups[8] consequently prove to be the enantiomorphic pair 6D-4 and 6D-5. There are numerous ways of arranging three silicon and six oxygen atoms according to the demands of these groups. All those structures which put oxygen atoms in special positions[9] (a)-(f) are excluded by the presence of first-order Laue reflections from planes (2m, 2n.p), where m, n, and q are any integers and $p \neq 3q$. The eight remaining structures are obtained by combining (a) and (c), as silicon positions, with (g), (h), (i) or (j), as oxygen positions. Four of these, (a)(g), (a)(i), (c)(g), and (c)(i) place the oxygen and silicon atoms in the same planes parallel to (00·1). If, then, one of these groupings were the correct structure, the observed 3rd, 6th, etc., orders from the base should show a "normal decline" of intensity with order. Both the spectrometer observations[10] and spectrum photographs indicate that

[1] A paper (*J. Soc. Glass Technology*, Sept., 1925) has just appeared in which W. H. Bragg describes a structure for β-quartz. His atomic arrangement seems to be essentially identical with the one deduced here.

[2] F. Rinne, "Die Kristalle als Vorbilder des feinbaulichen Wesens der Materie" (Berlin, 1921), p. 35.

[3] R. E. Gibbs, *Proc. Roy. Soc. A*, *107*, 561 (1925).

[4] R. Grossmann quoted in F. Rinne, *op. cit.*, p. 89.

[5] M. Siegbahn and V. Dolejsek, *Zeit. f. Physik*, *10*, 159 (1922).

[6] A. L. Day, R. B. Sosman, and J. C. Hostetter, *Am. J. Sci.*, *37*, 1 (1914).

[7] O. Mügge, *Neues Jahrb. f. Min.*, u.s.w. Festband, 1907, p. 181.

[8] P. Niggli, "Geometrische Kristallographie des Discontinuums" (Leipzig, 1919), p. 493; W. T. Astbury and K. Yardley, *Trans. Roy. Soc.* (London), *224A*, 221 (1924).

[9] These designations of atomic positions are the ones used in R. W. G. Wyckoff, "An analytical expression of the results of the theory of space groups" (Washington, 1922), p. 165.

[10] R. E. Gibbs, *op. cit.*