

## Conference of Australian Physicists.

A CONFERENCE of physicists and astronomers, arranged by members of the Institute of Physics resident in Australia, was held at Canberra on Aug. 15-18, and was attended by nearly forty research workers. This conference arose from a desire to hold more frequent meetings of physicists than are provided by the biennial meetings of the Australian Association for the Advancement of Science. It was felt that the conference had met a real need, and it was decided to hold a similar meeting in Sydney or Melbourne during August 1929. Advantage was also taken of the occasion to hold the fourth general meeting of Australian members of the Institute of Physics, under the chairmanship of Prof. A. D. Ross, of the University of West Australia. Meetings were also held during the conference of the Radio Research Board and the Geophysical Prospecting Committee. The conference was organised by Profs. Laby, Ross, Vonwiller, and Dr. Duffield, while Drs. G. H. Briggs and E. O. Hercus acted as secretaries; arrangements for the next meeting are in the same hands.

A visit was made to the Commonwealth Solar Observatory at Mount Stromlo, ten miles from the Federal capital, where members were welcomed by Dr. and Mrs. Duffield and shown the observatory buildings and equipment, including the Oddy and Farnham telescopes, the latter fitted with photoelectric cells for stellar intensity measurements, and the structural arrangements for the 30-inch reflector, which include the Reynolds dome, a vertical tube 6 ft. in diameter, and a thermally insulated horizontal tunnel in the basement.

The meetings of the Conference were devoted to reports of research work and to the discussion of topics of general interest to members. In opening a discussion on the new quantum theory, Mrs. G. H. Briggs gave an account of Bohr's recent work on the inherent conflict of the ideas of causality and space-time in quantum processes. Mr. H. S. W. Massey referred to the success of the wave mechanics in accounting for the space distribution of scattered electrons and other phenomena. Profs. Madsen and Laby contributed to a discussion on radio research in Australia; emphasis was laid on the need for pure research, and the suggestion was made that some fraction of the broadcasting revenue of a quarter of a million sterling should be set aside for this purpose. Mr. R. O. Cherry described measurements of the relative field strength distribution from the broadcasting station 3LO, Melbourne, found with a portable set over a range of about 50 miles from the aerial. Dr. Bieler, Deputy Director of the Imperial Geophysical Experimental Survey party, gave a description of methods of prospecting which are being tested in the field in selected localities in Australia. Major E. H. Booth, of the University of Sydney, discussed the seismic method of prospecting and described

experiments on earth waves detected with a modification of the Tucker microphone. At the conclusion of this discussion a resolution was passed by the Conference urging the executive committee of the Survey to include a study of the seismic method in the scope of the work.

Mr. S. Radcliff showed some exhibits, demonstrating by a new method the appreciable vapour pressure of such substances as sulphur, sealing-wax, and other waxes often used in physical apparatus. Prof. Ross described further work on the magnetic properties of manganese steels, showing that their properties could be attributed to the isomorphism of manganese and gamma iron. The manganese restrains the magnetic transformation on cooling the metal from high to ordinary temperatures, but at liquid air temperature the metastability is wholly or partly destroyed. The alloy may consist chiefly of either austenite, hardenite, troostite, sorbite, or pearlite, according to the heat treatment.

Mr. W. B. Rimmer, assistant director of the observatory, described a spectroscopic examination of type B stars, showing that in each spectral subdivision 'line character' is related to absolute magnitude, sharp lines being associated with bright stars. Mr. Allen discussed the measurement of some multiplet lines by the method of photographic spectrophotometry developed at the Utrecht Institute. Mr. J. Nangle, Government Astronomer for New South Wales, described the steady progress towards the completion of the section of the Astrographic Catalogue allotted to the Sydney Observatory. It is hoped that the work will be finished in about ten years. Prof. Bailey (University of Sydney) described experiments on the attachment of electrons to molecules, and Mr. J. Bannon experiments on the motion of electrons in pentane and ethylene. Mr. J. S. Rogers, in the ensuing discussion, stressed the importance in such work of eliminating impurities. Mr. J. Shearer described work carried out with Mr. Bingham and Prof. Laby establishing the reflection of radiation of about 50 Å. at grazing angles up to 25° from glass surfaces, and up to 45° for steel and quartz surfaces (NATURE, July 21, p. 96). Prof. Laby communicated a paper by Mr. Webster on X-ray intensity measurement by a photographic method, and one by himself and Mr. Kannuliuk on an accurate determination, corrected for the low heat loss, of the thermal and electrical conductivities of a large single crystal of copper at room temperature, and at the temperature of liquid air. Prof. Vonwiller described an interference method of measuring with high accuracy the refractive index of materials such as mica which can be obtained in the form of uniform sheets. Mr. Ray Davis contributed two papers on hydrogen ion concentration, and papers were received from Messrs. Cairns and Johnston of the Watheroo Magnetic Observatory.

Some Band and Emission Spectra.<sup>1</sup>

R. C. JOHNSON.—The band spectra of the alkaline earth halides. (1) CaF, SrF. A continuation and extension of theoretical work done recently on these band spectra by Meckel. A complete quantum analysis of the gross structure of the whole of the bands has been made, and for this purpose a re-measurement of some 250 of the heads under high dispersion was undertaken.

The molecules CaF and SrF give rise to at least

<sup>1</sup> Abstracts of papers read before the Royal Society on Nov. 1.

three band systems which are analogous in almost every respect. These are assigned to the electron transitions  $3^2S \rightarrow 1^2S$ ,  $2^2S \rightarrow 1^2S$ ,  $2^2P \rightarrow 1^2S$ . The vibrational constants of the molecules in these various states have been evaluated. Many unusual features found in these band spectra, such as the fewness of the sequences and their exceptional length, are attributed to the smallness of the variation of these vibrational constants with electronic state. Among the unusual features also observed and discussed are

(a) the occurrence of strong  $Q$  branches in  ${}^2S \rightarrow {}^2S$  transitions, and (b) a definite discrepancy in  $f(n'')$  as evaluated from the  ${}^2S \rightarrow {}^2S$  and  ${}^2P \rightarrow {}^2S$  systems.

(2) BaF, MgF. A quantum analysis is made of the gross structure of the band spectra of the molecules. In the case of the barium fluoride bands, new measurements of the heads have been made, from plates taken in the first order of a 21-ft. grating. The familiar BaF bands in the green region are believed to constitute two systems attributed to the electron transitions  $2 {}^2S \rightarrow 1 {}^2S$ , and  $3 {}^2D \rightarrow 1 {}^2S$ . A number of bands measured by George, and attributed by him to BaO, have been analysed and found to have their final state in common with the above BaF systems, thus proving their fluoride origin. This system is believed to be due to  $2 {}^2D \rightarrow 1 {}^2S$ . These suggested transitions of the type  ${}^2D \rightarrow {}^2S$ , which are believed to be new to band spectra, are discussed. The absence of the transition  $2 {}^2P \rightarrow 1 {}^2S$  from the recorded data of the BaF molecule is noteworthy.

The recorded emission bands of MgF constitute a  $2 {}^2P \rightarrow 1 {}^2S$  system, in which  $\Delta 2 {}^2P = 18.6 \nu$ . The vibrational constants of these various states of both the BaF and MgF molecules are given.

J. M. WALTER AND S. BARRATT.—The band spectra associated with zinc, cadmium, and mercury. The majority of these supposed band absorption spectra, and one band system previously attributed to mercury, would appear to be oxide and chloride spectra. In the present experiments the only bands found which can be attributed to zinc and cadmium themselves, are two weak and diffuse bands, one for each metal. The absorption spectrum of mercury, however, is much richer, and there is no doubt that mercury vapour contains diatomic molecules. The bromides of the three metals, together with the iodide of cadmium, all yield absorption band systems analogous to the chloride bands.

W. JEVONS.—Observations in connexion with the band systems of the fluorides of beryllium and magnesium. The vibrational analyses of the band-head data for the BeF and MgF doublet systems lead to the following interpretations of the heads in each band, those in brackets not having yet been detected. In BeF:  $R_2, R_1, Q_2, (Q_1)$  with a doublet separation of the order  $R_2 - R_1 = 3 \text{ cm.}^{-1}$ , rather than  $R_2, Q_2 (R_1), Q_1$  with a separation  $Q_2 - Q_1 = 35 \text{ cm.}^{-1}$  as hitherto assumed. In MgF:  $P_1, Q_1, (P_2), Q_2$  with an electronic doublet separation  $Q_2 - Q_1 = 5.5 \text{ cm.}^{-1}$ , not  $22 \text{ cm.}^{-1}$  as hitherto given. With these interpretations there is now a continuous increase of the separation of the system-origins of the doublet systems of the alkaline earth fluorides from beryllium to barium fluorides.

With beryllium oxide in the carbon arc in air, conditions may be so arranged as to obtain in the outer flame either (a) the fluoride system strong with the oxide system relatively weak, or (b) the oxide system strong with scarcely a trace of the fluoride system. In condition (b) the ultra-violet region  $\lambda 3500 - \lambda 2900$  (where the fluoride system would occur if developed) is occupied by a new set of bands, which, like the BeF and BeO bands, are degraded towards the red.

A similar result is obtained, though less satisfactorily, with other beryllium salts. The new bands are less regularly distributed than any bands of diatomic molecules, and are due either to BeF<sub>2</sub> or to an oxide of beryllium. No bands due to the chloride and no further bands of the fluoride have been found.

The data of the BeO band-system are extended by the recognition of a violet sequence  $n'' - n' = -2$ , not hitherto observed on account of the  $\lambda 4216$  sequence of CN and strong metallic lines.

W. E. CURTIS AND A. HARVEY.—The structure

of the band spectrum of helium (5). The details and analysis of five new He<sub>2</sub> bands are given. One of these is a weak vibrational band associated with the known band near  $\lambda 5730$  ( $3D \rightarrow 2P$  of He<sub>2</sub>). Another is the  ${}^1\text{He}_2$  counterpart of the  ${}^3\text{He}_2$  band designated  $3X \rightarrow 2P$ , and described in the preceding paper of this series. The remaining three have  $2P$  as the final electronic level and a new type of level ( $Z$ ) as initial. It is rotationally single, like  $S$  and  $X$ , but the rotation terms cannot be represented by the usual type of formula, nor are the relative intensities of the branches at all similar to those in other bands.

In consequence of the abnormal character of the initial level the appearance of the  $Z \rightarrow P$  bands is very peculiar; the wave-numbers of the  $R$  branch, for example, decrease continuously with increase of rotational quantum number, thus giving it the appearance of a  $P$  branch. Two perturbations are recorded in these bands, one a large displacement, and the other a splitting into two components of about equal intensity. The Zeeman effect has already been found to be very unusual in magnitude and character for the band  $4Z \rightarrow 2P$ .

The  $X$  and  $Z$  levels are clearly additional to the ordinary atomic system of levels, and the evidence leads to a tentative identification of them with certain new types predicted by Hund for diatomic molecules, but not hitherto definitely established by observation. Although the chief properties of the new bands may readily be accounted for on this view, several unexplained peculiarities remain, such as the absence of  $Q$  branches in  $X \rightarrow P$  transitions, and the relative intensities of the branches in  $Z \rightarrow P$  transitions.

J. C. McLENNAN, R. RUEDY, AND A. C. BURTON.—An investigation of the absorption spectra of water and ice with reference to the spectra of the major planets. In this investigation the absorption spectra of columns of water of 4 metres and of 21.5 metres length were photographed. Absorption spectra were also obtained with lengths of ice up to 14 metres. Three absorption bands were obtained with water in the infra-red region that would be identified with bands in the spectra of the major planets, and could be taken to indicate the existence of water about these planets not in the form of vapour or ice, but in the liquid state. The absorption in the green shown by planetary spectra cannot be attributed to water, and search for it is being made with certain other liquefied gases.

J. C. McLENNAN AND A. M. I. A. W. DURNFORD.—The Zeeman effect for the spectrum of tantalum. In all, some fifty-five Zeeman patterns were secured for wave-lengths of tantalum between  $\lambda 5548$  and  $\lambda 6700 \text{ \AA}$ . These include practically all the strong arc wave-lengths. A concave grating of 3 metres radius was employed that gave a dispersion for the second order spectrum of 2.6  $\text{\AA}$ . per mm. over the region examined. The light source consisted of a modified form of vacuum arc in a chamber that formed an integral part of the electromagnet. This latter was of the Du Bois type, and a field strength of 21,500 gauss was used.

J. C. McLENNAN, H. C. H. IRETON, AND E. W. SAMSON.—On the luminescence in solid nitrogen under cathode ray bombardment. With spectrographs of high-light power, the spectrum of luminescent solid nitrogen was photographed from  $\lambda 2000$  up to  $\lambda 8600 \text{ \AA}$ . In addition to the bands at  $\lambda 5945, 5609, \text{ and } 5230 \text{ \AA}$ . formerly observed, a strong band was found at  $\lambda 8535 \text{ \AA}$ ., one at  $\lambda 6725 \text{ \AA}$ ., one at  $\lambda 6400 \text{ \AA}$ ., and a faint narrow one at  $\lambda 6187 \text{ \AA}$ . in the long wave-length region. Two series of bands were observed with short wave-length region with nearly constant wave-

number differences that were approximately equal to 215 and 175. The bands at  $\lambda\lambda 5945, 5609, \text{ and } 5230 \text{ \AA}$ . were all phosphorescent ones, and the light emitted that corresponded to them was not noticeably polarised.

Decay curves were obtained for the luminosity corresponding to these three bands. In the decay of the  $\lambda 5945 \text{ \AA}$ . light, two distinct stages were noted, and

in the decay of that corresponding to  $\lambda 5230 \text{ \AA}$ . three stages were observed. In both cases the phosphorescence was of the 'vanishing type.'

The results of the investigation suggest that hydrogen occluded in minute traces in the solid nitrogen may account for the phosphorescence observed with the latter when subjected to electronic irradiation.

### Crystal Structure and Properties.<sup>1</sup>

**A. MÜLLER.**—A further X-ray investigation of long-chain compounds. The fortunate discovery of a single crystal of a normal hydrocarbon,  $n\text{-C}_{29}\text{H}_{60}$ , has made it possible to determine with considerable accuracy certain details of the structure of a long-chain molecule. The ratio of the length of the fundamental sub-period of the chain has been measured to 1 part in 1000. Various other constants have been less accurately determined.

Each carbon atom in the chain is known to be associated with two hydrogen atoms, with the exception of each of the end atoms, to which three are attached, forming methyl groups. If each carbon atom with its two hydrogens be considered as a separate group capable of representation by a single scattering centre, the chain is found to have a regular zigzag form with a centre at every corner. The two end carbons may with very good approximation be taken to be represented by the two ends of the zigzag. The centres therefore lie on two parallel lines, 15 on one, 14 on the other. The ratio of the distance between two consecutive centres on the same line to the length of the chain, the sub-period of the chain, is  $0.03286 \pm 0.00002$ . As the length of the chain is  $77.2 \text{ \AA}$ ., this distance is  $2.53 \text{ \AA}$ ., which is, within the limits of experimental error, the distance between two corresponding atoms in diamond. The closest distance between two lines of centres belonging to different molecules is  $3.7 \text{ \AA}$ . Thus there is room for the replacement of hydrogens by oxygens, and in fact it is found that the dimensions (though not the intensities of the reflections) of the ketone  $\text{C}_{30}\text{H}_{60}\text{O}$  and the hydrocarbon  $\text{C}_{30}\text{H}_{62}$  are identical.

The area of cross section of the molecule is found to be  $18.5 \times 10^{-16} \text{ sq. cm.}$ , a result in good agreement with the values already determined in the case of other single crystals of long-chain compounds.

**I. E. KNAGGS.**—The form of the central carbon atom in pentaerythritol tetra-acetate as shown by X-ray crystal analysis. The X-ray examination of these crystals was undertaken with the view of studying the behaviour of the central carbon atom in a compound in which the four carbon valencies are satisfied by like groups. Pentaerythritol tetra-acetate crystallises in the tetragonal bipyramidal class; the crystals are built on the Bravais lattice,  $I\bar{4}$  and the space group  $\text{C}_{4h}^2$ ; there are two molecules in the unit cell, which has the dimensions  $11.98^2 \times 5.47 \text{ \AA}$ .

The molecule possesses a four-fold alternating axis of symmetry, which must pass through the central carbon atom. The central carbon atom itself may be tetrahedral, though some slight departure from true tetrahedral symmetry is possible. A probable structure for the crystals is suggested.

**J. E. LENNARD-JONES AND B. M. DENT.**—The change in the lattice spacing at a crystal boundary. The contraction of the lattice at the (100) boundary of crystals of the NaCl type is confined almost entirely to the top layer and is of the order of 5 per cent. An upper limit is found for the decrease in the interatomic spacing in the surface layer; this also is of the order of 5 per cent. The surface tension

of a number of crystals of the NaCl type is calculated.

**N. A. ALSTON AND J. WEST.**—The structure of topaz. From a quantitative analysis by X-rays of the structure of topaz,  $[\text{Al}(\text{F},\text{OH})_2]_2 \text{SiO}_4$ , it appears that although this crystal is sometimes considered to belong to the orthorhombic pyramidal (polar) class, the structure actually found is holohedral in character.

The chief feature of the structure is the arrangement of the oxygen and fluorine atoms. Regarding these atoms as equal in size, they form a close-packed assemblage which belongs strictly to neither of the two well-known hexagonal and cubic types of close-packing. These two types and the assemblage found in topaz may be conveniently regarded as the simplest examples of the ways in which a series of identical planes, consisting of similar atoms in contact, may be closely stacked together, one on top of the other, so as to form a series of layers in periodic succession.

Some of the more complex structures still awaiting analysis, which, whilst exhibiting certain features characteristic of close packing, belong neither to the hexagonal nor to the cubic type, may actually prove to be based on one of these less simple arrangements. Although in a structure of this kind it is difficult to distinguish between oxygen and fluorine atoms, it is believed that the four atoms which surround tetrahedrally each silicon atom are oxygen, whilst of the six atoms arranged symmetrically about each aluminium atom, four are oxygen and two are fluorine.

**J. C. McLENNAN, R. RUEDY, AND E. COHEN.**—The magnetic susceptibility of single crystals of zinc and cadmium. The magnetic constants of single crystals of zinc and cadmium have been determined. For the magnetic susceptibility  $\chi_{\parallel}$  (parallel) and  $\chi_{\perp}$  (normal) to the hexagonal axis, the results are

$$\begin{aligned} \text{Cd} \dots \chi_{\parallel} &= 190 \times 10^{-6}, & \chi_{\perp} &= 145 \times 10^{-6}. \\ \text{Zn} \dots \chi_{\parallel} &= 261 \times 10^{-6}, & \chi_{\perp} &= 160 \times 10^{-6}. \end{aligned}$$

With mercury the results obtained lend support to the view that this metal crystallises in a rhombohedral form.

**R. W. JAMES AND G. W. BRINDLEY.**—A quantitative study of the reflection of X-rays by sylvine. The variation of the intensity of reflection of X-rays from sylvine with temperature is quantitatively in agreement with the Debye-Waller law from the temperature of liquid air up to about  $400^{\circ}$  abs. At higher temperatures the decrease of intensity with increasing temperature is much more rapid than the law indicates. The value of the temperature factor based on observations at room temperature and at the temperature of liquid air agrees very well with that calculated by Waller from the elastic constants of the crystal, and also with the value calculated from the Debye-Waller law using the characteristic temperature.

The absolute values of the intensity of reflection are in good agreement with those calculated from the Schrödinger density distribution for  $\text{K}^+$  and  $\text{Cl}^-$  obtained by Hartree's method, if each element of the distribution is assumed to scatter classically, and if, in correcting for temperature, the existence of zero-point energy is assumed.

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