

## CRYSTAL PHYSICS AND CHEMISTRY

UNDER the auspices of the fifth annual meeting of the Indian Academy of Sciences a symposium on "Crystal Physics and Chemistry" was held at Bangalore on the 31st December 1939. PROF. SIR C. V. RAMAN, the President of the Academy, was in the chair.

PROF. K. S. KRISHNAN spoke on the Stark splitting of the energy levels of paramagnetic ions in crystals under the influence of the strong electric fields due to the distribution of negatively charged atoms surrounding the paramagnetic ion. Three properties of the crystals which are largely affected by this are the optical properties, specific heat and the magnetic properties. In particular, the effect of this splitting on the magnetic behaviour of the ions throws considerable light on the origin of the magnetic anisotropy in a paramagnetic crystal. In crystals the orbital moments of the ions are partially quenched by the asymmetric crystalline electric fields. The spin moments, on the other hand, are not affected directly by the crystalline fields though indirectly they would be through their coupling with the orbital moments. The ground states of ions such as  $Mn^{++}$ ,  $Fe^{+++}$  and  $Gd^{+++}$  being S-states, there are no orbital moments to be quenched, and the magnetic moment is wholly due to the spin. The anisotropies in such cases are very feeble and arise from the Stark splitting of the S levels. From the magnetic data at room temperature, it is possible to get an idea of the Stark separation, the restriction of freedom of the ions, as well as the characteristic temperatures in the case of manganous and ferric salts. In the case of trivalent chromium,  $Cr^{+++}$ , also the magnetic moment is wholly due to the spin and it has, therefore, only a small anisotropy which follows the inverse square law with temperature. From the measurements on the magnetic anisotropy of nickel salts at different temperatures the strength of the coupling between the orbital and spin angular momenta of  $Ni^{++}$  has been calculated and is found to agree with the spectroscopic value. The striking contrast in the magnetic behaviour of the six co-ordinated and four co-ordinated cobalt compounds can be explained as due to the mutual inversion of the Stark levels of the  $Co^{++}$  ions in crystals. The effect of the spacing of the levels on the colour of the substances is also striking

as the six co-ordinated cobalt compounds are pinkish whereas the four co-ordinated ones are blue. The phenomenon of magnetic double-refraction observed by Raman and Chinchalkar in solutions of rare earth salts can also be readily explained as being due to the asymmetric quenching of the orbital moments of the paramagnetic ion in the electric fields due to the surrounding anions, since the paramagnetic complex will then possess both magnetic and optical anisotropy. In the case of the solution of salts of  $Gd^{+++}$  the magnetic double-refraction is extremely feeble as is to be expected since  $Gd^{+++}$  is in the S-state and hence there is practically no magnetic anisotropy of the complex. Further, it has been observed that the Stark components in the absorption bands of crystals of certain rare earth salts have different polarisation characteristics, thus clearly demonstrating the existence of asymmetric crystalline fields in these crystals.

PROF. S. BHAGAVANTAM gave a brief review of the present theoretical conceptions about the dynamics of the crystal lattices and the recent progress made in the study of the scattering of light in crystals. From Born's theory of crystal lattices, the modes of motion can be classified into two fundamental groups: (1) the acoustical series—same as the Debye heat waves—due to the simultaneous translatory motion of all the atoms defined by the elastic properties of the crystal, and (2) the optical series—occurring in Raman effect and infrared absorption which consist in the oscillation of the ultimate constituents that go to make up the crystal lattice, against each other. In class (2) the periodicity of oscillations of the set of atoms in space can be so varied as to get different modes of oscillation. However, only those modes are important in light scattering where all the atoms move in phase to produce the necessary polarisability changes. The change of symmetry of the crystal changes the number of distinct modes, the higher the symmetry the smaller being the number of these modes. One of the important symmetry elements is the centre of symmetry. The significance of the location of the centre of symmetry is clear from the different behaviour of sodium chloride as compared to that of diamond in light scattering. The geometric arrangement of the scattering units in crystal lattices

and their simplicity render the results obtained by light-scattering both accurate and easy of interpretation. One can get a variety of information from studies of the Raman effect in single crystals under different experimental conditions. The lecturer showed how the recent directional studies on calcite and sodium nitrate enabled one to draw important conclusions regarding the dynamics of their lattices.

DR. C. S. PICHAMUTHU detailed the mineralogical aspect of various properties of crystalline rocks. He referred briefly to the use of the more common optical instruments such as the polarisation microscope and the Federow stage to determine the optical constants of minerals. The optical anomalies such as the occasional biaxiality and anomalous interference colours shown by hexagonal crystals like quartz and garnet have puzzled the mineralogists till now. In the case of lavas and spherulites which are formed in a fine state of crystallisation, the mineralogist has recourse only to X-ray studies to find out their structure. In the case of ore minerals, studies are made by reflected light and by etching methods because of the opacity of the crystals. However, the study of the distribution of components in the ore samples is rather difficult. The lecturer then dealt in detail

with the formation and characteristics such as the orientation effects in stress minerals.

PROF. SIR C. V. RAMAN gave suggestions regarding the methods to be adopted in resolving some of the optical anomalies observed in minerals and stressed the possible influence of irregularities and crystal imperfections such as the mosaic structure on the optical behaviour of crystals particularly in light scattering.

MR. T. M. K. NEDUNGADI drew attention to the usefulness of the study of light scattering in crystals in the explanation of their various physical properties. He showed how his studies of the Raman spectrum of quartz at high temperatures have given an insight into the probable mechanism of the  $\alpha/\beta$  transformation in quartz.

Some interesting new results obtained from studies on the luminescence, light-scattering and light absorption in diamonds were presented by MR. P. G. N. NAYAR. Diamonds in general have a number of fluorescent bands. But among the different crystals there is wide variation in their intensities. Certain correlations between the frequency differences of the luminescent bands and infra-red and ultra-violet absorption were pointed out and discussed.

T. M. K. NEDUNGADI.

## A NATIONAL RESEARCH COUNCIL FOR INDIA

IN the December Number of *Current Science*, in an Editorial we pleaded strongly for the immediate inauguration of a National Research Council, on lines similar, in essentials, to the Department of Scientific and Industrial Research in Great Britain, for organising industrial research in this country. It is gratifying to learn that this suggestion has received strong support from the scientists of this country who had assembled at Madras under the auspices of the Indian Science Congress. At a meeting held on the 5th of January, under the Presidentship of Sir T. Vijayaraghavacharya, various speakers, including Profs. J. N. Ray, S. P. Agharkar and J. N. Mukherjee, spoke on the role of science in national planning and drew attention to the existence of lacunae in our scientific organisation. The inauguration of a

National Research Council at this stage of scientific development in India, was considered essential for an ordered utilisation of the industrial resources of the country. In bringing the proceedings to a close, Sir T. Vijayaraghavacharya mentioned that as long ago as 1931, he had suggested the formation of a national council of research for organising not only agricultural but also industrial research. He felt that the formation of such a body was long overdue.

A Committee consisting of Sir T. Vijayaraghavacharya (*President*), Prof. Birbal Sahni, Dr. J. C. Ghosh, Lt.-Col. R. N. Chopra, Prof. M. N. Saha and Prof. P. Parija (*Secretary*), was appointed to prepare a memorandum relating to the establishment of a National Research Council for India for being submitted to the Government of India.