

LETTERS TO THE EDITOR

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PHOTOELASTIC BEHAVIOUR OF AMMONIUM CHLORIDE

THE photo-elastic behaviour of some cubic crystals was critically examined by Mueller.² He found that TiCl , NaCl , CsCl and KCl are different from one another in regard to their photo-elastic properties. Unlike several other cubic crystals, NH_4Cl presents an interesting example in its lattice structure. Below the transition temperature, it belongs to CsCl group and above that temperature, it changes to NaCl group.

The author's experimental work has given the following values of the piezo-optic and elasto-optic constants of NH_4Cl (for $\lambda = 5893\text{\AA}$).

$$\begin{aligned}(q_{11} - q_{12}) &= -3.06 \times 10^{-13}; & q_{44} &= 3.63 \times 10^{-13}; \\ q_{11} &= 1.91 \times 10^{-13}; & q_{12} &= 4.89 \times 10^{-13}. \\ (p_{11} - p_{12}) &= -9.73 \times 10^{-2}; & p_{44} &= 2.47 \times 10^{-2}; \\ p_{11} &= 14.49 \times 10^{-2}; & p_{12} &= 23.97 \times 10^{-2}.\end{aligned}$$

At laboratory temperature, NH_4Cl thus behaves as a negative uniaxial crystal when stressed along a cube axis ($p_{11} - p_{12} = -0.097$). When stressed along a cube diagonal, it becomes a positive uniaxial crystal ($p_{44} = 0.25$). This is what is to be expected because it belongs to the CsCl group. Since the structure of NH_4Cl changes to NaCl group above the transition temperature, it will be interesting to see if ($p_{11} - p_{12}$) continues to be negative while p_{44} also becomes negative.

For ammonium chloride, when a stress is applied along $[211]$ and the direction of observation is along $[011]$ the axes of birefringence make an angle θ with the stress axes (Bhagavantam¹), given by the relation

$$\tan 2\theta = 2 \sqrt{2}(A - q_{44})/(A + 5q_{44}),$$

where $A = (q_{11} - q_{12})$.

This result has been verified experimentally and the observed value of θ is 22° , in close agreement with the value calculated from the experimentally determined values of the stress-optic constants.

Another observation made in the course of the present investigation is that for stresses beyond 0.5 kg./mm.^2 along any direction other than a cube edge, single crystals of ammonium chloride become plastic and show residual birefringence even after the stress is removed.

A full report of the investigations will be published elsewhere in due course.

The author's grateful thanks are due to Dr. S. Bhagavantam for his kind interest in the work.

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Osmania University,
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March 5, 1954.

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2. Mueller, H., *Phys. Rev.*, 1935, **47**, 947.

SOME NUCLEAR MODELS FOR HIGH ENERGY ELECTRON SCATTERING

RECENTLY, the experimental differential scattering cross-sections for the nuclear scattering of 150 Mev. electrons by tantalum and 125 Mev electrons by gold and lead have been obtained by Hofstadter, Fechter, and McIntyre.¹ To correlate this data, the following nuclear density distributions have been proposed by Schiff²:—

$$\rho_1(r) = \bar{\rho}_1 \exp[-(r/a_1)^2] \quad (1)$$

$$\rho_2(r) = \bar{\rho}_2 a_2^4 / (a_2^2 + r^2)^2 \quad (2)$$

$$\rho_3(r) = \bar{\rho}_3 \exp[-r/a_3] \quad (3)$$

$$\rho_4(r) = \bar{\rho}_4 [1 + (r/a_4) \exp[-r/a_4]] \quad (4)$$

Schiff has obtained the most appropriate parameters for these models from the point of view of the above electron scattering. He has also calculated the electrostatic energy for such charge distributions. One can discard the first two models because they give about twice the required value for this energy. However, the remaining two models give this energy only a

few per cent. higher than the required value. These models, therefore, require further consideration.

On the basis of a correlation between the nuclear shell numbers and the nuclear density proposed by Born and Yang,³ one obtains for the neutron or proton shell numbers

$$N_i = A (1 + 3/2)^3 / 3\pi^2 r_m^3 \rho(r_m)$$

where r_m is the value of r where $r^3 \rho(r)$ is a maximum. The empirical shell numbers are obtained provided one takes $r_m^3 \rho(r_m)/A = 0.112$. We have used this criterion to test the suitability of the remaining two models.

On normalisation we have

$$8\pi \bar{\rho}_3 a_3^3 = A; \quad 32\pi \bar{\rho}_4 a_4^3 = A$$

and using these conditions we obtain

$$r_m^3 \rho_3(r_m)/A = 0.053$$

$$r_m^3 \rho_4(r_m)/A = 0.059.$$

These values are independent of the respective parameters of the two models.

On the basis of the above considerations, it is concluded that these models also are unsuitable. Similar investigations on other nuclear models are now in progress, the results of which will be published later.

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Navarangpura,
Ahmedabad-9, March 13, 1954.

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2. Schiff, L. I., *Ibid.*, 1953, **92**, 988.
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EMPIRICAL RELATION FOR A VIBRATION FREQUENCY OF MONO-DERIVATIVES OF BENZENE

In the mono-derivatives of benzene, the vibration $\nu_{18}e_{2g}$ (606) of benzene splits into an a_1 component and a b_1 component. In the ground state the a_1 component has been represented¹ by a simple formula involving only the mass of the substituent. The b_1 component is known¹⁻⁹ to be in the neighbourhood of 615 cm.^{-1} . In the first excited singlet electronic level, which corresponds to the ${}^1B_{2u}$ level of benzene, the b_1 component is known¹⁻⁹ to be in the neighbourhood of 520 cm.^{-1} and the a_1 component ($\nu'_{18}a_1$) can be represented by the following empirically derived relation analogous to the one for the ground state,

$$\nu'_{18}a_1 = 1782 [(1/X) + (1/78)]^{1/2} \text{ cm.}^{-1}$$

where X is the weight of the substituent (on atomic weight scale). The relation holds for $X \geq 15$. The ratio of the corresponding factors