order equation in ω^2 . This is possible when the parameters of the transverse (longitudinal) vibrations are given numerically. The experimental determination of the parameters for the transverse vibrations can be made, for instance, by approximating through (3) the experimental dispersion curve for infrared light.

The relation between $\Omega_{\|}$ and $\Omega_{\perp}$ in the simplest particular case of two ions per cell, has been considered in earlier publications. It seems that Ref. 3 reports wrong relations. The relation (8) was derived for the first time in Ref. 4; it has later been derived by Tolpygo[1] and Callen[5] on the basis of the microtheory of ionic crystals; Huang[2] has derived it using the macroscopical electromagnetic theory.

In the case of an anisotropic crystal, if the orientation of one of its principal axes of polarization does not depend on the frequency (because of the symmetry of the crystal) the relation derived above between the parameters of longitudinal and transverse waves still hold for a longitudinal wave travelling along the said axis, and for a transverse wave travelling in a perpendicular direction and polarized along the principal axis. If the wave travels in an arbitrary direction it is, generally speaking, neither longitudinal nor transverse, and the relations derived above need a basic generalization.

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Hyperfine Structure of the Paramagnetic Resonance Spectrum of $^{53}Cr^{3+}$ in Al_2O_3

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IN Ref. 1 the fine structure of the paramagnetic resonance spectrum of Cr^{3+} in monocrystalline

Al_2O_3 was investigated. More detailed study of this spectrum showed that with concentrations of $Cr \sim 10^{-4}$ the fine structure lines, corresponding to various electronic transitions, have identical widths, equal to 13 G. Further decrease in the Cr concentration and also a lowering of the temperature of the crystal to the temperature of liquid nitrogen did not cause a narrowing of the lines. These data led to the conclusion, that the line width for small Cr concentrations depends mainly on the magnetic interaction of the spins of Cr^{3+} with the Al^{27} nuclei surrounding the Cr^{3+} ions in monocrystalline corundum.
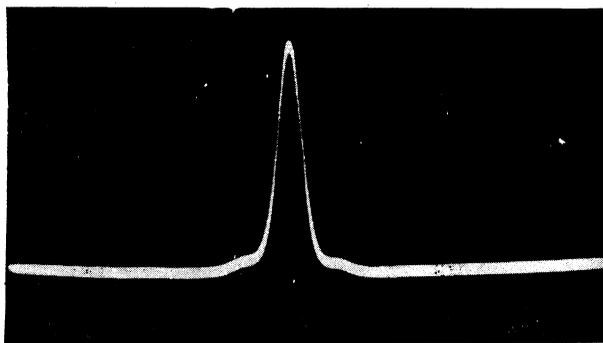

FIG. 1

For Cr concentrations greater than 10^{-4} , the line widths for various electronic transitions are not identical: the lines, corresponding to the transition $M = 3/2 \longleftrightarrow \frac{1}{2}$ and $M = -\frac{1}{2} \leftrightarrow -3/2$ are wider than the line $M = \frac{1}{2} \leftrightarrow -\frac{1}{2}$. This is connected with the fact that in this case the line width depends primarily on the magnetic interaction between the Cr^{3+} ions.

Relatively small line widths for small chromium concentrations permit one to observe hyperfine structure caused by the single stable odd isotope Cr^{53} whose concentration in the natural mixture of isotopes equals 9.4%. Figure 1 shows the oscillogram of the line corresponding to the electronic transition $M = \frac{1}{2} \leftrightarrow -\frac{1}{2}$. Two components of the hyperfine structure caused by the Cr^{53} isotope may be clearly seen on the wings of the central line from the even chromium isotopes, whose nuclear spins are zero. The relative intensities of the central line and the two supplementary lines are in agreement with the values of the nuclear spin of Cr^{53} , $I = 3/2^2$, and the concentration of the Cr^{53} isotope in the natural mixture, 9.4%.

In order to resolve the hyperfine structure completely, we investigated the paramagnetic resonance in monocrystalline corundum, containing chromium,
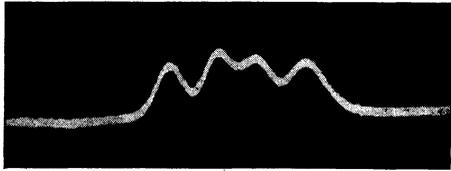
FIG. 2

enriched in the mass 53 isotope.

Figure 2 shows the oscillogram of the line $M = \frac{1}{2} \leftrightarrow -\frac{1}{2}$ in the case for a constant external magnetic field parallel to the axis of symmetry of the crystal. The hyperfine structure, consisting of the four lines, confirms the nuclear spin of Cr^{53} as equal to 3/2. The uneven spacing between the hyperfine components is caused by second order displacements. The hyperfine structure is described by the terms

$$AS_z I_z + B \, (S_x I_x + S_y I_y)$$

in the spin Hamiltonian, where S is the electron spin, I is the nuclear spin, A and B are hyperfine structure constants. From the experimental data we obtain the following values of the constants

$$|A| = (17.0 \pm 0.5) \cdot 10^{-4} cm^{-1}, \quad |B| \approx |A|.$$

Notice that the constant A of the hyperfine structure of Cr^{53} in corundum is near that observed in alums, but greater than that of cyanide.[2,3]

A detailed account of the results of the investigation of the fine and hyperfine structure of Cr^{3+} in corundum will be published later.

The authors wish to thank A. A. Popova for growing the single crystals, studied in the present work.

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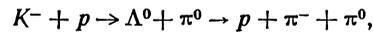
Correlative Phenomena in K-Meson Capture

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THE process of capture of a K-meson by a proton, followed by a decay with emission of a hyperon, i.e., the reaction

$$K^- + p \rightarrow \Lambda^0 + \pi^0 \rightarrow p + \pi^- + \pi^0,$$

can be used to determine the spin of the Λ-particle from the angular correlation of the π-mesons.

If the spin of the K-meson is equal to zero, then the momentum of the initial system is equal to $\frac{1}{2}$ (if the K-meson is captured in a S-state). The angular distribution $I_j (\theta)$ is given as a function of j and of the angle θ between the directions n_1 and n_2 of the relative momenta of the systems (Λ, π^0) and (p, π^-) $(I_{\frac{1}{2}} (\theta) = 1)$

$$I_{3/2} (\theta) = 1 + P_2 (\cos \theta) \sim 1 + 3 \cos^2 \theta;$$
$$I_{5/2} (\theta) = 1 + \tfrac{8}{7} P_2 (\cos \theta) + \tfrac{6}{7} P_4 (\cos \theta) \qquad (1)$$
$$\sim 1 - 2 \cos^2 \theta + 5 \cos^4 \theta$$

(to be compared with the analogous formula for the decay of the Ξ-particle[1]). If the spin of the K-meson is 1, then the momentum of the initial system can be $\frac{1}{2}$ as well as 3/2, and, therefore, the formula for the angular correlation are not unique.

If the system is in an external magnetic field, the dependence of the angular distribution on the field H can be used to determine the magnetic moment of the Λ-particle. In the presence of a magnetic field the correlation function has the form (see, e.g., Ref. 2):

$$\Omega = - kT \ln \sum_{n,N} \exp \left\{ \frac{\mu N - E_{nN}}{kT} \right\}, \qquad (2)$$

where ω is the appropriate Larmor frequency, τ the lifetime of the Λ-particle and A_n the coefficient of P_n in Eq. (1). If the gyromagnetic ratio for the Λ-particle is equal to that of the proton, then $\omega \tau$ reaches the value ≈ 0.3 for $H = 3 \times 10^4$ G.

For the $j = 3/2$, Eq. (2) takes the form

$$\begin{aligned} I = 1 &+ P_2 (\cos \theta_1) P_2 (\cos \theta_2) \\ &+ \tfrac{3}{4} \sin 2\theta_1 \sin 2\theta_2 \, [\cos (\varphi_1 - \varphi_2) \\ &\quad - \omega \tau \sin (\varphi_1 - \varphi_2)] \, / \, (1 + \omega^2 \tau^2) \\ &+ \tfrac{3}{4} \sin^2 \theta_1 \sin^2 \theta_2 \, [\cos 2 (\varphi_1 - \varphi_2) \\ &\quad - 2 \omega \tau \sin 2 (\varphi_1 - \varphi_2)] \, / \, (1 + 4\omega^2 \tau^2), \end{aligned} \qquad (3)$$