(with accuracy up to terms $\sim\epsilon^3$); here $\epsilon = (a/b)^2 - 1$. Taking $p \gg 1$, we can neglect the curvature of the surface of the nucleus and use the probability of stripping and of diffraction break up, calculated per unit length of a screen in the form of an infinite half-plane (see Ref. 2). Upon multiplication by the length of the projection of the nucleus, and averaging over all its orientations, we obtain the total cross section of stripping and diffraction disintegration of the deuteron (with accuracy up to ϵ^3):

$$\sigma_p = \sigma_n = \frac{\pi}{2} bR_d\left(1 + \frac{\varepsilon}{6} - \frac{\varepsilon^2}{40}\right);$$
$$\sigma_d = \frac{\pi b R_d}{3}\left(2\ln 2 - \frac{1}{2}\right)\left(1 + \frac{\varepsilon}{6} - \frac{\varepsilon^2}{40}\right). \quad (4)$$

The following relation holds among σ_e, σ_d and σ_t: $\sigma_e + \sigma_d = \sigma_t/2$. This equality, which was established in Ref. 1 for a spherical nucleus, holds also in the case of a black, nonspherical nucleus. Therefore, we can determine the elastic diffraction scattering cross section:

$$\sigma_e = \pi b^2\left(1 + \frac{\varepsilon}{6} - \frac{\varepsilon^2}{15}\right) + \frac{2\pi}{3} bR_d(1 - \ln 2)\left(1 + \frac{\varepsilon}{6} - \frac{\varepsilon^2}{40}\right). \quad (5)$$

For a spherical nucleus, all the formulas reduce to the formula of Akhiezer and Sitenko[1] and of Glauber.[2]

In conclusion, I express my thanks to I. S. Shapiro for discussion of the results.

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Translated by R. T. Beyer
208

CERENKOV RADIATION OF LONGITUDINALLY POLARIZED ELECTRONS

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Submitted to JETP editor January 16, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) 34, 1022-1023 (April, 1958)

THE discovery of parity non-conservation by Lee and Yang has aroused renewed interest in an investigation of longitudinal (circular) polarization since longitudinally polarized electrons are produced in β-decay.

In investigating the radiation associated with longitudinally polarized electrons, the Casimir formula cannot be used to calculate the matrix elements; instead, use must be made of Eq. (21.12) of Ref. 1 in which the spin state is explicitly taken into account, since the spin quantum number $s = \pm 1$ characterizes the eigenvalue of the operator $(\nabla\sigma)/i\sqrt{-\nabla^2}$. As has already been noted in Ref. 2 (and also in the detailed literature), this same formula can be used conveniently (with different mass values) in investigating the polarization properties of electrons produced in β-decay.

In the present work we extend the results[3] obtained in an investigation of the polarization properties of Cerenkov radiation to the case in which the electrons are longitudinally polarized.

Carrying out the summation indicated in Eq. (21.12) of Ref. 1 over the final spin states s' and fixing the initial value of the spin s we find that the Cerenkov radiation consists of three parts (in analyzing the polarization properties of the Cerenkov radiation, as in the earlier work,[3] we have used Eqs. (10), (11) and (12) of Ref. 4*):

$$W_{s\lambda} = \frac{e^2}{2c^2}\int_0^{\omega_{max}} \dot{w}_{s\lambda}(\omega)\,d\omega$$
$$= \frac{e^2}{2c^2}\int_0^{\omega_{max}} (w_{class}(\omega) + w_{quant}(\omega) + s\lambda w_{long}(\omega))\,d\omega.$$

Here $w_{class}(\omega) = \omega(1 - \cos^2\theta)$ is the classical component of the radiation (completely linearally polarized);

$$w_{quant}(\omega) = \hbar^2(n^2\omega^3/2c^2p^2)(1 - n^{-2})$$

is the quantum contribution which is completely unpolarized;

$$w_{long}(\omega) = \hbar\frac{n\omega^2}{cp}\left(1 - \frac{1}{\beta n}\cos\theta\right)$$

characterizes the longitudinally polarized radiated photons (in accordance with conventional classical optics, for $\lambda = -1$ we have right-hand circular polarization while with $\lambda = +1$ we have left-hand circular polarization although the opposite convention would be more natural). It is of interest to note that this part of the radiation is not proportional to $\hbar^2$ (as w_{quant}), but rather to $\hbar$.

The degree of circular polarization is given by the following expression:

$$P = \frac{w_1(\omega) - w_{-1}(\omega)}{w_1(\omega) + w_{-1}(\omega)} \cong s\frac{\hbar n\omega}{cp}.$$

*The notation and a bibliography for this problem are given in Ref. 3.

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Translated by H. Lashinsky
209

ELECTRON PARAMAGNETIC RESONANCE OF THE V^{+++} ION IN SAPPHIRE

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Submitted to JETP editor, January 16, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) **34**, 1023-1024 (April, 1958)

THE electronic paramagnetic resonance (epr) spectrum of the V^{+++} ion has been investigated in a sapphire single crystal Al_2O_3.

The ground state of this ion is $^3F_2$. The sevenfold degeneracy of the orbital energy level is split by a crystalline electric field of cubic symmetry into a singlet and two triplets with the triplet found at the lower level. A crystalline field of trigonal or tetragonal symmetry splits this orbital triplet into a doublet and a singlet. The lowest energy level of the V^{+++} ion in a crystalline field of trigonal symmetry is the singlet, which has a triple degeneracy $(S = 1)$. In work by Siegert[1] and van Vleck[2] it has been shown that at zero magnetic field the levels with $S_z = 0$ and $S_z = \pm 1$ should be separated by approximately $10\ cm^{-1}$. Hence one would expect to see a line corresponding to the transition from the $S_z = +1$ level to the $S_z = -1$ level. Since the number of unpaired electrons is even the $S_z = +1$ and $S_z = -1$ levels should be slightly split at zero magnetic field.

To observe the line it is necessary that its width be small, i.e., the spin-lattice relaxation time must be greater than 10^{-11} sec. In the sapphire lattice there is a strong electric field of trigonal symmetry which produces a wide separation in the lower orbital levels of the V^{+++} ion. Hence one would expect that the spin-lattice relaxation time should be sufficiently long at low temperatures. In those crystal lattices in which the axial component of the electric field is weaker there is not much hope of seeing epr lines for V^{+++}. It is for this reason that the V^{+++} spectrum has probably not been studied up to this time.

We have observed one line of the V^{+++} ion in a sapphire single crystal at $T = 4.2°K$ at frequencies ranging from 14 to 38 kilomegacycles/sec. There was a sharp reduction in line intensity when the temperature was reduced to 2°K. When the temperature was increased the line became smeared out and vanished. The line could not be observed at $T = 77°K$. The line comprises eight equidistant components corresponding to a nuclear spin $I = 7/2$ for V^{51}.

The line was observed in the parallel orientation, i.e., with the fixed magnetic field parallel to the z axis of the crystal and vanished, becoming broadened, when the crystal was rotated through an angle greater than 60° with respect to the parallel orientation. The half-widths of the individual components in the parallel orientation were 20 oersteds; the components were 108 oersteds apart.

The spectrum was interpreted by means of the spin Hamiltonian:[3]

$$\mathscr{H} = DS_z^2 + g_\parallel \beta H_z S_z + g_\perp \beta (H_x S_x + H_y S_y) + \Delta S_x + A S_z I_z + B(S_x I_x + S_y I_y),$$

where S_x, S_y and S_z are the electron spin projections, I_x, I_y, and I_z are the nuclear spin projections, H_x, H_y and H_z are the projections of the magnetic field vector, β is the Bohr magneton, D is the spacing between the $S_z = 0$ and $S_z = 1$ levels, $g_\parallel$ and $g_\perp$ are the g-factors for the two orientations, A and B are the hyperfine-splitting constants for the various orientations and the term ΔS_x denotes the small splitting of the $S_z = +1$ and $S_z = -1$ levels at zero magnetic field. The spectrum was interpreted under the assumption that $D \gg \Delta$ and $g_\parallel \beta H$ and $g_\perp \beta H$ were each greater than A or B.

$\Delta M = 1$ transitions were not observed since $D \gg h\nu$. In the case of a $\Delta M = 2$ transition we have:

$$h\nu = (2 - D^{-2}(\Delta + g_\perp \beta H \sin\alpha)^2)(g_\parallel \beta H \cos\alpha + Am),$$

where α is the angle between the magnetic field and the trigonal axis of the crystal and m is the projection of the nuclear spin on the z axis.