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On the Angular Distribution of β-Radiation. II

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THE analysis of β-radiation from oriented nuclei is of considerable interest, as relative measurements of angular distribution of β-radiation, in conjunction with theory, can give valuable information about the spins, parities and magnetic moments of β-radioactive nuclei.

A theoretical analysis of angular distribution of β-radiation has been carried out in references 1 and 2. Reference 2 in particular gives the expression $W(E, \theta)$ for the distribution (as a function of energy and of angle) of β-particles emitted by oriented nuclei for the transition $\Delta I = \pm 2$, "yes" (I is the nuclear spin, "yes" denotes that the parity of the nucleus changes upon emission of a β-ray). However the introduction of this expression in reference 2 applies only in the Born approximation.

By comparing the expression for $W(E, \theta)$ obtained in the Born approximation with the expression for the β-spectrum of the corresponding transition (including Coulomb effects[3]), it becomes quite simple to include Coulomb effects in the formula for angular distribution: in order to carry this out it is sufficient to multiply by ϕ_1 the term proportional to p^2 in the square brackets of Eq. (2), reference 3, and to multiply by ϕ_0 the term proportional to q^2; according to reference 3 (using the notation and units of reference 2):

$$\varphi_0 = \frac{1 + s_0}{2} F_0(Z, E), \tag{1}$$

$$\varphi_1 = \frac{2 + s_1}{4} F_1(Z, E). \tag{2}$$

where

$$s_n = \sqrt{(n+1)^2 - (\alpha Z)^2}, \tag{3}$$

$$\xi = Z\alpha / \beta, \tag{4}$$

and the Coulomb factors F_0 and F_1 are given by the formula

$$F_n(Z, E) = \frac{[(2n+2)!]^2}{(n!)^2 [\Gamma(1 + 2s_n)]^2} \times (2pR)^{2(s_n - n - 1)} \exp(\pi\xi) |\Gamma(s_n + i\xi)|^2. \tag{5}$$

In Eqs. (1) - (5), α denotes the fine structure constant, R the nuclear radius, β the electron velocity, Z the nuclear charge (in the case of positron emission, ξ must be replaced by $-\xi$).

Finally we obtain for the distribution of β-radiation as a function of energy and angle, for the transition $\Delta I = \pm 2$, "yes":

$$W(E, \vartheta) = {}^1/_3 (2\pi)^{-5} \pi G^2 |B_{ik}|^2 pEq^2 \times \{q^2\varphi_0 + p^2\varphi_1 [1 - a(I) f_2 P_2(\cos\vartheta)]\}. \tag{6}$$

Note that Eq. (6) can be transformed into Eq. (2) of reference 2 by neglecting terms of the order of $(\alpha Z)^2$.

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The Absorption of Ultrasonic Waves in Armco Iron and Plexiglass

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THERE are a number of works devoted to the measurement of the ultrasonic absorption coefficient in solids, although the number is still comparatively small. In many metals and dielectrics, no measurements have as yet been made, and the existing theory of the mechanism of this

TABLE

Substance	Density ρ in gm/cm^3	Frequency ν in 10^6 cps	Absorption Coefficient in cm^{-1}	Ultrasonic Velocity v in m/sec	Measurements of Other Investigations	
					α in cm^{-1}	v in m/sec
Armco Iron	7.85	0.66	0.0024			
		6	0.024			
		10	0.038	5920		
Plexiglass	1.19	0.66	0.11		0.14 [5]	
		1.4	0.21		0.22 [5]	2660 [4]
		6	0.40			2640 [5]
		10	0.55	2680		2662 [6]

absorption has not been tested experimentally. Therefore the investigation of the propagation of ultrasonic waves in different solids over a wide range of frequencies and temperatures presents considerable scientific and practical interest.

In this letter we report the results of measurements by the pulse method of the absorption and propagation velocity of ultrasonic waves over a frequency range from 0.66 to 10 mc in two substances: Armco iron and plexiglass. The experimental arrangements and techniques of measurement will be reported separately.

The results of the measurement of the absorption coefficient of ultrasonic waves α, and the propagation velocity ν in the two materials are listed in the table.

From the values obtained in the frequency range 0.6 - 10 mc, it follows that the ultrasonic absorption coefficient in Armco iron is directly proportional to the ultrasonic frequency. Investigations[1] of ultrasonic absorption in magnesium over a wide frequency range also gave a linear frequency dependence.

The data for plexiglass indicate that the absorption increases proportional to $\sqrt{\nu}$, which is in agreement with the results of other authors[2,3]. The measured velocity of the ultrasonic waves in plexiglass at $\nu = 10$ mc is also in agreement with the values in the literature[4-6]. There were no available data on ultrasonic absorption in Armco iron.

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On the Causal Development of a Coupled System in Relative Time

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IN the relativistic covariant equation which describes the coupled motion of two interacting particles[1-3], one ascribes to each particle its own time: to the first particle t_1 and to the second t_2. The question in what manner are these times t_1 and t_2 related to each other is of interest. If the external fields are stationary, we can introduce a general time $T = (t_1 + t_2)/2$ and a relative time $t = t_1 - t_2$; for simplicity we assume that the masses of the particles are equal (this corresponds, for example, to the case of positronium). We are interested in how the wave function of different times ($t \neq 0$) can be found by means of the wave function of the same times ($t = 0$), in other words in the development of a coupled system in relative time.

We recall, for example, that the development of the wave function in time of a freely moving particle is described by the operator $e^{-(i/\hbar)Ht}$

$$\psi(t) = e^{-(i/\hbar)Ht}\psi(0), \qquad (1)$$

where H is the Hamiltonian, independent of time. If we know (for example by means of some measure-