the nuclear energy level in the latter. It should be noted that in the present problem the width of the nuclear energy level is of no importance.

In the case of an electric transition, the relative probability of the internal Compton effect is given by the following:

$$\beta_j^{(1)} = \frac{2\pi (Zm\alpha)^3 (2j+1) p_f \alpha^2}{(j+1) pk} |L|^2 \Big\{ \Big(\frac{1}{m^2} + \frac{1}{p'^2}\Big) [\Delta E m^2 + k(m+k) p'] \tag{2}$$

$$\times \Big[j - (2j+1)\frac{\Delta E^2}{p^2}\Big] - \frac{2jm^3}{p'^2} + \Big(\frac{\Delta E}{mp'} + \frac{m+k}{m^2}\Big)\frac{k\Delta E^2}{p^2} p_f [(j+1)\cos\vartheta$$

$$+ (j-1)\cos(\hat{pp_f})\cos(\hat{pk})] + \frac{1}{mp'}[2j\varepsilon_f [k(\Delta E - m) - 2m^2]$$

$$-(2j+1)\frac{m\Delta E^3 \varepsilon_f}{p^2} - \frac{2k\Delta E}{p} j [m\Delta E + \varepsilon_f(\Delta E + m)] \cos(\hat{pk})$$

$$+ \frac{2\Delta E m}{p} j p_f [(\Delta E + m)\cos(\hat{pp_f})] + \frac{1}{m^2}\Big[2j[k\cdot(\varepsilon_f - m)(k - 2m) - m^2 \varepsilon_f]$$

$$-(2j+1) mk\varepsilon_f \frac{\Delta E^2}{p^2} - \frac{2\Delta E k}{p} j \Big[k\varepsilon_f + m(\Delta E + m)\cos(\hat{pk})$$

$$- \frac{2\Delta E j}{p} p_f [k(k+m) - m^2]\cos(\hat{pp_f})\Big]\Big\} \sin\vartheta d\vartheta dk.$$

Figure 2 presents curves of the angular distribution of gamma rays emitted as a result of the internal Compton effect; these were obtained by numerical integration from (1) and (2) with the photon energy k in the range from 0.05 to 0.4 mev for curve 1 and up to 0.7 mev for curve *2*. Curve *1* refers to a transition in Ba^{137m} ($M4$ transition, $\Delta E = 0.662$ mev), while curve *2* refers to a transition in Mg^{24} ($E2$ transition, $\Delta E = 1.38$ mev).

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228

On the Magnetization Mechanism of Some NiZn Ferrites in Very Weak Fields

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RATHENAU and Fast recently published the results[1] of their investigation of the initial permeability σ_a of two types of NiZn ferrites: $Ni_{0.5}Zn_{0.5}Fe_2O_4$ and $Ni_{0.36}Zn_{0.64}Fe_2O_4$ under different external stresses σ_a. The experimental data were interpreted in terms of rotations of the direction of magnetization of ferromagnetic domains. This interpretation has in particular been used by Smit and Wijn[2] as one proof that Snoek[3] was right in attributing the magnetic radio-frequency spectra of NiZn ferrites to gyromagnetic resonance.

As a basis for this view Rathenau and Fast took the agreement between the experimental data and the theoretical formula which they derived for the rotation; this formula (1) establishes a relation between $\Delta\mu_a$ and σ_a:

$$\Delta\mu_a = (9/40\pi)(\lambda_s \sigma_a \mu_a / I_s^2)\mu_a, \tag{1}$$

where I_s is the saturation magnetization and λ_s is the saturation magnetostriction.

Formula (1) was obtained (neglecting the correction for porosity of the sample) by inserting in

$$\Delta\mu_a = {}^1/_5 \, ({}^3/_2 \, \lambda_s \sigma_a \mu_a / {}^2/_3 \, K) = (9\lambda_s \sigma_a / 20K\mu_a), \tag{2}$$

the value of K from the equation

$$\mu_{a\,\mathrm{rot}} - 1 = 2\pi I_s^2 / K, \tag{3}$$

which was given by Wijn[2] and which follows from the theory of pure rotation processes that was first developed by Akulov[4].

Rathenau and Fast[1] arbitrarily assumed

$\mu_{a\,rot} = \mu_a$, which apparently predetermined their result since in actuality μ_a can be written as the sum of the initial permeabilities $\mu_a = \mu_{a\,dis} + \mu_{a\,rot} - 1$ which result from boundary displacements and magnetization rotation, respectively.

Experimental values of the anisotropy constant K_1 and the effective internal fields H_i of some NiZn ferrites have been given by Miles[5]; for example, for $Ni_{0.55}Zn_{0.45}Fe_2O_4$, which is nearly the same in composition as one of the samples investigated in Ref. 1, he gave $K_1 = 105\ I_s$ and $H_i = 190$ oersteds, whence, according to Kittel[6], we obtain the effective anisotropy constant $K = {}^1/_2 H_i I_s = 95 I_s$, which is in good agreement with K_1.

Substitution of this value of the anisotropy with $I_s = 335$ gauss and $\lambda_s = 10 \times 10^{-6}$ in (2) gives for the first sample $\Delta\mu_a = 0.013\ \mu_a$ kg/mm² as compared with the experimental value $0.15\mu_a$ = kg/mm² which was calculated by Rathenau and Fast using an excessively high estimate of $\mu_{a\,rot} = \mu_a = 240$ gauss/oersted instead of the more probable value $\mu_{a\,rot} \sim 2\pi\,(335/105) + 1 = 20$ gauss/oersted (or, according to Kittel's formula, $\mu_{a\,rot} \sim (4\pi/3) \times (335/105) + 1 = 15$ gauss/oersted).

For boundary displacements, as noted in Ref. 1, the coefficient 1/5 of (2) must be considerably increased. On the basis of the experimental information in Ref. 1 and the values of the anisotropy constant in Ref. 5 it is easily shown that this coefficient must be ~ 2 for the first sample of a NiZn ferrite and ~ 3 for the second sample, i.e., it is of the order of the values obtained by Bozorth and Williams[7] for 45% permalloy.

For boundary displacements, the magnetization process in very weak fields can be attributed, according to Kondorskii's general theory of reversible displacement (Ref. 8, Sec. 53) to impurities and internal stresses σ_i. Since Ref. 1 does not contain information concerning impurities in NiZn ferrites we shall attempt to estimate $\mu_{\alpha\,dis}$ for these ferrites according to Kondorskii's theory of stresses (Ref. 8) p. 359), especially since experimental data definitely indicate the importance of magnetoelastic energy $\lambda_s \sigma_i$ in some ferrites. For this purpose we shall use the graphs of $\mu_a(\sigma_a)$ given in Figs. 1 and 2 of Ref. 1, from which, according to Vonsovskii's theory (Ref. 8, pp. 408 and 767) we can estimate the mean value of the internal stresses, obtaining $\sigma_i \sim 1$ kg/mm² for the first sample and $\sigma_i \sim 0.2$ kg/mm² for the second sample. Assuming in zero approximation that the stress distribution in the material is sinusoidal, we obtain the values of the internal stress amplitudes $\sigma_{0i} \sim 2$ kg/mm² and $\sigma_{0i} \sim 0.4$ kg/mm², respectively, whence from

$$\mu_{a\,dis} - 1 \approx 4\pi I_s^2 / 3\lambda_s \sigma_{0i}, \tag{4}$$

we obtain for the first sample $\mu_{a\,dis} = 235$ gauss/oersted and for the second ($I_s = 2966$, $\lambda_s = 5 \times 10^{-6}$ $\times\ \mu_{a\,dis} = 1820$ gauss/oersted. The first of these values is in extremely good agreement with Rathenau and Fast[1] ($\mu_a = 240$ gauss/oersted); the second value is in much poorer agreement with these data ($\mu_a = 700$ gauss/oersted), which probably indicates the large role of impurities in the second sample, which was apparently sintered at a relatively low temperature. It is interesting to note that the composition of the second sample is close to the optimum for NiZn ferrites, which is usually used at quite high sintering temperature $\sim 1350°$ in order to obtain cores of high initial permeability $\mu_a \approx 2000$ gauss/oersted. The possibility of obtaining such values of μ_a for the given composition when the effect of impurities is eliminated follows directly from the calculations.

We note in conclusion that the predominant role of displacements in NiZn ferrites sintered at not too low temperatures also follows from our investigations[9] of the magnetic spectra of ferrites with zero and residual magnetization. The foregoing considerations can therefore be regarded as an additional confirmation of our deduction.

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230