W_m, arising from the magnetic field a minimum. This energy is

$$W_m=\int \Psi^* H_m \Psi d\tau=\frac{1}{2m}\Sigma_\alpha \int \Psi_0^*\left[-\frac{ie\hbar}{c}\,\mathrm{div}(\mathbf{A}_\alpha+\mathrm{grad}\varphi_\alpha)\right]$$
$$-\frac{2ie\hbar}{c}(\mathbf{A}_\alpha+\mathrm{grad}\varphi_\alpha)\,\mathrm{grad}_\alpha+\frac{e^2}{c^2}(\mathbf{A}_\alpha+\mathrm{grad}\varphi_\alpha)^2\Psi_0 d\tau_1\cdots d\tau_n. \quad (6)$$

After an integration by parts, (6) can be written in the form

$$W_m=\frac{i}{c}\int(\mathbf{A}+\mathrm{grad}\varphi)\cdot\mathbf{j}_0(\mathbf{r})d\tau-\frac{2}{2mc^2}\int(\mathbf{A}+\mathrm{grad}\varphi)^2\rho_0(\mathbf{r})d\tau, \quad (7)$$

where $\mathbf{j}_0$ and ρ_0 are the current and charge densities in the absence of a field:

$$\mathbf{j}_0(\mathbf{r})=(ie\hbar/2m)\Sigma_\alpha\int(\Psi_0^*\,\mathrm{grad}_\alpha\Psi_0-\Psi_0\,\mathrm{grad}_\alpha\Psi_0^*)$$
$$\times\delta(\mathbf{r}-\mathbf{r}_\alpha)d\tau_1\cdots d\tau_n,$$
$$\rho_0=-e\Sigma_\alpha\int\Psi_0^*\Psi_0\delta(\mathbf{r}-\mathbf{r}_\alpha)d\tau_1\cdots d\tau_n. \quad (8)$$

We shall assume that $\mathbf{j}_0=0$ and $\rho_0=$const. The condition that W_m be invariant for small changes $\Delta\varphi$ in φ is then

$$\delta W_m=-(e\rho_0/mc^2)\int[(\mathbf{A}+\mathrm{grad}\varphi)\cdot\mathrm{grad}\Delta\varphi]d\tau=0,$$

or, after an integration by parts

$$\int\Delta\varphi\,\mathrm{div}(\mathbf{A}+\mathrm{grad}\varphi)d\tau-\int\Delta\varphi(\mathbf{A}+\mathrm{grad}\varphi)_\perp dS=0. \quad (9)$$

The second integral is over the surface, S. If (9) is to be satisfied for all $\Delta\varphi$ we must have

$$\mathrm{div}(\mathbf{A}+\mathrm{grad}\varphi)=0;\quad(\mathbf{A}+\mathrm{grad}\varphi)_\perp=0\text{ on }S. \quad (10)$$

Choosing φ in this way is equivalent to choosing the gauge so that (2) is satisfied and taking $\Psi=\Psi_0$.

We have used[3] this approach in a theory of superconductivity based on interactions between electrons and lattice vibrations.[4]

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Crystalline Magnetic Anisotropy in Zinc Manganese Ferrite

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We have grown crystals of zinc manganese ferrite whose composition is approximately $Zn_{0.55}Mn_{0.45}Fe_2O_4$. From the saturation magnetization, M_s, and from ferromagnetic resonance data, we have determined the crystalline magnetic anisotropy, K, of these crystals. The measurements were made at room temperature, by essentially the same procedure as the earlier measurements on nickel ferrite.[1,2] The value of M_s was measured by comparison with nickel ferrite in a hysteresis loop tracer; M_s for nickel ferrite has been measured by Guillaud and Roux[3] as well as by us.[2]

The crystals were grown in a manner similar to that by which nickel ferrite crystals were grown earlier.[2] A mix of 15 g borax, 6.4 g Fe_2O_3, 1.6 g ZnO, 1.4 g MnO was heated to 1325°C in a platinum crucible and held for 5½ hours. It was then cooled at approximately 100°C/hr simply by turning off the furnace. The resulting crystals ranged in size up to octahedra 1 mm on an edge. Most of them were not mechanically sound, but one good one was found which showed cubic symmetry magnetically. Chemical analysis showed that this material is approximately $Zn_{0.55}Mn_{0.45}Fe_2O_4$. There were no significant impurities.

The value of K/M for these materials at room temperature was determined from the variation with crystallographic direction of the magnetic field required to produce ferromagnetic resonance[1,4] at 24,160 Mc. The width of the resonance line, ΔH, and the g factor[5] were also observed. The variations in ΔH with crystallographic direction were not large enough to be significant. The results are given in Table I.

TABLE I. Measurements on zinc manganese ferrite.

K/M	M(cgs units)	K(ergs/cc)	ΔH(oe)	g
−21±5%	181±10%	−3800±15%	70	1.997

Check measurements were made on a second sample. This sample did not show cubic symmetry magnetically but the magnitude of the variations in the field required for resonance was the same.

Snoek[6] has suggested that the effect field due to magnetocrystalline anisotropy acting on a material in no external field will cause resonance or perhaps relaxation behavior in the initial permeability of the material; this behavior should occur at the frequency of the Larmor precession in the effective field. This effective internal field when the magnetization is along an easy direction ([111] in these crystals) is:[7]

$$H_{\mathrm{eff}}=-1.33K/M.$$

This leads us to expect this behavior at 78 Mc in this material. This frequency may be increased if the effective field is increased by the presence of free poles due to the domain pattern; it is therefore a lower limit in practice.

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The Absence of Cross-Over Transitions in Tellurium Isomers

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A MODIFIED estimate of multipole radiation probabilities has been put forward recently by Weisskopf.[1] According to this theory, the probability λ of electric 2^e pole radiation is given by

$$\lambda=\frac{2(e+1)}{e}[1\cdot3\cdot5\cdots(2e+1)]^{-2}\frac{K^{2e+1}}{\hbar}e^2R^2l,$$

and the probability of magnetic 2^e pole radiation is lower than that of electric 2^e pole by a factor $\sim(\hbar/McR)^2$. K is the wave number, $2\pi\nu/c$, of the radiation, M is the nucleon mass, and R is the nuclear radius. It is to be realized that this formula, like previous ones based on older estimates, is claimed to be valid only to within a factor $\sim10^{\pm2}$. In the following note it is pointed out that Weisskopf's formula, unlike earlier ones, is consistent with the absence of cross-over transitions in the decay of several long-lived tellurium isomers.

Isomers of $Te^{121,123,125}$ have been observed[2] to decay in two successive transitions, the first being preponderantly magnetic 2^4 pole and the second being magnetic dipole. It was puzzling, on the basis of the older radiation formulas, that no cross-over transitions of an electric 2^5 character, between the long-lived and the ground states, were observed experimentally.

Relative probabilities of magnetic 2^4 and electric 2^5 transitions have been calculated and are tabulated in Table I. Columns 2 and 3 give, respectively, the energies of the long-lived magnetic