where coulomb forces probably are of importance. Other points in Fig. 1 represent odd proton nuclei for which the corresponding odd neutron nuclei have not yet been measured. The moments of these odd neutron nuclei may then be predicted with some assurance to lie near those for the corresponding odd proton nuclei.

On this basis predictions of magnetic moments of odd neutron nuclei are given in Table I. Judging from the deviations in Fig. 1, the accuracy of these predictions should be approximately ± 0.1 nuclear magneton.

All nuclear moments used in Fig. 1 and Table I are taken from Mack's review article,[3] except S^{33} and Mg^{25} which are from more recent publications.[4,5]

Considerations of this general type are probably not new, but it seems worthwhile to examine the agreement with experiment now that some odd neutron nuclei moments are being measured. The predicted values may be of use in searching for unknown moments by the nuclear induction method.

* Work supported by the AEC.

[1] The O^{17} spin is 5/2 according to F. Alder and F. C. Yu, Phys. Rev. **81**, 1066 (1951). A spin of 5/2 is also indicated by recent work at Columbia University.

[2] A. Bohr, Phys. Rev. **81**, 134 (1951).

[3] J. E. Mack, Revs. Modern Phys. **22**, 64 (1950).

[4] Eshbach, Hillger, and Jen, Phys. Rev. **80**, 1106 (1950).

[5] We are grateful to F. Alder and F. C. Yu for communicating their value of the Mg^{5} moment to us before publication. This value is consistent with, but more precise than, the spectroscopic value quoted by Mack.

The Magnetization Process in Ferrites

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IT is known how the initial permeability μ_0 of ferrites[1] changes with frequency:[2] μ_0 is constant at relatively low frequencies and drops to very low values in a frequency range where resonance phenomena take place. Snoek ascribes this drop to the resonance of the magnetic spins caused by the rf magnetic field in the constant internal anisotropy fields. A close relationship between the value of this resonance frequency and the expected strength of the internal anisotropy fields, as deduced from the value of the initial permeability, has been well proven.[3] In Snoek's theory, it is assumed that the magnetization of ferrites in a small external field is caused by the simultaneous rotation of the electron spins, and not by the reversible Bloch-wall displacements, which are believed to be the cause of the magnetization of ferromagnetic metals in small fields.[4] Therefore, we wish to draw attention to some experiments we performed which shed some light on the magnetization process of ferrites, also at higher inductions.

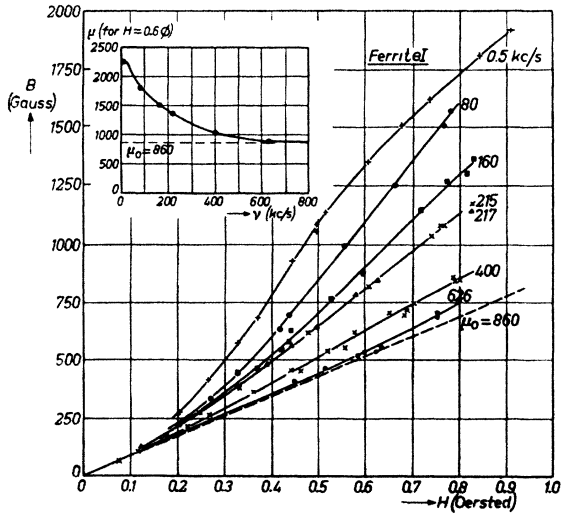

FIG. 1. Initial magnetization curve of ferrite I as a function of frequency.

TABLE I. Composition of ferrites.

Ferrite No.	Composition in mol. % (balance Fe_2O_3) MnO	NiO	ZnO	Density	Gyromagnetic resonance frequency* in Mc/sec
I	43.5	—		4.70	1
IIA	—	25	25	4.55	14
IIB	—	27	23	5.21	10

* The frequency for which μ'' has a maximum ($\mu_0 = \mu' - j\mu''$).

The initial magnetization curve of some ferrites has been measured as a function of frequency by applying a sinusoidal magnetic field of amplitude H_{max} to a toroidal ferrite core with a rectangular cross section. The maximum of the nonsinusoidal induction B_{max} in the core has been determined from the emf induced in a second winding on the core and rectified by a Gratz circuit. Precautions were taken to avoid partial short-circuiting of the primary and the secondary of the transformer.

For the manganese-ferrous-ferrite I (see Table I), Fig. 1 shows the behavior of the initial magnetization curve as a function of frequency. All ferrites with a high permeability have similar frequency-dependent magnetization curves. From Fig. 1 it is clear that here we have two different magnetization processes. The first, which is independent of frequency below the gyromagnetic resonance frequency, determines μ_0, while for field strengths approximately equal to the coercive force the other gives an additional magnetization which already disappears for a frequency below the gyromagnetic resonance frequency of the ferrite (see the straight line $B = \mu_0 H$ for the magnetization curve of ferrite I at 626 kc/sec). The frequency-dependence of the latter process can be described with a single relaxation time.

Another fact seems to give an indication of the kind of magnetization process involved. When two ferrites of about the same composition (IIA and IIB, see Table I) are fired at 1200°C and 1400°C, respectively, the magnetization curves are very different

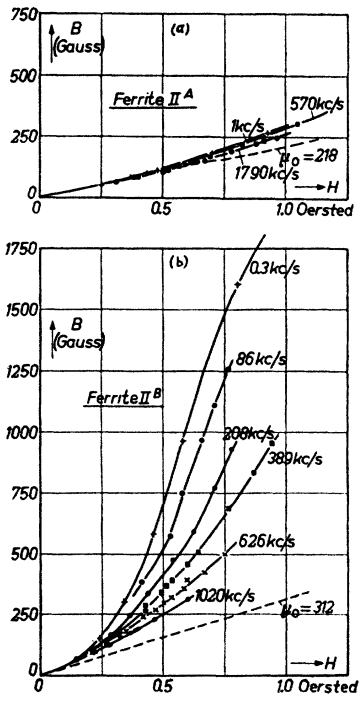

FIG. 2. Initial magnetization curves of ferrites IIA and IIB as functions of frequency.

(Figs. 2a and 2b). The additional magnetization of the ferrite IIB is frequency-dependent, similar to that of ferrite I.

Distortion measurements have also been carried out on transformers having these ferrite cores. The distortion gradually decreases with frequency and reaches zero at the frequency where B is a linear function of H.

From these results it is concluded that in ferrites with a high permeability, at magnetic field strengths of about H_c, an additional magnetization process occurs which (a) is frequency-dependent already below the gyromagnetic resonance frequency, (b) takes place at a lower field strength as the density of the ferrite is greater, (c) is irreversible (since Rayleigh's law holds in small fields).

The initial permeability and the permeability at high frequencies, which is independent of the field strength, are, in our opinion, related to a pure rotational process. In contrast to the magnetization process giving rise to the above-mentioned permeabilities, the additional process is to be ascribed to irreversible Bloch-wall displacements in the ferrite. These results are contradictory to the conclusions reached by Rado *et al.*,[5] that the initial permeability of ferrites is determined by reversible Bloch-wall displacements. A detailed paper on these experiments will be published shortly.[6]

[1] See J. L. Snoek, *New Developments in Ferromagnetic Materials* (Amsterdam, New York, 1947).
[2] J. L. Snoek, Physica **14**, 207 (1948).
[3] D. Polder, Proc. Inst. Elec. Engrs. **97**, II, 246 (1950).
[4] C. Kittel, Revs. Modern Phys. **21**, 541 (1949).
[5] Rado, Wright, and Emerson, Phys. Rev. **80**, 273 (1950).
[6] J. J. Went and H. P. J. Wijn, Physica, to be published.

Cross Section for the Reaction $C^{12}(\gamma, n)C^{11}$

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THE cross-section curve for the reaction $C^{12}(\gamma, n)C^{11}$ has been determined by Baldwin and Klaiber.[1] However, in view of the discrepancy in the results obtained by these authors and the workers in our laboratory[2] for the reaction $Cu^{63}(\gamma, n)Cu^{62}$, the carbon cross section has been redetermined.

Carbon disks, 1.5 cm in diameter and 1.27 mm thick, were irradiated in a cavity in a Lucite block. The dose was monitored by an "r" meter placed in the same position. The resulting 20.6-min activity was counted in a fixed geometry. Figure 1 shows the saturated specific activity as a function of maximum betatron energy. Corrections for back-scattering, self-absorption, isotopic abundance, and geometry have been applied. The threshold for this reaction, assumed at 18.7 Mev,[3,4] has been used as a calibration point for the betatron energy scale. No attempt has been made to show the portion of the activity curve between 18.7 and 20 Mev, although the contribution of this portion has been considered in the cross-section determination. The experimental points on the activity curve represented by circles were determined with the integrator circuit previously reported.[3] The points marked with a cross were determined by the betatron panel meter. The two sets of results were brought into agreement by determining overlapping activity curves in the region 22 to 24 Mev.

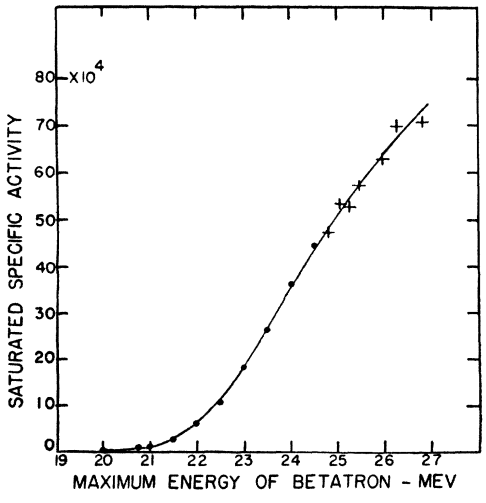

FIG. 1. Saturated specific activity in disintegrations per gram per 100 r as a function of maximum betatron energy, for the reaction $C^{12}(\gamma, n)C^{11}$. Corrections for geometry, etc., have been applied.

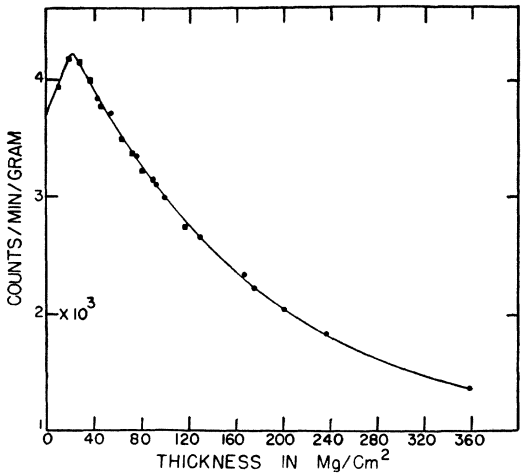

FIG. 2. Self-absorption curve for the positron activity of C^{11}.

As a check on some of the corrections applied in finding the saturated specific activity of carbon, copper and carbon samples were irradiated simultaneously at 23.5 Mev and counted in the same geometry. In determining the carbon activity, use was made of the results previously reported for copper[2] (lowered by 10 percent in agreement with more recent determinations). This latter method yielded a value for the saturated specific activity of carbon 5 percent higher than is reported here. This agreement is very satisfactory when one considers the possible errors involved.

The saturated specific activity curve has been used to determine the neutron yield at 22 Mev. The value obtained, 7.5×10^3 neutrons/mole/r, is in good agreement with the value 6.7×10^3 obtained by Price and Kerst.[5]

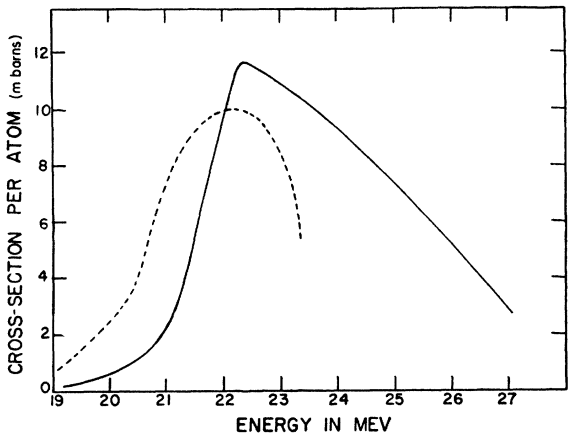

FIG. 3. Cross section *vs* energy curve for $C^{12}(\gamma, n)C^{11}$. The dotted curve shows the shape of the corresponding curve for $C^{12}(\gamma, p)B^{11}$ (reference 12).