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CIRCULAR POLARIZATION OF GAMMA QUANTA IN THE REACTION $B^{10}(d, p\gamma)B^{11}$

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ZIMANYI has shown in an earlier paper[1] that a reaction that yields polarized products causes the final nucleus to become excited so as to emit a circularly-polarized γ quantum after emission of the nucleon, if the quantum is registered simultaneously with the nucleon. This circular polarization is connected with the polarization of the final nucleus by the known relations of multipole radiation, so that by determining the degree of polarization of the γ quanta we determine the polarization vector of the final nucleus. Satchler[2] and Zimanyi[3] have established recently that measurement of the circular polarization of the γ quanta may be particularly important in the investigation of stripping reactions, since it can yield information on the noncentral part of the interaction.

We have carried out experiments on the determination of the circular polarization of 2.14-Mev γ quanta from the first excited state of B^{11} in the reaction $B^{10}(d, p\gamma)B^{11}$. A thick layer of boron enriched with B^{10} to 90 percent was bombarded with 420-kev deuterons. The stripping mechanism plays an important part even at so low an energy.[4]

The experimental setup is shown in Fig. 1. We detected the protons and γ quanta emitted at 90° to the deuteron beam; the azimuthal angle between the two detectors was also 90°. We used the usual slow and fast coincidence system with resolution $\tau = 2.3 \times 10^{-9}$ sec. The slow part of the circuit consisted of two single-channel pulse-height analyzers to detect the 7.1-Mev protons and 2.14-Mev γ quanta. The polarization analyzer used was a core 8 cm long, made of Armco iron.

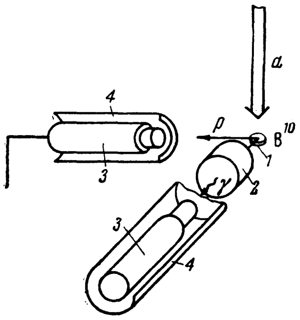

FIG. 1. Diagram of experimental setup: 1 – target, 2 – analyzer, 3 – photomultiplier, 4 – shield.

If we denote by N^+ and N^- the number of γ quanta detected after passage through an analyzer magnetized parallel and antiparallel to the direction of propagation of the γ quanta, then the polarization is

$$P_\gamma = A(N^+ - N^-)/(N^+ + N^-).$$

The constant A depends on the energy of the γ quanta and on the geometry of the analyzer. In our case A = 32.

To prevent the stray field of the magnet from producing an asymmetry that may affect the photomultiplier, we used a permalloy shield and carried out two series of measurements, the geometry of which is shown in Fig. 2. If the magnetic field has axial symmetry, the asymmetry of the setup for cases 2a and 2b will be the same, but the sign of the polarization will be reversed. The effect of instability of the electronic apparatus was eliminated by changing the magnetization direction every 200 sec.

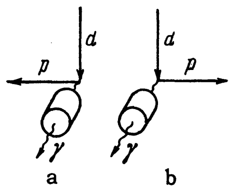

FIG. 2. Paths of deuterons, protons, and γ rays for the two measurements.

The results obtained so far are tentative, since only some 40 000 coincidences were counted. The polarization was found to be $P_\gamma = 37 \pm 19$ percent with the sign of $\mathbf{n} = \mathbf{k}_d \times \mathbf{k}_p$ chosen positive, in accordance with the agreement in Basle. Since the radiation of the 2.14-Mev γ quanta investigated in our experiment is a pure M1 transition[5] and the first excited level of B^{11} has a spin $I = 1/2$, the connection between the circular polarization and the polarization of the final nucleus is of the form $P_f = -2P_\gamma$. At the present state of the measurements, the statistical error is considerable, so that we are continuing our measurements to accumulate adequate statistics.

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CAUSES OF ANOMALOUS BROADENING OF FERROMAGNETIC RESONANCE ABSORPTION LINE IN FERRITES NEAR THE CURIE POINT

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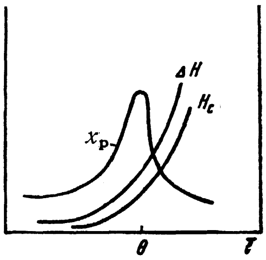
IN measurements of the temperature dependence of ferromagnetic resonance in ferrites (both mono- and polycrystals) it was noted many times that as the Curie point is approached the width of the resonance-absorption line increases anomalously. In the theories of de Gennes, Kittel and Portis[1] and of Skrotskii and Kurbatov[2] this increase is ascribed to the influence of thermal fluctuations of the spontaneous magnetization, which, as is well known, reach a maximum near the Curie point. According to reference 2, this last circumstance leads to inhomogeneities of the internal (exchange) field, causing a spread in the resonance frequencies and consequently a broadening of the resonance line.

Making use of an analysis of the experimental material, we propose here arguments that indicate that the thermal fluctuations of the spontaneous magnetization are not the principal cause of the marked increase in the width of the ferromagnetic-resonance line near the Curie point; the main cause of the anomalous broadening of the resonance line near the Curie point is masked by the influence of structural factors. These arguments are as follows.

1. The quantitative manifestation of the intensity of thermal fluctuations of spontaneous magnetization near the Curie point may be the maximum (see Fig. 1) of the susceptibility of the para process, χ_p (inasmuch as χ_p is measured in a field, the fluctuations of the magnetization are somewhat suppressed by this field). According to the foregoing theories, it might appear that the temperature dependence of the line width $\Delta H(T)$ should essentially duplicate the course of the $\chi_p(T)$ curve, i.e., a maximum should be observed on the $\Delta H(T)$ curve in the vicinity of the Curie point. This, however, is not observed experimentally. Near the Curie temperature, where thermal fluctuations of the spontaneous magnetization take place, ΔH increases continuously (see the figure).

Temperature variation (schematic) of the width ΔH of the resonance curve, the coercive force H_c, and the susceptibility of the para process χ_p in ferrites in the vicinity of the Curie point.



In addition, the maximum increase in ΔH does not coincide with the position of the maximum of χ_p. This suggests that the thermal fluctuations of the spontaneous magnetization influence little the width of the resonance line, if at all.

2. In our opinion, a more influential factor causing the broadening of the resonance line near the Curie point are the structural inhomogeneities in the ferrites, which, in turn, lead to inhomogeneities in the spontaneous magnetization through the body of the specimen (volume fluctuations of the spontaneous magnetization). In ferrites (both mono- and polycrystals) such structural inhomogeneities may be the following: disordered distribution of the magnetic ions over the octohedral and tetrahedral sites,* the presence of atomic vacancies, dislocations, etc. As shown by us in earlier papers,[3] the spontaneous magnetization is particularly sensitive to the structural inhomogeneities in the region of the Curie point, where the