the way, we should note that the commonly assumed opinion that the meson has spin equal to ½ is based not on very dependable, but only on indirect evidence; in reference to the choice between the values ½ and 3/2 for the spin, a choice cannot be made at the present time.

The levels of the meson atoms are degenerate in orbital momentum and this makes the identification of the transitions difficult. However, the effect of the finite size of the nucleus leads to the removal of the degeneracy for large Z. For instance, for the meson atom formed in the nucleus of lead the $2s$ level is approximately 1 mev above the $2p$ level[2]. Consider now the μ meson which got to the $2s$ level during the formation of the meson atom and by subsequent transitions; it goes over into the ground state of the meson atom by the way of the subsequent radiative transitions $2s \rightarrow 2p \rightarrow 1s$. If the spin of the meson is ½ or 3/2, then the angles between the γ-quanta are distributed almost isotropically, i.e., $W(\theta) \sim \sin\theta$. On the other hand, if the spin is zero, $W(\theta) \sim (1 + \cos^2\theta)\sin\theta$. In an analogous way, we can observe the difference between spins of ½ and 3/2. In particular, for the transition $3p \rightarrow 2s \rightarrow 2p$ the angular distribution is exactly isotropic if the spin is ½ and non-isotropic if the spin is 3/2.

During the cascade emission of γ-quanta by nuclei, the angular correlation can in some cases be strongly supressed because of the interaction of the magnetic moment of the nucleus with the magnetic field caused by the electron shell. The estimates given in reference 1 show that this phenomenon does not appear if the lifetime of the intermediate state $t \leq 3 \times 10^{-11}$ sec. Approximately the same estimates are valid in the case under consideration, the only difference being that the role of the magnetic moment of the nucleus is replaced by the magnetic moment of the meson atom. The lifetimes of meson-atom transitions are very small. For instance, for lead the lifetime of the μ meson in $2s$ state is $\sim 10^{-17}$ sec, and for $Z = 25$, $t \sim 2 \times 10^{-13}$ sec[2]. Therefore, as a rule, we can neglect the effect of the electron orbits.

For meson atoms an additional question can arise concerning the interaction of the magnetic moments of the meson atom and the nucelus. We will not consider this question here in detail, but note that in practice it is always possible to study the meson atoms formed in nuclei with zero momentum, where the above interaction is absent. Another complication arises if the mesons experience very large nuclear capture (for instance π-mesons). In this case we must exclude from consideration levels for which the probability of nuclear capture is much greater than the probability of the radiative transition. For not too large Z the above applies only for levels with zero orbital momentum.

The author is thankful to I. S. Shapiro for participating in the discussion.

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Rotation of the Plane of Polarization in a Longitudinal Magnetic Field at a Wavelength of 3 cm

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WITH the development of radio direction finding and the appearance of ferromagnetic dielectrics[1], the rotation of the plane of polarization in a magnetic field (Faraday effect) has become of great practical importance and has found extensive application in UHF techniques.

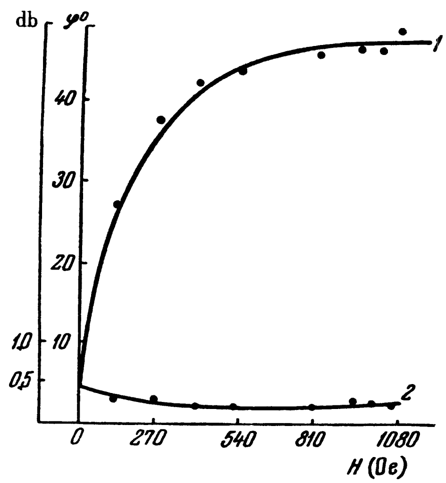

FIG. 1. Dependence of (1) angle of rotation of the plane of polarization φ in degrees, (2) losses, in decibels, on the magnetic field intensity for a sample of NZ-500 45 mm long.

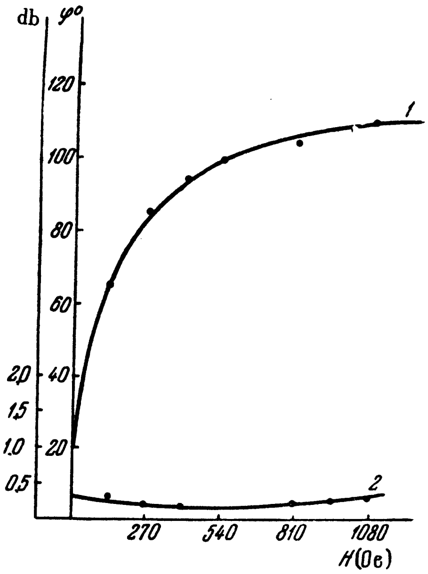

FIG. 2. Dependence of (*1*) angle of rotation of the plane of polarization φ in degrees, (*2*) losses, in decibels, on the magnetic field intensity for a sample of NZ-500 77 mm long.

The Faraday effect has been utilized in the design of microwave switches, one-way transmission systems, electrically controlled attenuators, devices for the measurement of weak magnetic fields, for obtaining circular polarization, for high-frequency modulation, for beacon rotation in radio direction finding, for automatic control of high-frequency signals, etc.

The application of the Faraday effect to wavelengths of the order of a few centimeters is limited by high-frequency losses introduced by ferromagnetic semiconductors – ferrites, which are used as the rotating medium. It has therefore been important to investigate commercial ferrites as to the possibility of their application and practical utilization of magnetic rotation of the plane of polarization in the centimeter-wave region.

We investigated the "oxyfers" (RCh-10, RCh-15, RCh-50) and the Ni-Zn ferrites (NZ-100, NZ-250, NZ-500, NZ-L, NZ-L_2, NZ-31, NZ-38, NZ-40, NZ-41, NZ-43 and NZ-45) in the form of thin discs completely filling the wave guide and in the form of thin cylinders placed along the axis of a cylindrical wave guide. The measurements were carried out by a wave with $\lambda = 3$ cm, using a method similar to that described in reference 2. The ferrites NZ-500, NZ-250 and NZ-L showed relatively small losses. Best results were obtained with the ferrite NZ-500 in powder form, annealed at 1000° C. The pulverized ferrite filled a polystyrene or a quartz tube having external and internal diameters 7.0 and 5.7 mm, respectively.

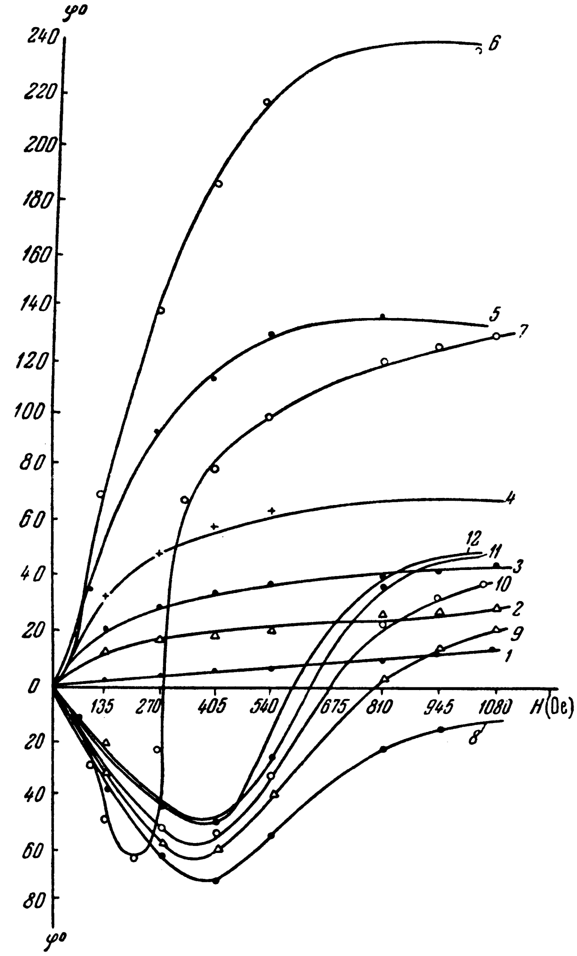

FIG. 3. Dependence of φ on H for the NZ-100 ferrite rods of diameters: 1-3 mm, 2-4 mm, 3-5 mm, 4-6 mm, 5-7 mm, 6-8 mm, 7-9 mm, 8-10 mm, 9-11 mm, 10-12 mm, 11-13 mm, 12-14 mm.

Figure 1 shows the dependence of the angle φ of rotation of the plane of polarization (in degrees), and of the losses (in decibels), on the intensity of the external longitudinal field H for the NZ-500 ferrite sample, in powder form, filling a quartz tube of 45 mm length. Figure 2 shows the same relation for a sample of powder form ferrite NZ-500 in a quartz tube 77 mm long. The first sample was prepared for use in a one-way transmission system. The desired angle of rotation of 45 degrees was attained at a relatively weak magnetic field of 540 oersteds, where saturation was reached. The second sample was prepared for the construction of a high-frequency switch. The desired angle of

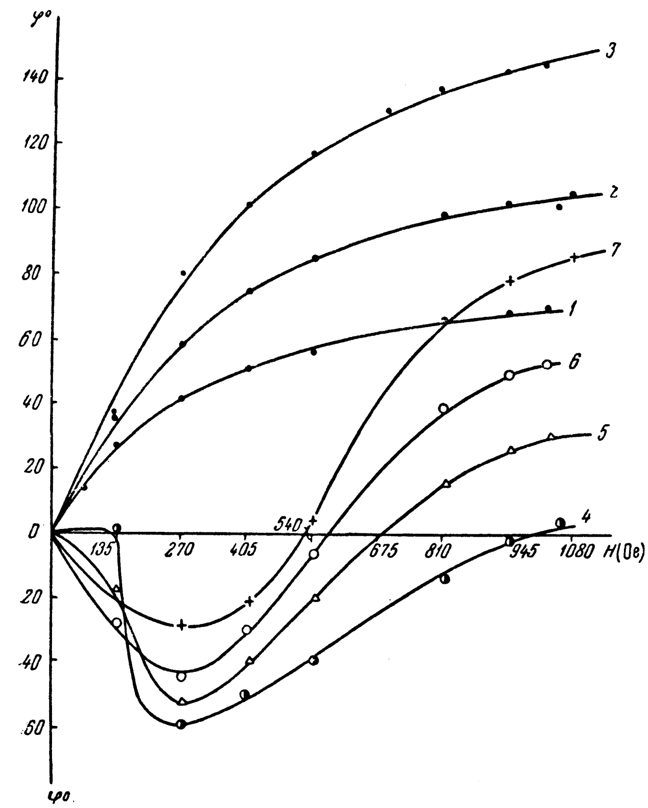

FIG. 4. Dependence of φ on H for the NZ-40 ferrite rods of diameters: 1-7 mm, 2-8 mm, 3-9 mm, 4-10 mm, 5-11 mm, 6-12 mm, 7-13 mm.

rotation of the plane of polarization of 90 degrees was attained with the external field of 400 oersteds. In both cases the wave at the output remains linearly polarized, and the high-frequency losses do not exceed 0.5 db. The latter fact demonstrates that the high-frequency losses, being quite small (0.5 db) are not caused by absorption in the ferrite but by reflection off the sample, since in this experiment the sample did not specially fit the wave guide. The ferrite NZ-500, not showing losses at the wavelength of 3 cm, may therefore be used successfully in UHF applications.

In connection with the fact that waves of higher modes may become excited in ferrite rods of large diameter, it was very important to investigate how the rotation of the plane of polarization (dependence of φ on H) changes with the diameter of the ferrite rods. The dependence of φ on H for rods of various diameters was investigated with a NZ-100 ferrite sample 41.3 mm long (Fig. 3) and a NZ-40 ferrite sample 36.5 mm long (Fig. 4). From Figs. 3 and 4 it may be seen that the normal dependence of φ on H is obtained for relatively thin ferrite rods of 3 to 8 mm in diameter (wave guide diameter 21.8 mm). The ferrite rods of larger diameter, in which waves of higher modes are excited, show an anomalous dependence of φ on H, a fact which should be taken into account when ferrite rods are used.

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