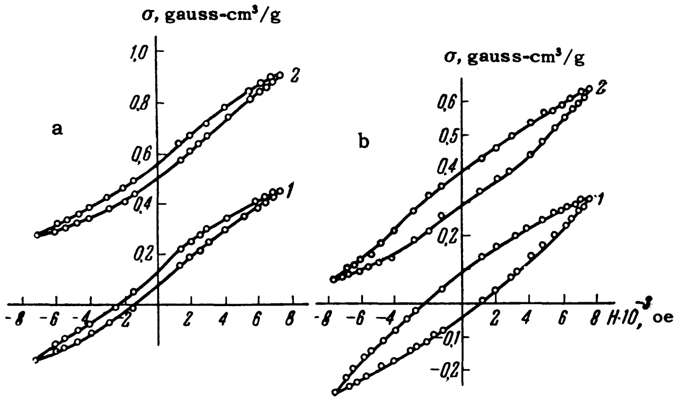

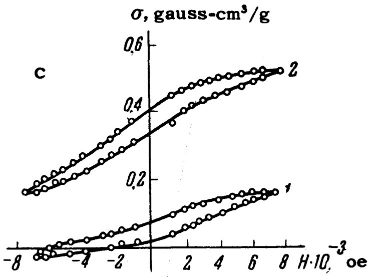

FIG. 2. Magnetic hysteresis loops at 22°C: a – stoichiometric $Pr_2O_3 \cdot Fe_2O_3$ ferrite, b – for specimen with excess iron, $Pr_2O_3 \cdot 1.67Fe_2O_3$, c – for $La_2O_3 \cdot Fe_2O_3$ specimen (1 – initial state, 2 – after cooling in magnetic field from the Curie point).

composition of the specimen to stoichiometric and decreases with increasing excess of Fe_2O_3. Analogous phenomena were recently observed by Watanabe[4] for $Nd_2O_3 \cdot Fe_2O_3$ and $La_2O_3 \cdot Fe_2O_3$.

It should be noted that the hysteresis loops shown in Fig. 2 are partial cycles, since the magnetization did not reach saturation in 7500-oe fields for any of the investigated ferrites. Nevertheless, the coercive force of the partial cycle is very large, on the order of 1000 oe. There are grounds for assuming that the total coercive force of the investigated ferrite samples is tremendous. This is apparently a common property of many rare-earth ferrites with perovskite structure, which are characterized, as indicated by Bozorth,[5] by a large magnetic anisotropy.

This explains the asymmetry of the hysteresis loop about the ordinate axis after cooling in the field. Upon cooling from the Curie point in a field, a residual magnetization corresponding to the total coercive force is produced (thermoremanence magnetization). This magnetization cannot be completely destroyed by a 7500-oe field. The "undestroyed" portion of the residual magnetization indeed shifts the partial hysteresis cycles of Fig. 2 along the magnetization axis. The presence of excess Fe_2O_3 in the ferrite apparently reduces the anisotropy of the perovskite-ferrite, and this leads in turn to a reduction in the effect of shifting the hysteresis loop along the magnetization axis.

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USE OF DISPERSION RELATIONS FOR A TEST OF QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES

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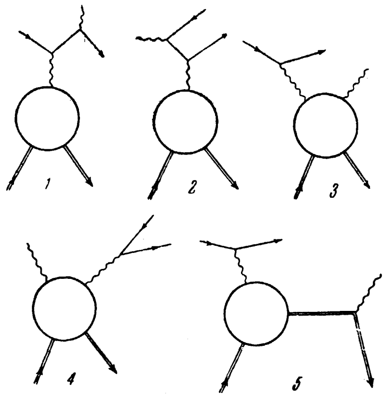
FOR electron and γ quantum energies higher than 150 Mev in bremsstrahlung and pair creation processes it is evidently necessary to consider not only the diagrams of the Bethe-Heitler type 1 and 2 (see the figure), but also the contributions from the generalized diagrams 3 and 4. These latter diagrams were not calculated in reference 1. However, their inclusion would make it possible to test quantum electrodynamics, in the spirit of the idea of Drell,[2] energies $\geq$ 500 to 600 Mev, as long as the higher order corrections in e do not become significant.

To compute the diagrams 3 and 4 we used the method of dispersion relations developed by Bogolyubov.[3] Starting from the existence proof of Vladimirov and Logunov[4] for the dispersion relations in the case of the virtual Compton effect, we obtained these relations in the center of mass system.[5] The first approximation of these dispersion relations allows us in a rigorous fashion to introduce form factors of the Hofstadter type at the nucleon vertex connected to the virtual γ quantum. The method of dispersion relations also makes it possible, in principle, to include the contributions from an arbitrary number of π-meson states.

We calculated, for the bremsstrahlung process, the diagrams of the type 1 (references 6 and 7), the one-nucleon approximation (diagram of the type 5), and the interference term. We also made an approximate estimate of the one-pion contribu-



tion. The diagrams of the Bethe-Heitler type have been treated exactly. In the one-nucleon approximation we kept only the term proportional to the direct contribution from the electric charge, and the interference term contains only the contributions proportional to the electric charge and the first power of the anomalous magnetic moment. In general, such an approximation leads to an error < 3% for incident electron energies of ≈ 500 Mev and angles ≤ 90°. The exact calculation of the one-pion approximation, which requires the knowledge of the amplitudes for the virtual photoproduction of π mesons, is possible in principle, but connected with great technical difficulties. For our purpose it is sufficient to make an approximate estimate of the one-pion contribution. If the length of the 4-vector of the virtual γ quantum, κ^2, is close to zero, we may regard the virtual Compton effect as a real one. We obtain the required estimate by comparing the contributions from the real Compton effect, calculated by the method of dispersion relations with account of the one-pion state,[8] with the one-nucleon approximation. The contribution from the one-pion state to the bremsstrahlung process for angles < 30° is < 3 to 5%; it increases rapidly for angles > 30°, and at angles ~ 90° it becomes of the order of magnitude of the Bethe-Heitler cross section. The multiple bremsstrahlung process gives a negligibly small contribution,[9] and the higher order corrections in the electric charge[10-11] become significant only in the region of large angles (> 90°) and high energies (> 500 Mev).

In this way we find that in the case of a bremsstrahlung process in which the momenta of the photon, the electron, and the proton in the final state lie in the same plane, for angles ~ 30°, with an initial electron energy 0.54 and photon energy 0.25 (in the units $\hbar = c = M = 1$, where M is the nucleon mass), quantum electrodynamics is valid for distances $\geq 3 \times 10^{-14}$ cm. Here we have assumed that the experimental accuracy is 10%.

It is interesting to note that, for those angles where $\kappa^2 \approx 0$, the one-nucleon and interference terms in the bremsstrahlung cross section have a sharp and high maximum which is 3 to 4 orders larger than the Bethe-Heitler cross section. As the energy of the γ quantum is decreased, the maximum becomes sharper.

In conclusion we express our deep gratitude to Academician N. N. Bogolyubov and A. A. Logunov for proposing this problem and useful advice, and also to D. V. Shirkov and A. N. Tavkhelidze for fruitful discussions.

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