which is subject to electrodynamic forces tends to reduce its large radius, contracting to the center of the vacuum chamber.[2] However no essential difference was observed in the behavior of the plasma loops in the two series of experiments indicated above. This may be due to the fact that the electrodynamic forces, which are proportional to the square of the current, are small or to the presence of strong dissipative forces due to the high gas density.

Thus, it has been established that in a high-frequency induction discharge at pressures above 1 mm Hg sharply defined plasma loops are formed; these remain separated from the walls of the vacuum chamber and exist for the duration of the high-frequency magnetic field pulse.

The authors are indebted to R. A. Latypov for assistance in the construction of the apparatus and for help in carrying out the experiments, V. A. Kiselev for carrying out the spectroscopic measurements, and L. M. Kovrizhnykh, M. S. Rabinovich and I. S. Shpigel' for a discussion of the results which have been obtained.

---

[1] L. M. Kovrizhnykh, J. Exptl. Theoret. Phys. (U.S.S.R.) **36**, 1834 (1959), Soviet Phys. JETP **9**, 1308 (1959).

[2] S. M. Osovets, Физика плазмы и проблема управляемых термоядерных реакций (Plasma Physics and the Problem of a Controlled Thermonuclear Reaction), Vol. II, 1958, p. 238.

[3] M. D. Raĭzer and S. E. Grebenshchikov, Отчет ФИАН (Reports, Institute of Physics, Acad. Sci.) 1958.

Translated by H. Lashinsky
105

MAGNETOSTRICTION OF ANTIFERROMAGNETIC NICKEL MONOXIDE

K. P. BELOV and R. Z. LEVITIN

Moscow State University

Submitted to JETP editor May 5, 1959

J. Exptl. Theoret. Phys. (U.S.S.R.) 37, 565-566 (August, 1959)

DATA on the magnetostriction of antiferromagnets are at present lacking in the literature. On the basis of general considerations, however (the presence of domain structure), the magnetostriction of antiferromagnets should have an appreciable magnitude, at any rate larger than that of ordinary paramagnets.

We have measured the magnetostriction of polycrystalline nickel monoxide, NiO, prepared by the standard ceramic technique. Before the magnetostriction measurements, the room-temperature mass susceptibility and the Curie point of the specimens were measured by way of control. The measurements showed that in fields up to 7000 oe, the susceptibility is slightly field-dependent and equal to 6×10^{-6}; the Curie point was determined by the jump in Young's modulus and was 251° C. These data agree with results obtained for NiO by other authors.[1]

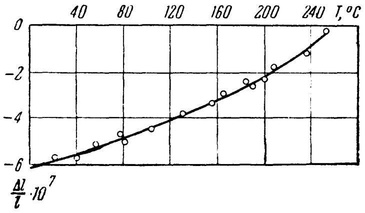


FIG. 1. Temperature dependence of the magnetostriction of NiO in a field of 14,200 oe.

The magnetostriction measurements were made by the wire-probe method by use of a photoelectro-optical amplifier. Figure 1 shows the temperature dependence of the transverse magnetostriction, measured in a field of 14,200 oe. The magnetostriction has a negative sign and decreases monotonically on approach to the Curie point. Figure 2 shows the field dependence of the transverse magnetostriction at various temperatures, and also the longitudinal magnetostriction at room temperature; the latter has a positive sign. What attracts attention is the fact that there is a certain "critical" field ($H_c \approx 5000$ oe) below which the magnetostriction is practically zero. Only after attainment of this field does the increase of magnetostriction begin.

In our opinion the magnetostriction in antiferro-

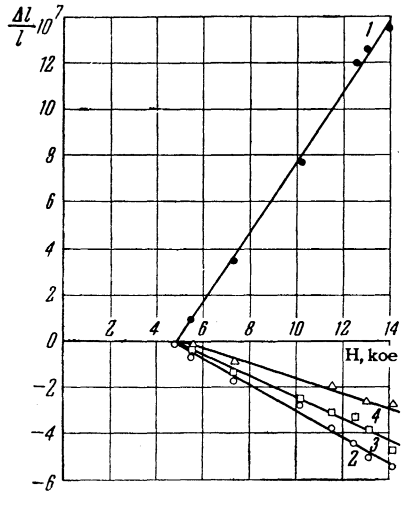


FIG. 2. Longitudinal and transverse magnetostriction of NiO. 1, longitudinal magnetostriction at 21°C; 2, transverse magnetostriction at 21°C; 3, at 53°C; 4, at 74°C.

magnetic nickel monoxide is dependent on the presence of a domain structure. This is indicated by the decrease of magnetostriction with increasing temperature, and also by the opposite signs of the longitudinal and transverse magnetostriction. The presence of a critical field is connected, in our opinion, with the existence of a coercive force, which is of order 10^4 oe for antiferromagnets according to an estimate given by Néel[2] and by Labhart.[3]

We also observed, in the specimens studied, a decrease of Young's modulus on application of a strong magnetic field (the antiferromagnetic ΔE-effect); this also indicates the existence of magnetostriction in antiferromagnetic nickel monoxide.

---

[1] R. Street and B. Lewis, Nature **168**, 1036 (1951); F. Trombe, J. phys. et radium **12**, 170 (1951).

[2] L. Néel, Ann. phys. **3**, 137 (1948).

[3] H. Labhart, Z. angew. Math. Phys. **4**, 1 (1953).

Translated by W. F. Brown, Jr.
106

SPACE ASYMMETRY OF LOW ENERGY POSITRONS FROM π^+-μ^+-e^+ DECAY

A. O. VAĬSENBERG

Submitted to JETP editor May 7, 1959

J. Exptl. Theoret. Phys. (U.S.S.R.) **37**, 566-568 (August, 1959)

THE aim of this note is to discuss the totality of the data obtained in this laboratory and given in the literature on the asymmetry in the space distribution of low energy positrons from the π^+-μ^+-e^+ decay.

We shall be interested in the asymmetry coefficient $a_{0-\epsilon}$ averaged over the spectrum from $\epsilon = 0$ up to the energy ϵ. The two component neutrino theory[1] gives for this coefficient the following expression

$$a_{0-\varepsilon} = a(-2\varepsilon^3 + 3\varepsilon^4)/(2\varepsilon^3 - \varepsilon^4). \qquad (1)$$

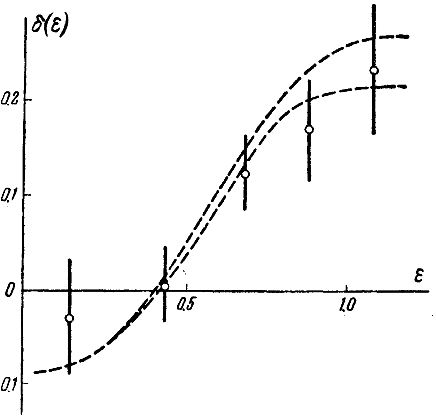
Here a is the asymmetry coefficient averaged over the entire spectrum and it is, as is well known, negative; ϵ is expressed in units of the maximum positron energy in the μ-e decay. It follows from this expression that for small energies the asymmetry coefficient $a_{0-\epsilon}$ should decrease from the positive value of $-a$, at the very beginning of the spectrum, to zero at $\epsilon = 2/3$. Until now this prediction of the theory has not been verified with sufficient accuracy because the number of low energy particles in the spectrum of the decay positrons is small. Radiative corrections to the spectrum (Kinoshita and Sirlin[2] and also V. P. Kuznetsov, private communication) and the dispersion in the energy measurement in photoemulsion[3] result in a decrease of $a_{0-\epsilon}$ by approximately 40% in comparison with (1), and in a shift of the energy at which $a_{0-\epsilon}$ goes through zero from $\epsilon = 2/3$ to $\epsilon = 0.55 - 0.60$.

The following measurements were carried out in our laboratory: 1) a measurement of the entire spectrum for 1102 particles with $a = 0.077$;[4] 2) a measurement of the spectrum of slow electrons in which 345 particles were selected with energy $\epsilon < 0.6$ with $a = 0.077$;[4*] 3) a measurement of the entire spectrum for 565 positrons with $a = 0.28$.[3] Measurements 1) and 2) were performed in the usual emulsion NIKFI-R and measurement 3) in the same emulsion but placed in a magnetic field of 17 kgauss.

It is convenient to discuss the resultant experimental data in terms of the relative difference of the number of positrons emitted forwards and backwards

$$\delta = (N_F - N_B)/(N_F + N_B).$$

In the graph and in Table I are shown values of N_F, N_B, and the excess δ in the energy intervals $0 - 0.3$, $0.3 - 0.6$, $0.6 - 0.8$, $0.8 - 1.0$, and > 1.0. These results were obtained by combining data from all three above-mentioned spectra. These data show that the asymmetry falls sharply



The dependence of the excess $\delta = (N_F - N_B)/(N_F + N_B)$ on the positron energy ε. The dashed line shows the dependence $\delta(\varepsilon)$ predicted by the two-component theory under the conditions of small (upper curve) and large (lower curve) dispersion of measurements. Eighty percent of the positrons were measured with intermediate values of dispersion.