electron capture rate [process (a) plus process (b)] to be (13.5±4) percent of the β^- decay rate, and determined the gamma-ray rate to be (12.7±1) percent of the β^- decay. If the gamma-ray is process (a), then there remains a maximum of 5 percent of process (b). If the upper limit of Fireman's ratio is used, there must be less than one positron to 10^5 electrons.[4]

The coincidences of annihilation quanta were looked for with two scintillation counters. The angular correlation was partially determined by noting the coincidence rate per gram of potassium as a function of the diameter of the source. The experimental arrangement is shown in Fig. 1.

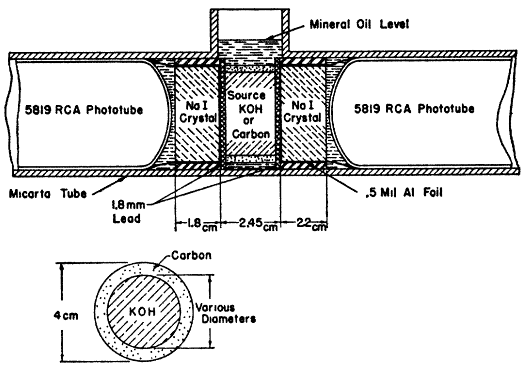

FIG. 1. Experimental arrangement. Typical ring and disk source.

Figure 2 shows the measured counting rates for various source diameters. It is to be noted that the observed potassium coincidence rate (curve I) has a slope opposite to that for the positron detection efficiency (curve II), and, therefore, gives no evidence that the observed coincidence rate from potassium comes from positrons. Furthermore, the potassium curve suggests that the observed coincidence rate arises from the back scattering of the 1.5-Mev gamma-rays. The Compton back scattering of the 1.5-Mev gamma-rays from one NaI crystal to the other would give the observed positive slope of curve I.

The absolute positron detection efficiency was determined by a calculation of the probability for an observation of one of two annihilation quanta in one crystal, and then multiplying this by the observed ratio of the double coincidence rate to the total rate in one crystal for a pure positron source (C^{11}) in the identical geometry. The calculation was checked by using the same solid angles and the corresponding absorption coefficients to find the detection efficiency of the 1.5-Mev gamma-rays of potassium. The gamma-ray activity of potassium, determined by the calculated efficiency and the observed total counting rate, was within 5 percent of the value obtained by Sawyer and Wiedenbeck.[3]

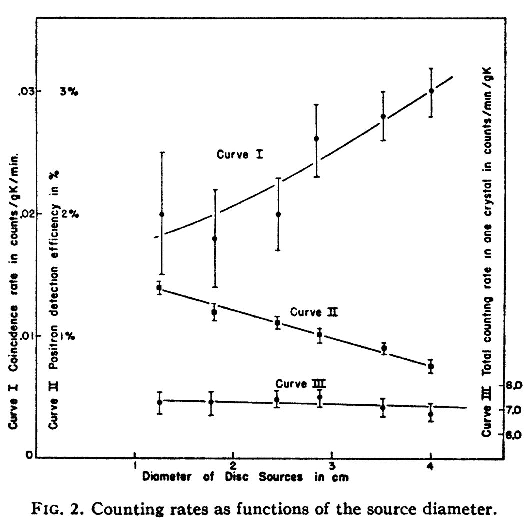

FIG. 2. Counting rates as functions of the source diameter.

A calculation of the positrons created in pair production by the 1.5-Mev gamma-rays and the corresponding detection efficiency gives a background of 0.007 counts per min per gram of potassium. If the minimum counting rate observed is 0.02, the difference gives the rate possibly arising from positrons from the decay process. This results in an upper limit of less than one positron in 1700 electrons.

The lifetime of the excited state of A^{40} was found to be less than one second. The gamma-ray rate of one kilogram of KOH at 20°C, and when boiling violently at 370°, showed no difference within ±5 percent, indicating that the A^{40} driven off had already decayed to the ground state. Theory[5] indicates a quadrupole transition with a lifetime of the order of 10^{-12} sec.

The pure positron sources were carbon disks irradiated in the gamma-ray beam of the Cornell synchrotron. The reaction $C^{12}(\gamma,n)C^{11}$ gave ample activity of the pure positron emitter C^{11}.

I am indebted to Professor P. Morrison for suggesting the experiment and to him and Dr. R. R. Wilson for invaluable discussions during its course.

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The Dielectric Properties of $BaTiO_3$ at Low Temperatures*

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BLUNT and Love,[1] using ceramics, measured the dielectric behavior of $BaTiO_3$ at low temperatures. They found a pronounced peak in the dielectric loss at about 70°K, whereas the dielectric constant showed no anomaly down to liquid helium temperatures. Hulm,[2] on the other hand, measured multidomain single crystals and observed a strong increase in the coercive field strength in the region from about 20°K downwards. The increase was so strong that he was unable to polarize the crystals completely and, thus, could not measure the behavior of the electric spontaneous polarization at these very low temperatures.

Since these results were not conclusive, we have measured the dielectric constant and loss of our "single-domain crystals"[3,4] at audiofrequencies, and the hysteresis loop at 60 cps from room temperature down to 4.2°K. The crystal holder, consisting of two spring-loaded silver contacts, was enclosed in a brass chamber serving as a constant volume gas thermometer. The chamber was filled with helium gas and connected to a mercury manometer by a steel capillary.

The results were as follows. The dielectric constant in the direction corresponding to the *c* axis at room temperature[3] decreases approximately linearly below the last transition near 180°K and reaches a value of about 120 at 4.2°K. We could find no anomaly in the dielectric loss, in contrast to Blunt and Love's measurements; the loss stays about constant and remains small. The coercive field strength, as derived from the hysteresis loops, starts to increase strongly with falling temperature below 90°K. However, our good crystals could be saturated even at helium temperature (Fig. 1) and thus allow measurement of the spontaneous

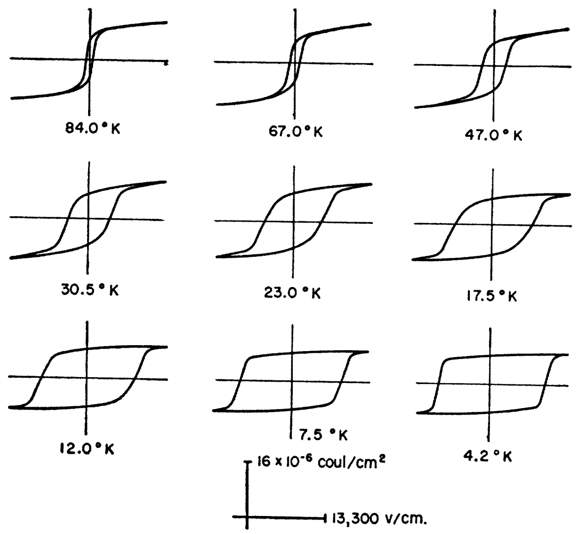

FIG. 1. Hysteresis loops for $BaTiO_3$ at low temperatures.

polarization. This stays almost constant from the 180°K transition down to 4.2°K; its value is of the order of about $P_s \simeq 8.0\times 10^{-6}$ coulomb/cm². The absolute value changes from sample to sample because of domain formation at the two transition points[3] near 270° and 180°K. In interpreting P_s it must be kept in mind that below the 180°K transition the polar axis points in the (111) direction.[3] The coercive field strength increases strongly from about 250 v/cm at 180°K to almost 10,000 v/cm at 4.2°K (Fig. 2).

These results show that $BaTiO_3$ stays ferroelectric down to liquid helium temperature, and there is no indication that the crystal will change to a nonferroelectric modification. The fact

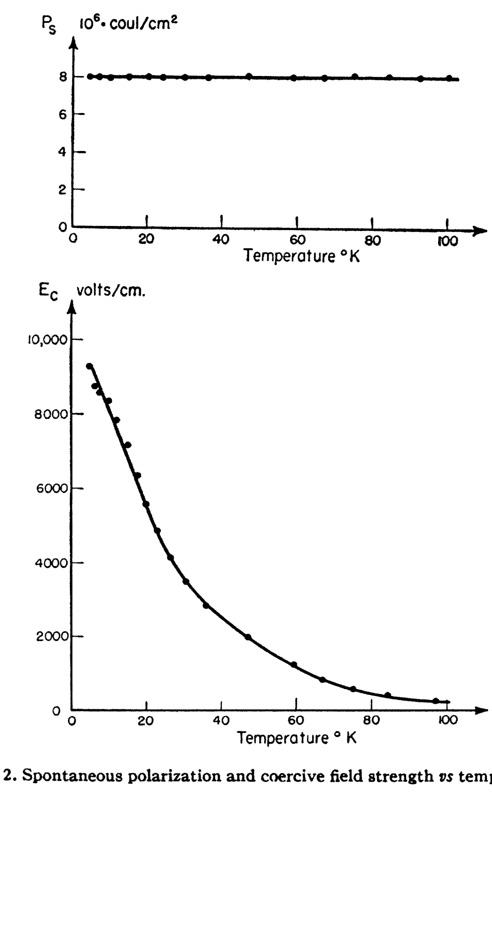

FIG. 2. Spontaneous polarization and coercive field strength *vs* temperature.

that the coercive field strength increases strongly at low temperatures and that the hysteresis loops become wider and more and more rectangular indicates freezing-in of the domain boundaries. It is of interest to note that $BaTiO_3$, while becoming ferroelectric by a displacive transition similarly to rochelle salt (small specific heat anomaly) and, in contrast to the KH_2PO_4 group, shows no second curie point at which the ferroelectricity disappears as in the case of rochelle salt.

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The Intensity of the Total and of the Hard Component of the Cosmic Radiation as a Function of Altitude at Geomagnetic Latitudes of 28° N and 55° N*

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THE equipment used in this experiment consisted of four fourfold coincidence counter telescopes (*ABCD, BCDE, BCDF, BCDG*). The counter geometry of the individual telescopes is shown in Fig. 1. Each counter had an outside diameter of 2.54

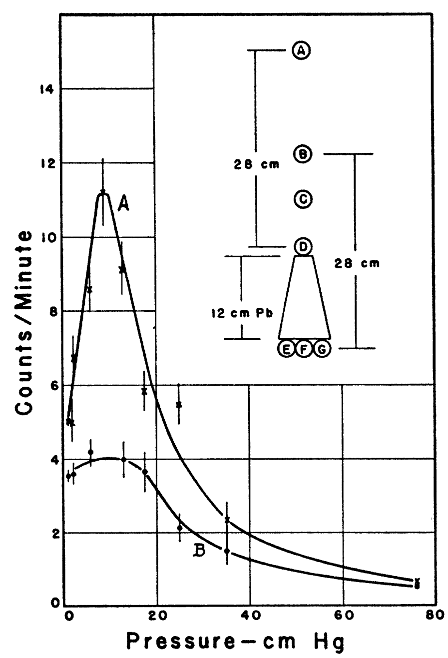

FIG. 1. Measurements at 28°N geomagnetic latitude (Cuba).

cm, a length of 13 cm, and brass walls of 0.078 cm in thickness. A block of 12 cm of lead was interposed between counter *D* and counters *EFG*. Each fourfold coincidence was separately registered on photographic film moved by a clock mechanism.

Through the courtesy of the Office of Naval Research, the first of the two balloon experiments was carried out with the aid of a General Mills balloon launched south of Cuba at a geomagnetic latitude of 28°N. The launching took place from the deck of an