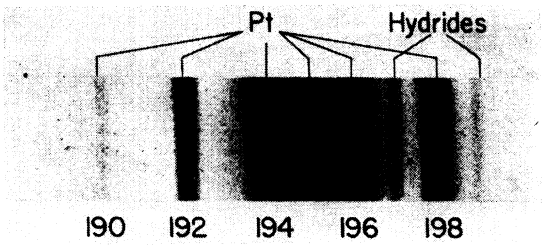

FIG. 1. Mass spectrum of platinum.

exposure. Figure 1 is a reproduction of one of the mass spectra taken with commercial platinum electrodes. As nearly as can be judged from microphotometric traces, the ratio 190/192 is independent of the type of platinum used.

In concluding that the faint 190 is due to platinum, rather than to an impurity, the authors have been influenced by the following additional arguments. The fact that the faint line appears at a mass less than the known platinum isotopes precludes the possibility of its being a hydride, as are the lines at 197 and 199 in Fig. 1. It cannot be the stable isotope of osmium at mass 190 since this has an abundance of 26.4 percent and would have been accompanied by the 16.1 percent abundant Os^{189}. It is possible for particles of mass 95 to reach the 190 position by passing through the accelerating field and electrostatic analyzer as doubly-charged ions and losing one charge before entering the magnetic analyzer. In such a case the 15.7 percent abundant Mo^{95} would have been accompanied by the 9.12 percent abundant Mo^{94} at mass 188. Thus it seems clear that the line is a faint isotope of platinum.

An approximate measure of the abundance was obtained by making short exposures on which the intensity of the 0.78 percent Pt^{192} could be compared with the intensity of the 190 on the long exposures. Comparisons were made on five plates and give for the abundance of Pt^{190} the values 0.0052 percent, 0.0056 percent, 0.0046 percent, 0.0060 percent, and 0.0088 percent. The average of these values is 0.006 percent and is probably accurate to 20 percent, the inaccuracy arising from the unsteadiness of the spark.

The authors wish to thank Mr. Clifford Geiselbreth for his excellent machining of many essential parts and Dr. Richard Clarke for the use of the recording microphotometer.

* This letter is based on work done at Wesleyan University under Contract AT (30-1)-451 with the AEC.

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[2] Milo B. Sampson and Walter Bleakney, Phys. Rev. **50**, 732 (1936).
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Decay of Scintillations in Calcium Fluoride Crystals*

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March 18, 1949

IT has been estimated[1] that the inorganic phosphors have a decay time greater than 0.2 microsecond with the possible exception of fluorites. The decay of the scintillations of a calcium fluoride crystal has been measured by a delayed coincidence method in which data on the scintillations of a crystal are obtained as a function of time. This method is based on a delayed coincidence counting of the pulse of a proportional counter activated by a beta-particle with the pulse of an electron multiplier tube detecting the scintillation from the crystal activated by the same particle.

The experimental procedure utilizes a beam of beta-particles from P^{32} which penetrates the proportional counter and impinges on the scintillation phosphor. As the pulse from the channel of the proportional counter is delayed by a variable delay line, coincidences are obtained as a function of line length which can be directly calibrated in units of time. Provided the pulse from the proportional counter is appreciably faster than the pulse from the scintillation phosphor channel, the resulting variation of coincidences per unit time with time shows the decay of the scintillations. The variable delay is introduced by means of seventy-ohm coaxial cable (RG 11/u) calibrated to desired lengths.

The proportional counter used has a resolving time of 2.8×10^{-8} second and works into a cathode follower and amplifier of 23 megacycles/sec. band widths.[2] The scintillations of the phosphor were detected by a 931A electron multiplier tube working into a similar cathode follower and amplifier.

Figure 1 shows the variations of the coincidences with time delay, the data taken with the phosphor at dry ice temperature. The selection of the zero point is arbitrary since the amplifiers and associated circuits are not of equal natural delay. For comparison, curves of both naphthalene and calcium fluoride crystals are shown. The fast rise time is seen to be the same in both cases and shows the limitations of the time variation that may be detected as imposed by circuit band width, variation in pulse formation, or other broadening factors.

Following the analysis of Van Name[3] for coincidences between a pulse fixed in time and a pulse from an exponential decay process, it is known that for values of delay greater than the pulse half-width distribution, the coincidences are directly proportional to $e^{-\lambda D}$ where D is the delay time and λ is the decay constant.

For this analysis the logarithm of the coincidences was plotted against time, giving a reasonably straight line with a half-life of 15×10^{-8} second. The corresponding value for the leading edge of the curve is 1.4×10^{-8} second. This time is shown by the dotted curve in Fig. 1, which was drawn by reflecting the leading edge of the naphthalene curve about its zero point.

Similar analysis for the naphthalene curve indicates a value of the order of magnitude of 3.3×10^{-8} second but this is too close to the limitations of the circuit to ascribe much value to the estimate.

Figure 2 shows similar measurements for the calcium fluoride crystal taken at room temperature. The variation of 100°C has resulted in no change of decay time of sufficient

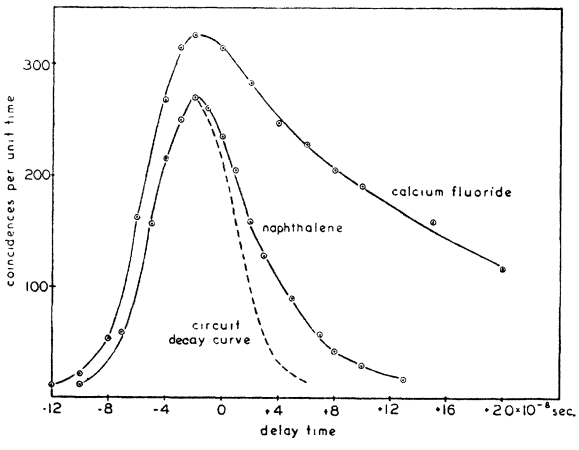

FIG. 1. Coincidence rate *versus* delay curve for calcium fluoride and naphthalene scintillations. The dotted curve refers to circuit decay time obtained by plotting a symmetrical curve with decay constant equal to that of the leading edge. Data taken at dry ice temperature.

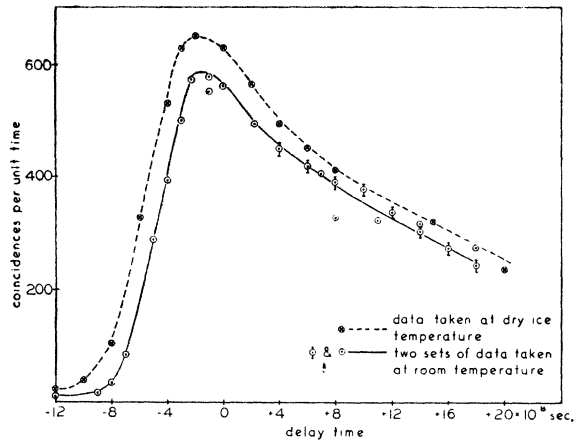

FIG. 2. Comparison of coincidence rate *versus* delay curve for calcium fluoride scintillations taken at room temperature and at dry ice temperature. Note similar decay rates within the accuracy range of the equipment.

magnitude to be detected by this equipment. Plotting of this decay section of the curve shows the half-life to be still in the range of $14\text{–}16\times10^{-8}$ second.

The apparent temperature independence together with the magnitude of the decay time indicate several possibilities: (a) the process of emission may be a straight radiative transition of a slightly forbidden state; (b) if the process is one of electron migration the barrier would be small, say of the order of a few hundredths of an electron volt with the tunnel effect being large in relation to overcoming the barrier; (c) the process may be twofold, with fast electron migration preceding radiative transition.

The writer wishes to express his thanks to Professor E. C. Pollard for valuable discussions throughout, to Professor H. L. Schultz for discussion of coincidence counting techniques and circuits involved, and to Dr. R. B. Setlow for suggestions on interpretation. Thanks are also due Mr. J. A. Rich for loan of the naphthalene and calcium fluoride crystals.

* Assisted by the joint program of the ONR and the AEC.

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[2] H. L. Schultz, *High Speed Counters and Short Pulse Techniques* (Brookhaven Conference Report, August 1947), p. 35.

[3] F. W. Van Name, Phys. Rev. **75**, 102 (1949).

Anomalous Behavior of the Dielectric Constant of a Ferromagnetic Ferrite at the Magnetic Curie Point

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March 14, 1949

IN the discussion following our papers "Magnetic Properties of a Ferromagnetic Ferrite," presented at the 1948 Annual Meeting of the American Physical Society, we showed the lantern slide reproduced here. This represents the effective dielectric constant, as a function of temperature, measured at 10,000 c.p.s. on a block of a commercial ferromagnetic ferrite (Ferroxcube III) provided with evaporated gold electrodes. Direct current measurements of the resistivity of the block were made at the same time and show, in the same temperature interval, only the variation with temperature expected of semiconductors.

At that time we thought that the almost discontinuous course of the dielectric constant *versus* temperature curve at the magnetic Curie point might be some indication of the

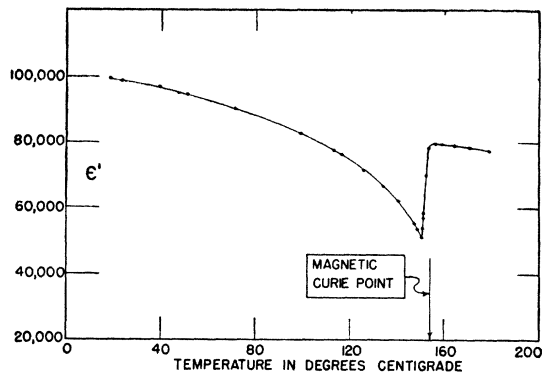

FIG. 1. Real part of dielectric constant *vs.* temperature.

fundamental character of the dielectric behavior, perhaps related to a coupling of the electric and magnetic dipoles.

We have found, however, that the behavior of the dielectric constant at the magnetic Curie point can be described on the basis of straightforward electromagnetic theory. The decrease in the measured dielectric constant between room temperature and the Curie point is due principally to the increasing ohmic conductivity in this region. The sudden rise at the Curie point follows from the collapse of the permeability. Differences between the experimental and calculated curves indicate that the actual dielectric constant decreases slowly with increasing temperature throughout the entire region.

A paper covering in more detail our work on the dielectric and magnetic properties of a ferromagnetic ferrite is in preparation for submission to the Physical Review.

Divergences in Field Theory

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March 17, 1949

THE considerable advances which have recently been achieved in quantum electrodynamics have been based on the twin concepts of charge and mass renormalization. Thus it has been found that the divergences that occur as a result of the interaction between electron and electromagnetic fields are due to terms which, if finite, would be interpreted as changing the mechanical mass and charge of the electron to the empirically observed values. On separating out the additional mass and charge terms, it has been found that the present form of electrodynamics gives finite and unambiguous predictions with at least reasonably close agreement with experiment.

The question immediately arises as to whether the use of these concepts is sufficient to remove the divergences of other current or proposed forms of quantum field theories, or if their success is an accident peculiar to electrodynamics. Offhand, one would say that the latter is obviously the answer. The divergences encountered with a Dirac electron interacting with the electromagnetic field are particularly weak. While it would seem not unreasonable that the removal of two infinite quantities would render electrodynamics convergent, the success of this procedure in theories with much stronger divergences is *a priori* rather unlikely. Surprisingly, it has been found that the utilization of the renormalization ideas does give convergent results for the scalar and pseudoscalar meson theories (even with dipole coupling) and for the scalar electron interacting with the electromagnetic field. This might tend to support the view that all the divergences of the