A much simpler explanation seems worth investigating. The frictional charges are very large and after the stream has slid some distance over the metal the charge per unit volume is sufficient to create a large potential difference between the particles and the metal. If this gets high enough to produce a discharge through the air round the particles, it will put an automatic limit on the final charge on the particles. In this case we should expect the curve charge against pressure to resemble the well-known curve of sparking potential against pressure, which it does.

Additional confirmation is that, taking his experimental results for the charges at 1 mm pressure, it is easy to calculate that in the stem of the metal funnel down which the particles pass the P.D. between the center and the sides is of the order of 400 volts which is of the order of the minimum sparking potential.

Microwave Magnetic Dispersion in Carbonyl Iron Powder

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MEASUREMENTS have been made of the complex permeability of mixtures of carbonyl iron powder and paraffin wax at microwave frequencies, using the dual impedance wave guide method.[1] Typical results for the modulus of permeability $|\mu|$ and the magnetic loss angle δ_μ of specimens containing 18 percent by volume of iron powder are given in Table I. The modulus of permittivity $|\epsilon|$ of the mixture and its dielectric loss angle δ_ϵ remained constant, within the experimental error, over the complet wave-length range, at 5.60 (±2 percent) and 1.0° (±0.1°), respectively.

TABLE I.

λ (cm)	58.4	39.6	29.9	22.4	15.4	9.1	5.95	3.09
$\|\mu\|$	2.28	2.23	2.17	2.05	1.91	1.70	1.53	1.40
δ_μ	6.8°	9.0°	12.2°	13.3°	17.7°	17.7°	18.1°	21°

The magnetic dispersion and absorption of iron does not display any of the resonance characteristics, attributable to internal anisotropy fields, observed in the iron oxides.[1,2] This marked difference in behavior is due to the high conductivity of iron, and the consequent skin effect which restricts the penetration of the microwave field into the iron, to a depth of 10^{-4} to 10^{-5} cm. The skin effect masks any ***natural*** resonance effects resulting from the anisotropy field, although the much more pronounced ***induced*** resonances can be observed, when the electron spins are aligned by an applied saturation magnetostatic field.[3,4]

Kittel[5] has pointed out that the skin depth in iron at microwave frequencies is only a small fraction of the domain thickness, so that the applied h.f. magnetic field only penetrates a little way down a surface domain boundary. The force on this boundary is consequently less than at low frequencies, so that the domain boundary shift and the resultant magnetization are correspondingly reduced, leading to a decrease in permeability with increase in frequency. Kittel has considered a thin film, one domain thick, as a theoretical model, and he has derived and evaluated expressions for its magnetic dispersion.

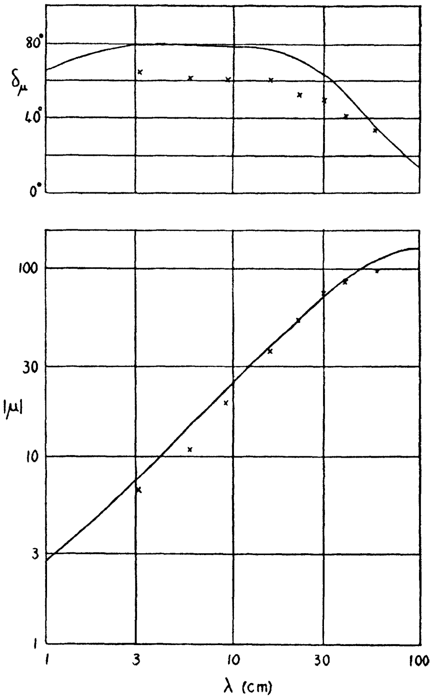

FIG. 1.

It is of interest to compare the experimental results with Kittel's theoretical curves. It has been found for carbonyl iron mixtures up to 50 percent concentration, that $|\mu|$ and $\tan\delta_\mu$ obey similar logarithmic and linear concentration laws to those observed for γ-ferric oxide mixtures.[1] Above this concentration, deviations from the laws become apparent, as a result of particle agglomeration. The measurements on mixtures below 50 percent concentration have been extrapolated to zero dilution, and the results are plotted together with the curves for Kittel's film model (see Fig. 1).

The extrapolated permeability values are not in general equivalent to observations on solid iron, since the majority of the particle surfaces responsible for the dispersion disappear into the bulk of the material as the concentration is increased. On the other hand, the extrapolation corresponds much more closely to a thin film, in which the particle surfaces remain exposed to the applied h.f. field. This presumably accounts for the good agreement between the extrapolated experimental data and Kittel's thin film model. The average particle size of the carbonyl iron was 5.5 microns compared with 2.5 microns for Kittel's model.

The results appear to substantiate the validity of the theory, and it is likely that an elaboration of the model, to take account of the eddy currents induced in the material behind the surface film, would lead to better agreement with the observations on solid iron. At wavelengths below 10 cm, where such an elaboration becomes less necessary because of the very small field penetration, the extrapolated permeability values are found to approach closely the measurements on iron wires by Arkadiew and others.[5]

[1] J. B. Birks, Proc. Phys. Soc. **60**, 282 (1948).
[2] J. B. Birks, Nature **160**, 535 (1947).
[3] J. H. E. Griffiths, Nature **158**, 670 (1946).
[4] W. A. Yager and R. M. Bozorth, Phys. Rev. **72**, 80 (1947).
[5] C. Kittel, Phys. Rev. **70**, 281 (1946).

On the Lateral Extension of Auger Showers

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A SHOWER experiment has been carried out by Skobeltzyn, Zatsepin, and Miller[1] in which they measured the coincidence rate between two sets of counter trays as a function of their separation. They conclude that their experimental results give a much higher coincidence rate at large counter separations than the curve calculated on the basis of a primary electron shower model. Possible reasons for this discrepancy have recently been examined by Cocconi.[2] He points out that good agreement can be reached between theory and experiment if one takes into account the effect of showers incident at large zenith angles. Particularly for large tray separations, this effect cannot be neglected; for a shower whose axis is at zenith angle θ in the vertical plane joining the counter trays, the effective separation between the trays is reduced by a factor $\cos\theta$, thereby increasing the probability for the shower to be detected. It is the purpose of this note (a) to extend Cocconi's argument, and (b) to report on an experimental confirmation.

(a) A shower striking the experimental arrangement at an angle θ not only sees a smaller separation but—depending on the geometry of the counter tray—a smaller area as well. This decrease in area reduces the sensitivity of the equipment to low density showers, and thereby lowers the counting rate. The net effect is an increase in counting rate smaller than calculated in reference 2.

(b) To check this point, the following experiment, suggested by Professor J. A. Wheeler, was carried out at Silver Spring, Maryland (altitude 120 meters). The coincidence rate of two Geiger counters was measured. The counters were 29.2 cm long and 2.4 cm in diameter; their separation in the horizontal plane was 40 meters. In arrangement A, the counter axes were parallel to each other and perpendicular to their line of separation. In arrangement B (see Fig. 1), the counters were rotated through 90° about a vertical axis so that their axes were along their line of separation. Evidently, arrangement B is subject to the effect discussed in (a) to a much greater degree than arrangement A. This is borne out by the result of the experiment: the counting rate under arrangement A was greater than the corresponding rate for arrangement B by 32 percent±13 percent.

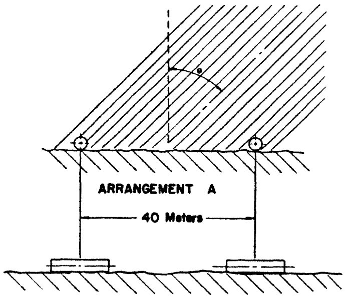

FIG. 1.

The experiment was repeated with the separation reduced from 40 meters to 20 meters. Within the statistics of the experiment (10 percent) there was no difference in counting rate between arrangements A and B.

From the experimental results, it appears reasonable to conclude (i) that non-vertical showers contribute greatly to the coincidence rate of arrangement A for large counter separations; (ii) arrangement B has a lower counting rate than arrangement A since it does not record many non-vertical showers of low particle density because of the decrease of counter area discussed above.

[1] D. V. Skobeltzyn, G. T. Zatsepin, and V. V. Miller, Phys. Rev. **71**, 315 (1947).
[2] G. Cocconi, Phys. Rev. **72**, 350 (1947).

The Specific Charge of the Positron

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SEVERAL considerations regarding the properties of elementary particles[1] seem to suggest that the mass of an elementary particle is composed of intrinsic mass and mass-defect. The positron as a free particle has a positive intrinsic mass equal to the intrinsic mass of the electron, i.e., to m_0, whereas its mass-defect $-0.00177m_0$ has equal size but opposite sign. Accordingly, the mass of the positron would be with 0.354 percent less than the mass of the electron, entailing the consequence that the specific charge of the positron would be higher by the same amount.

Spees and Zahn[2] report measurements in which they compared the specific charge of electron and positron. A close scrutiny of the position of the peaks upon the curves seems to indicate that the specific charge of the positron slightly exceeds that of the electron. Unfortunately, the accuracy of the measurement does not permit a determination with greater accuracy than one percent. It would seem to be worth while to investigate this point with an improved method of greater accuracy.

A further consequence of this mass difference is that the g value of the positron will slightly differ from that of the electron:

$$g_p = 1.99636, \quad \text{while} \quad g_e = 2.00343.^{3}$$

[1] J. Barnóthy, Terr. Mag. No. 2 (1947).
[2] A. H. Spees and C. T. Zahn, Phys. Rev. **58**, 861 (1940).
[3] J. Barnóthy, Phys. Rev. **73**, 113 (1948).