creases very rapidly after scattering—it is obvious that the ordinary simple interpretation of experiments of the Bucherer type is not justifiable.

In the meantime (at an unofficial meeting in Indianapolis, December, 1937, and also in a recent Letter to the Editor) this same possibility for dispensing with the neutrino hypothesis was again proposed—by G. E. M. Jauncey, who also described experimental evidence for heavy beta-particles, based on measurements of the Bucherer-Neumann type. The conflicting results obtained here at the University of Michigan were again pointed out by the author at this meeting, and a description was given of the unpublished results of our analysis showing that the Bucherer method is unreliable as regards its simple interpretation.

We believe it quite possible, if not probable, that the radiation photographed by Jauncey was largely scattered radiation, for the following reasons: Jauncey's experiments were performed at a low velocity where the distribution function is small, so that the radium E spectrum was composed almost exclusively of velocities larger than that "observed." When electrons are scattered, their average momentum is reduced, and at the same time the effective resolution width is increased. If the ratio of the condenser separation to the square of the length is near the critical value at which the filter breaks down, then, under the above conditions, the probability for the *leakage* of high velocity scattered radiation becomes relatively large, and one might expect the apparatus to behave rather as a momentum spectrograph for the scattered radiation. Hence one might obtain a spurious peak due to the scattered electrons, and even miss the weak theoretical line altogether.

An examination of the values of Jauncey's geometrical constants in the light of our theory shows that his theoretical resolving power was very near the critical value. We therefore believe it quite possible that his observations correspond to the conditions just outlined. In any case, our results for radium E electrons of $H\rho$ 2000, or $\beta=0.75$, are definitely not consistent with the particular hypothesis discussed here. It is conceivable that *another* type of heavy beta-particle exists, such that the anomaly is inappreciable for $\beta=0.75$ and large for $\beta\sim0.4$; but this does not seem probable in view of the above-mentioned uncertainties.

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[1] See G. Breit, Rev. Sci. Inst. **8**, 141 (1938).

[2] Zahn and Spees, Phys. Rev. **53**, 524 (1937).

Ferromagnetic Impurities

An experimental method has been developed whereby very minute ferromagnetic impurities may be detected in various materials and the magnetic properties of these impurities studied.

The specimen to be tested may have any shape but a short rod of about 0.3 cc volume is most convenient. It is first placed in a field of several thousand oersteds supplied by an electromagnet. This serves to magnetize all ferromagnetic impurities in one direction; the field is then removed and it is assumed that any ferromagnetic impurities present will then be left with a certain remnant magnetization in this direction. This is detected and measured by hanging the specimen from a quartz fiber in the center of a pair of Helmholtz coils, the remnant magnetization being at right angles to the axis of the coils. A field of 40 oersteds or less is applied and the resulting rotation noted by a mirror and scale. The fact that reversing the field reverses the rotation, shows that the effect is a ferromagnetic one. With a strong quartz fiber, whose torsion constant was 0.028 dyne-cm per radian, a magnetic moment per cc, I, of 2×10^{-7} could be detected. A comparison of this with a remnant magnetization of over 500 for pure iron shows the sensitivity attainable.

The values of I found for various materials are given in Table I.

Table I.

Brass, commercial	7.5×10^{-2}
Copper, No. 12 D.C.C. wire, insulation removed	1.7×10^{-4}
Bismuth, extruded rod	3.4×10^{-4}
Bismuth, crystallized C.P. analyzed, 0.00% Fe	1.0×10^{-5}
Cadmium, Baker analyzed, 0.003% Fe	6.2×10^{-5}
Tin, Baker analyzed, 0.002% Fe	8.5×10^{-6}
Bakelite	1.0×10^{-4}
Pyrex rod	$3\ \ \times10^{-7}$

The surfaces were carefully cleaned and handled only with forceps. Tests failed to show the effect a surface one, unless perhaps for the Pyrex.

Calculations showed that dia- or paramagnetism of a specimen could cause rotation only through (1) different demagnetizing factors in different directions when the specimen is not spherical, or (2) different susceptibilities, K_1 and K_2, in different directions. As (1) depends on K^2H^2 it was too small to be noticeable in the weak fields used, but (2) depends on $(K_1-K_2)H^2$ and so is of a considerably larger order of magnitude. The crystallized Bi sample, which appeared to be a single crystal, gave just such an effect, dependent on H^2 and of just the right magnitude, in addition to the ferromagnetic effect which varies in magnitude and direction with H. We have then also a sensitive method of detecting magnetic anisotropy.

The ferromagnetic impurities could be magnetized in any direction desired or demagnetized by reversals. They would not likely be magnetic in such minute amounts unless they exist as inclusions of aggregates of atoms rather than in a state of diffusion throughout the metal, although the latter may explain the almost null result for Pyrex glass.

The foregoing was prompted by a discussion with F. Bitter at the Cornell Symposium in July, 1937.

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