LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Direct Determination of the Charge of the Beta-Particle

The charge of the β-particle has been determined directly by measuring the charge deposited per second on a Faraday collector placed at the exit slit of a β-ray spectrometer and, after replacing the collector by a Geiger-Mueller counter, by counting the number of particles emerging per second, the magnetic field being kept constant. The highest counting rate which could be measured with a 0.1 percent accuracy was roughly 300 per second, but the corresponding collector current was too weak to be measured with the same accuracy within a reasonable time. Therefore it was necessary to start with a strong source for the collector measurements and then reduce the beam by a known ratio for the counter measurements by allowing the source to decay. To determine this ratio it was impossible to rely on the known half-life because of the possible presence of impurities. Therefore this ratio was measured directly by reversing the field and sending the beam through a duplicate exit slit into an ionization chamber filled with argon at three atmospheres. The charge of the β-particle is given by the following expression:

$$e=\frac{I_F/I_S}{n/I_W},$$

where I_F is the Faraday collector current; n the number of β-particles per second; I_S and I_W are the ionization currents at the time at which I_F and n were measured, respectively. (I_F, n, I_S and I_W are all measured at the same value of $H\rho$.)

Both collector and ionization currents were measured with the same electrometer tube, a Western Electric D-96475 employed in a modified Barth circuit.[1] The null method of Townsend[2] was used. By the use of accurately calibrated condensers of different sizes in this electrometer a large range of currents could be measured. The counters were of the alcohol-argon self-extinguishing type,[3] a separate counter being used for all the data taken at each value of $H\rho$. The counter circuit consisted of a two-stage amplifier followed by a scale-of-sixty-four and a Cenco recorder. To eliminate corrections for the foils on the windows of the counters an equivalent foil was placed in front of, but insulated from, the Faraday collector. Corrections for the counting loss due to the finite resolving time of the counters were made by an improved method to be published shortly.

Series of measurements at five values of $H\rho$ were made on a radium E source having an original strength of about three millicuries. The collector currents observed were between 5 and 11×10^{-15} ampere and the counting rates used varied from 85 to 275 counts per second. Ionization currents ranged from 1 to 600×10^{-14} ampere. The results are given in Table I, where each value is the mean of a number of measurements.

TABLE I. *Values of charge on the β-particle for various values of $H\rho$.*

$H\rho$	e IN 10^{-19} COULOMB
2200	$-1.59_5\pm1.2\%$
2400	$-1.59_2\pm1.3\%$
2650	$-1.61_2\pm1.1\%$
2900	$-1.60_9\pm1.2\%$
3400	$-1.66_4\pm1.2\%$
Average	-1.61_5
or	$-4.84_0\times10^{-10}$ e.s.u. $\pm0.6\%$ probable error.

By far the largest source of this statistical error was due to the fact that if several counters were compared, they failed to agree better than to one percent, although much better agreement was expected from the number of counts used, the reasons not being fully understood. Compared to this error all other statistical errors were nearly negligible.

A possible *systematic* error of $\frac{1}{4}$ percent may be due to the failure of the collector to be a perfect trap for all particles entering. Another source of systematic error may be due to the fact that a particle hitting the outside of the collector might be recorded, whereas the counter would not record it under similar conditions. Large tolerances on the sizes of the slits and careful alignments cut this error to a minimum. Also a secondary electron ejected from the foil would affect the collector, but, being simultaneous with the primary, would not be counted. Investigations by applying retarding potentials indicated such secondaries were less than one percent of the main beam and probably a good deal less.

The present experiment, being the first by this method, is not meant to compete with the older and more accurate methods of measuring the charge of the electron, but it affords an interesting check upon the present conceptions of β-particles as well as upon the reliability of the G–M counter as an absolute instrument when properly handled. A longer report containing details of the main experiment and of control experiments too numerous to be mentioned in this preliminary letter will be published shortly by one of us (Y. B.)

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[1] D. B. Penick, Rev. Sci. Inst. **6**, 115 (1935).
[2] J. S. Townsend, Phil. Mag. **6**, 603 (1903).
[3] A. Trost, Zeits. f. Physik **105**, 399 (1937).