(4) Getting states that the Neher-Harper circuit requires the first vacuum tube to stand the entire counter voltage, and remarks that all the tubes are used within their ratings in the multivibrator circuit. However, the writer tried a modification of the Neher-Harper circuit in which the tube operated at rated potential; the source of high voltage for the counter was inserted between one counter terminal and the plate of the first tube; this source was an *unshielded* bank of B batteries, about 1000 volts in all, but no trouble was experienced in getting the arrangement to count. It was used both with the counter wire on the grid of the first tube and with the cylinder of the counter on the grid. (Of course the circuit constants were appropriately changed in going from one of these arrangements to the other. The counter wire was always positive to the cylinder in these tests.) A real advantage of the multivibrator over the Neher-Harper arrangement is that it works with the first grid normally at ground potential. When the grid potential is adjusted in the Neher-Harper circuit the voltage applied to the counter is altered, and this change must be compensated in many types of work.

(5) Dr. Getting remarks that the statistics of the multivibrator circuit are different from those of previous ones. Brammer and the writer[3] have treated the corrections for recovery time in any circuit which controls the counter voltage during the discharge and the subsequent period in which the ions are swept out of the counter. It is believed that in general the analysis given applies to both the multivibrator circuit and the Neher-Harper circuit.

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January 15, 1938.

[1] Getting, Phys. Rev. **53**, 103 (1938).
[2] Gingrich, Evans and Edgerton, Rev. Sci. Inst. **7**, 450 (1936).
[3] Ruark and Brammer, Phys. Rev. **52**, 322 (1937).

Note on the Existence of Heavy Beta-Rays

During the winter of 1936–37 the author, together with J. J. Turin, E. R. Gaerttner and D. S. Bayley, carried out some rather extensive experiments in an effort to determine whether or not beta-rays of nuclear origin behaved differently from those of extranuclear origin. The results of a comparison of nuclear beta-rays with recoil electrons produced by gamma-rays seemed at the time to indicate that a difference in penetrating power existed.[1] The idea that the total energy (mass plus kinetic) might be the same for all the beta-rays from a given kind of emitter, and equivalent to the energy lost by the nucleus was at that time discussed as an alternative to the neutrino hypothesis. In the course of discussion of this idea at the Washington Conference on Theoretical Physics[1] many grave objections to such a mechanism were brought forward, the principal of which were the results of calorimetric experiments on Ra E, measurements on the primary ionization of beta-rays, and the stopping power of matter for beta-rays of various momenta from a given source. However, in spite of these arguments, experiments specifically designed to test such a hypothesis were carried out by the group of which the author was a member, and also by C. T. Zahn and A. H. Spees. The latter have already published a preliminary note[2] on their results. Inasmuch as the same question has again been raised[3] (this time in regard to Ra E it seems appropriate to describe briefly an experiment performed in this laboratory which bears directly upon the question raised, even though a different beta-ray emitter (Li^8) was used.

Li^8 emits a continuous spectrum of beta-rays having an upper limit of 12 Mev.[4] Using the cloud chamber method already described[5] we measured the absorption in $\frac{1}{2}$ cm of carbon of a group of beta-rays coming from about the center of the spectrum. We next carried out the same absorption measurements on a group of beta-rays which originated near the upper limit of the spectrum, but which had been slowed down to the same momentum as those measured in the first case, by passage through about $1\frac{1}{2}$ cm of carbon surrounding the source. The results indicated that the beta-rays from these two widely separated parts of the spectrum were absorbed very nearly alike when brought to the same momentum. On the hypothesis considered by us, and later by Jauncey,[3] the beta-rays originating near the middle of the spectrum (say 10 mC momentum) should have lost roughly six times as much energy as those taken from the upper end of the spectrum. In fact a consideration of the kinetic energy shows that they should not have passed through the $\frac{1}{2}$ cm carbon absorber in the cloud chamber at all. Results for the fractions stopped by the carbon are given below, based upon a total of about 1000 tracks.

Momenta of incident particles, in units mC	6 to 8	8 to 10	10 to 12	12 to 14
Unfiltered	64%	45%	34%	15%
Filtered	63%	41%	27%	17%

In addition to this, the loss of momentum suffered by those particles which passed through the carbon absorber was found to be the same for the filtered and unfiltered groups, and agreed with the theoretical predictions for ordinary electrons. It therefore appears that if in the case of Ra E the rest mass is continuously variable and is a function of the initial momentum,[3] the phenomenon does not extend to all beta-ray emitters, and cannot be thought of as clearing up the question of the conservation of energy in beta-ray emission.

In the course of the experiments described a few individual beta-rays (amounting to only a small fraction of a percent of the total number) appeared to behave in an anomalous way, but a satisfactory interpretation of these cases has not been found.

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January 25, 1938.

[1] Breit, Rev. Sci. Inst. **8**, 141 (1937).
[2] Zahn and Spees, Phys. Rev. **52**, 524 (1937).
[3] Jauncey, Phys. Rev. **52**, 1256 (1937); Phys. Rev. **53**, 106 (1938); Phys. Rev. **53**, 197 (1938).
[4] Bayley and Crane, Phys. Rev. **52**, 604 (1937).
[5] Turin and Crane, Phys. Rev. **52**, 63 (1937); Phys. Rev. **52**, 610 (1937).