geneities would tend to neutralize each other's effect. Experience seemed to show that it was better to first test the condition of the wire rather than rely on accidental corrections. A wire tester adapted to insulated wires several meters in length was made of a steam-jacketed glass tube. The wire was gradually drawn out of this tube, so that the thermoelectric height of the portion which was at the opening at any time was compared directly with another immovable portion. The result showed for No. 36 Advance wire a rise and fall of thermoelectric height with a fairly constant period of 60 cm., averaging about .25 per cent. of the electromotive height against copper, or over ten times the height of the short period variations found by Professor Hall.¹

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THE VELOCITY, AND RATIO e/m , FOR THE PRIMARY AND SECONDARY β -RAYS OF RADIUM.²

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THE work of Kaufmann has shown that the primary β -rays are composed of negatively charged particles travelling with velocities nearly equal to that of light, and that further, as the velocity of light is approached the apparent mass of the electron increases rapidly. In trying to repeat these results, using, instead of the photographic method of Kaufmann, the well-known ionization one, the author experienced at first great difficulty in getting any true deflection of the β -rays. By further investigation however this difficulty was shown to be due to the presence of secondary and tertiary rays, which to a great extent masked the action of the primary β -rays.

An investigation into the nature of these secondary and tertiary rays, more especially absorption tests, and their behavior in a magnetic field, brought forth the following facts:

1. When the β -rays strike upon solid objects, there is produced at the surface of these, secondary rays, which differ both in quantity, and penetrating power with the nature and density of the object.
2. Nearly all of the secondary rays, whether from dielectrics or metals, are deflected in a magnetic field in the same direction as the primary β -rays would be.

¹ Proc. Am. Acad., 41, 543.

² Abstract of a paper presented at the Washington Meeting of the Physical Society, April 21, '06.

3. The penetrating power of secondary rays is greater for the substances of high density, but in any case it is not much less than the medium and slow velocity primary rays.

4. When the secondary rays in turn strike upon solid objects, there is produced a third type of rays similar in all respects to the secondary rays, but of slightly less penetrating power.

5. The amount of secondary rays produced by the γ -rays is small compared with that produced by the β -rays, but is of the same general nature. From these results an explanation of the difficulty experienced at first by the author can at once be obtained.

When a beam of β -rays, cut down to a supposed narrow width is allowed to fall upon the window of an electroscope of width the same as that of the incident beam, then besides this beam of β -rays there is also present a diffuse beam of secondary and tertiary rays, which as has just been shown are of the same general nature as the β -rays themselves, *i. e.*, deflectable in a magnetic or electrostatic field. Consequently the deflection of the β -rays would be very much confused by the accompanying deflection of the secondary and tertiary rays, so that an apparent total deflection of some 30 per cent. might mean more than complete deflection of the primary rays.

This difficulty was removed by the following method which proved successful.

The beam of β -rays was just prevented from entering the electroscope window by a suitable screen. Now it was found that, when the magnetic or electrostatic field was applied in such a direction as would bend the rays into the window, the ionization in the electroscope gradually increased to a maximum with increasing fields. When this maximum point had been reached for either the magnetic or electrostatic fields, the β -rays of least velocity had just been bent across the electroscope window. Knowing the strengths of the magnetic and electrostatic fields necessary to produce this maximum ionization, the velocity of the least penetrating ray could at once be calculated. By interposing in the path of the rays suitable layers of absorbing material, the velocity of the least penetrating ray which could just get through the absorbing layer could be ascertained. The effect of the secondary and tertiary rays was to change the amount of the increase of ionization but not the maximum point.

The experiments were performed in a high vacuum, the rays emerging from the vacuum vessel through a thin sheet of mica.

The velocity of the secondary rays was obtained in exactly the same manner, the radium being enclosed in a lead box which cut off all the primary rays and allowed only the secondary rays to pass out through a small opening. The complete results for both primary and secondary rays are given in the following table :

Primary β -Rays.

Absorbing Layer.	X (max.).	H (max.).	mv/e	V cm./sec.	e/m
0	—	—	1.57×10^8	2.20×10^{10}	1.40×10^7
6 sheets paper.	5.7×10^{11}	13.5	1.87	2.37	1.27
10 “ “	6.1	14.3	1.98	2.40	1.21
14 “ “	6.6	15.1	2.10	2.45	1.17
18 “ “	7.2	16.2	2.25	2.49	1.10
22 “ “	7.7	17.0	2.36	2.54	1.07
30 “ “	8.3	17.9	2.49	2.60	1.04
1.5 mm. glass.	9.6	20.0	2.78	2.69	.96
.3 “ copper.	11.0	22.2	3.09	2.77	.90
.4 “ zinc.	14.0	27.2	3.79	2.88	.76
.8 “ “	—	—	4.60	2.95	.64
1.2 “ “	—	—	5.00	2.97	.59

Secondary Rays from Lead.

0	—	—	1.56×10^8	—	—
6 layers paper.	6.9×10^{11}	16.0	1.85	2.35×10^{10}	1.27×10^7
14 “ “	7.5	17.0	1.97	2.40	1.21
22 “ “	8.5	18.5	2.16	2.50	1.16
30 “ “	9.6	20.2	2.36	2.58	1.09

It will be seen at once from these tables that the limiting velocity of the rays for the same thickness of material is the same for both primary and secondary radiations. The values of the velocity, and ratio e/m , for the rays are very close to those found by Kauffman, and lend additional weight to the view that the mass of the electron is entirely electrical in nature. The fact is also brought out in this investigation that the secondary rays are of the same nature as the primary β -rays, and travel at nearly the same velocity.

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