

our figures suggest that a large proportion of the observed flux is not a true primary flux of light nuclei but secondary in origin.

An experiment is now in progress to test the above assumptions by observing the proportion of lithium, beryllium, and boron fragments produced by interactions of primary nuclei occurring in the plastic (cellulose acetate) layers of a stripped emulsion-plastic stack.

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<sup>1</sup> Characterized by a recoil proton at a much greater angle than the fast fragments of the incident nucleus. Charge balance can be obtained. The proportion of hydrogen interactions observed is in agreement with that calculated from the known composition of emulsion.

<sup>2</sup> H. Bradt and B. Peters, *Phys. Rev.* **80**, 943 (1950).

<sup>3</sup> Dainton, Fowler, and Kent, *Phil. Mag.* **43**, 729 (1952).

<sup>4</sup> Racette, Kaplon, and Ritson (to be published).

### Total Ionization of $\alpha$ Particles of Po in Mixtures of Gases

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THE total ionization of  $\alpha$  particles of Po has been measured in the following mixtures of gases: A-N<sub>2</sub>, A-H<sub>2</sub>, A-CH<sub>4</sub>, A-C<sub>2</sub>H<sub>5</sub>OH, A-C<sub>6</sub>H<sub>6</sub>.

The experimental apparatus consisted of a gridded ionization chamber attached to a gas purifier. The purification of argon, nitrogen, and methane was done with continuous circulation of the gases over Ca-Mg turnings kept at 300-400°C. The hydrogen was circulated over Mg only. In the mixtures of argon with C<sub>2</sub>H<sub>5</sub>OH and C<sub>6</sub>H<sub>6</sub> the previously purified argon was added to the other gas which had a purity higher than 99.9 percent. The pressure in the chamber was such that the  $\alpha$  particles lost all of their energy in the sensitive volume and a field was produced that assured the complete collection of the electrons. The amplification chain consisted of a preamplifier and a Bell and Jordan amplifier<sup>1</sup> or a Model-100 amplifier.<sup>2</sup> The pulses were analyzed with an amplitude discriminator.

The results of our measurements are shown in Figs. 1 and 2. The ratio  $W_A/W_m$  between the average energy expended in producing an ion pair in argon and that in the mixture is plotted as a function of the parameter  $z = s_1 p_1 / (s_1 p_1 + s_2 p_2)$ , where  $s_1$  and  $s_2$  are the stopping powers of the two components and  $p_1$  and  $p_2$  their pressures. It can be shown that the ionization in the mixtures is a linear function of  $z$  if it is assumed there is no interaction between the components of the mixture itself.<sup>3</sup> It is seen in Figs. 1 and 2 that the ionization rises rapidly with  $z$  and reaches a maximum at percentages of about 2 percent, 0.2 percent, and 0.2 percent for CH<sub>4</sub>, C<sub>2</sub>H<sub>5</sub>OH, and C<sub>6</sub>H<sub>6</sub>, respectively. The ionization exceeds that in pure argon by 1.5 percent, 15 percent, and 21 percent respectively. These results can be interpreted by assuming that the

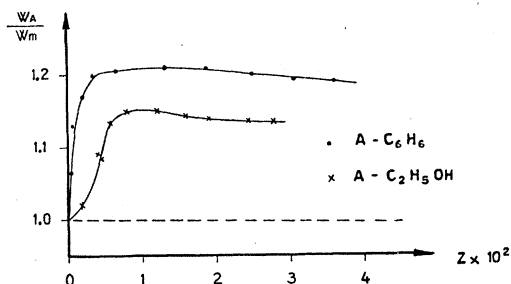


FIG. 1. Variation of  $W_A/W_m$  with  $z$ . The dotted line shows the variation of ionization in the mixture on the assumption of independent ionization of the components. The stopping powers used are:  $s(A) = 0.95$ ,  $s(C_6H_6) = 3.33$ ,  $s(C_2H_5OH) = 2.02$ .

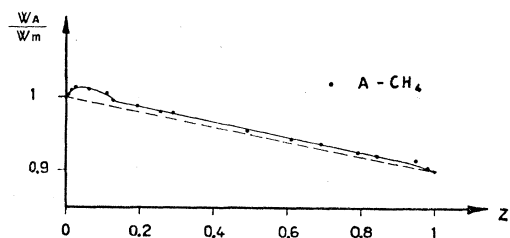


FIG. 2. Variation of  $W_A/W_m$  with  $z$ . The dotted line shows the variation of ionization in the mixture on the assumption of independent ionization of the components. The stopping powers used are:  $s(A) = 0.95$ ,  $s(CH_4) = 0.91$ .

excited atoms of argon transfer their energy, during a collision, to atoms of foreign gas and ionize them:  $A+S \rightarrow S^+ + A + e$ , where S indicates a molecule of foreign gas (CH<sub>4</sub> or C<sub>2</sub>H<sub>5</sub>OH or C<sub>6</sub>H<sub>6</sub>). This process is possible because the ionization potentials of foreign gas are lower than that of argon. A, CH<sub>4</sub>, C<sub>2</sub>H<sub>5</sub>OH, and C<sub>6</sub>H<sub>6</sub> have ionization potentials of 15.4, 14.5, 11.5, and 9.6 volts, respectively, and it can be seen that the lower the potential of the foreign gas, the higher is the maximum ionization of the mixture.

It can further be noted that at the conditions of pressure and temperature in which the mixture was studied, the time of collision of an excited atom of argon with one of foreign gas is  $\sim 5 \times 10^{-11}$  sec, considering that an excited atom has a collision cross section ten times the geometrical cross section.<sup>4</sup>

The curves of  $W_A/W_m$  for A-H<sub>2</sub> and A-N<sub>2</sub> mixtures are in agreement with the measurements of Haerberli, Huber, and Baldinger,<sup>3</sup> and Valentine and Curran.<sup>5</sup> In these mixtures the ionization values can be understood when the ionization of  $\delta$  rays is taken into account.<sup>3</sup>

A more detailed description of the results is to be published in *Il Nuovo cimento*.

<sup>1</sup> W. H. Jordan and P. R. Bell, *Rev. Sci. Instr.* **18**, 703 (1947).

<sup>2</sup> W. C. Elmore and M. Sands, *Electronic Experimental Techniques* (McGraw-Hill Book Company, Inc., New York, 1949), p. 165.

<sup>3</sup> Haerberli, Huber, and Baldinger, *Helv. Phys. Acta* **23**, 481 (1950); **26**, 145 (1953).

<sup>4</sup> J. P. Molnar, *Phys. Rev.* **83**, 940 (1951).

<sup>5</sup> M. Valentine and S. C. Curran, *Phil. Mag.* **43**, 964 (1952).

### Decay-Electron Spectrum of the $\mu$ Meson\*

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WE have completed an experiment to determine the shape of the energy spectrum of electrons from the decay of the  $\mu$  meson. Pi mesons from a paraffin target in the gamma-ray beam of the M.I.T. synchrotron passed through an argon-filled cloud chamber, at one wall of which was an anthracene scintillation counter (see Fig. 1). The magnetic field in the cloud chamber (9000 gauss) selected a broad momentum band of positive pions which crossed the chamber and stopped in the anthracene crystal or the Lucite light-pipe behind it. The positron from the subsequent  $\pi \rightarrow \mu \rightarrow e$  decay was then visible if it came out in a favorable direction.

Out of 4350 pictures, 830 showed clearly-associated meson and electron tracks. Rigorous selection criteria were necessary to avoid biasing the sample. The lower limit of acceptable initial kinetic energy was set at 20 Mev. Each event was reconstructed graphically and required to pass the following tests: (a) the calculated electron trajectory in the Lucite must intersect the known end point within stated limits; (b) any electron of energy between 20 Mev and 52.4 Mev having the initial direction determined from this trajectory must have a path in the Lucite plus anthracene of less than 4.2 cm; (c) any electron with this initial direction and with energy between 20 Mev and 52.4 Mev must have a visible track in the cloud chamber of more than 5 cm of arc. Consideration