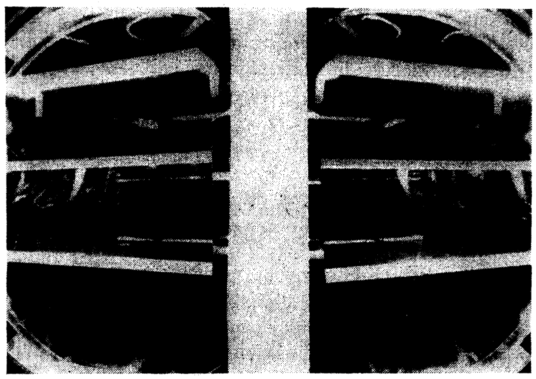

FIG. 2. Cloud-chamber photograph of a mesotron which stops in a graphite plate (lower left), and disintegrates with the emission of a lightly ionizing particle.

36±3 Mev for the energy of the disintegration particle. This value for the energy is somewhat smaller than the average value of 45 Mev found by Thompson[2] and considerably larger than the value of 25 Mev found by Anderson *et al.*[3] The spread in disintegration energies indicates that more than 2 particles are created in the process of disintegration of the light mesotron.

The writers are indebted to Professor Carl D. Anderson who first suggested this problem and who rendered valuable aid during the progress of this work.

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* Assisted by the Joint Program of the Office of Naval Research and the Atomic Energy Commission.

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[1] J. C. Fletcher, thesis (Ph.D.), California Institute of Technology, June, 1948.

[2] R. W. Thompson, Phys. Rev. **74**, 490 (1948).

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Relative Sensitivities of Some Organic Compounds for Scintillation Counters*

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A SEARCH for organic materials which would serve as scintillation-type detectors similar to naphthalene[1] has resulted in establishing the sensitivities of nine compounds relative to naphthalene,[2,3] both for 1P21 and 1P28 photomultipliers. Recrystallized and sublimed samples of all compounds were used with the exception of one sample of commercial naphthalene for comparative purposes. 1.8 grams of each material were used, packed as nearly as possible at constant volume in quartz test tubes, the scintillations observed by four photo-multipliers in parallel surrounding the test tube. The pulses were amplified by a Los Alamos Model No. 500 pulse amplifier, voltage discriminated, and recorded on a scale of 4096 and register. The multipliers were not refrigerated. A 20 mc radium gamma-source placed at a standard distance of 71.5 cm was used for all tests.

Figures 1 and 2 show a series of integral, pulse height distributions for the compounds investigated as observed with 1P28s and 1P21s. In addition it is desired to call attention to the following features:

(1) Several compounds, in particular anthranilic acid, showed exceedingly strong fluorescence to ultraviolet excitation but were very poor as scintillating materials with radium gammas.

(2) The dynode power supply was arranged so that the supply voltage could be varied and also the voltages to the individual tubes could be separately adjusted. This made it possible to equalize the detection sensitivities of the parallel tubes and after adjustment to shift all the tubes together to any desired average dynode voltage. Dynode voltage on the 1P28s was so adjusted that for two bias values the purified naphthalene counts coincided with those using the 1P21s. Since this voltage was nearly identical with that used for the 1P21s, it appears from the RCA Handbook data that the 1P28 observes about ten times more luminous flux from the naphthalene radiation than the 1P21.

(3) The scintillation property appears to be connected with molecular structure since phenanthrene is a very poor material and its isomer anthracene a very good one.

(4) This property does not seem to be connected with condensed-ring systems in general, since 1,2-benzanthracene was exceedingly poor, but may possibly be more closely associated with the conjugate bonding observed in stilbene.

(5) The stilbene, at the high biases, is at least a factor of three better than anthracene which had been the best material found previously.[3]

(6) Although refrigeration was not used, the pulse height curves do not seem to extrapolate back to the same zero bias value for all the compounds. On the curves for naphthalene, anthracene and stilbene the zero bias values could possibly be the same, as shown in the figures, indicating that most of the betas arising from the gamma-radiation make enough photons to be counted. For most of the other materials, however, there seems to be some

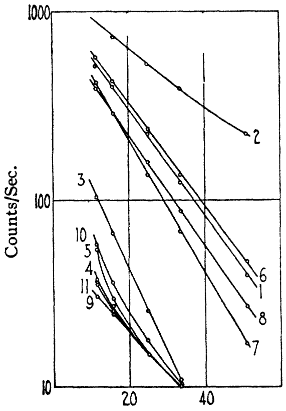

FIG. 1. Integral bias curves with 1P21s. 1—anthracene, 2—stilbene 3—phenanthrene, 4—phenyl benzal glyoxalidone, 5—triphenyl methane, 6—naphthalene, 7—naphthalene—stock, 8—fluorene, 9—anthranilic acid, 10—acenapthene, 11—benzanthracene, 12—diphenyl.

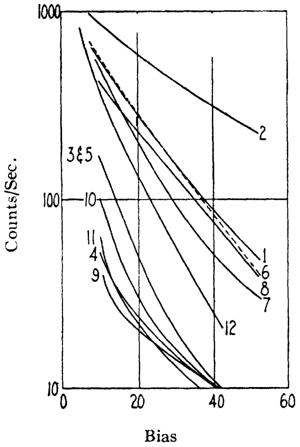

FIG. 2. Integral bias curves with 1P28s. 1—anthracene, 2—stilbene, 3—phenanthrene, 4—phenyl benzal glyoxalidone, 5—triphenyl methane, 6—naphthalene, 7—naphthalene—stock, 8—fluorene, 9—anthranilic acid, 10—acenapthene, 11—benzanthracene, 12—diphenyl.

indication that not all betas are counted even at zero bias. The great advantage of the stilbene is its high conversion efficiency, i.e. large number of photons per unit beta-energy loss, which is apparent at the large pulse heights. The flatness of the stilbene curve at low bias leads one to hope that a sufficiently good material may be found for which the extrapolation to zero pulse height can be made unambiguously without the use of refrigeration. Stilbene is at present being investigated with multiplier refrigeration.

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* This document is based on work performed under government contract number W-7405-eng-36 for the Los Alamos Scientific Laboratory of the University of California.

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[2] Progress Report, Laboratory for Nuclear Science and Engineering, M.I.T., April (1948).

[3] P. R. Bell, Phys. Rev. **73**, 1405 (1948).

Radiation from Columbium 95

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NEDZEL[1] using the beta-ray spectrometer in studying columbium 95 has reported one beta-ray (0.154 Mev) and one gamma-ray (0.77 Mev). In addition, he observed a conversion electron peak with energy of 0.224 Mev. Levinger[2] further studied this peak and assigned it to a short-lived columbium 95 isomer the gamma-ray of which is completely converted, and which undergoes isometric transition to 35-day columbium 95. Using a beta-ray spectrometer similar to that described by Deutsch *et al.*[3] we have recently examined both the 35-day and the short-lived nuclide of columbium 95.

From a hydrochloric acid solution containing columbium 95 and its parent zirconium 95, the zirconium was removed by repeated extractions with 0.5M thenoyltrifluoacetone benzene solution. From the pure aqueous solution, active columbium was precipitated by the addition of 0.5 mg of columbium carrier and evaporation in nitric acid. This material ($\sim$100 microcuries) was placed on a laminated Formvar-polystyrene film ($\sim$50 micrograms/cm^2) and used as a source for the study of the beta-spectrum in the beta-ray spectrometer. From the data obtained, a plot of the counts per minute per unit momentum interval ***versus*** the current in amperes $[(N/I)$ *vs.* $I]$ has been made (Fig. 1). A conversion peak may be noted at 0.200 Mev, and another at 0.735 Mev. The Kurie plot (Fig. 2) indicates one beta-ray of energy 0.146 Mev is associated with the decay of the 35-day columbium 95 nuclide. Using values for intensities obtained by graphical integration under the counts per minute per unit momentum interval *vs.* coil current plot, we find that the short lived isomer is present to the extent of 1.4 percent in a solution in which zirconium 95 and columbium 95 are in equilibrium. The decay of a columbium source has been followed on a standard bell-type thin-end window Geiger-Mueller counter equipped with continuous recorder. These data indicated the half-life to be 90 hours which is identical with the value reported by Steinberg.[4]

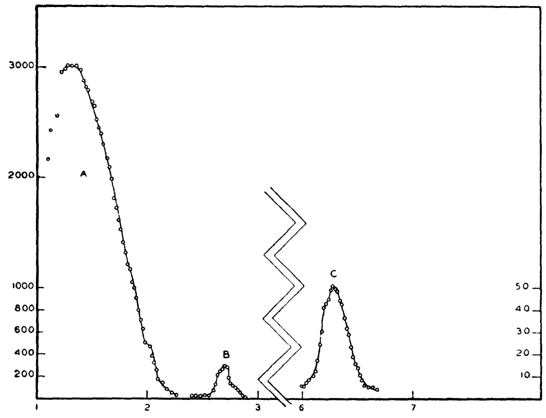

FIG. 1. The beta- and conversion-electron spectra of Cb^{95} (counts per minute per unit momentum interval plotted against coil current in amperes).

A is the continuous beta-spectrum of Cb^{95}; B is the conversion electron peak of the 90-hr. Cb^{95}; C is the conversion electron region of the 0.75 Mev gamma-ray.

After extrapolation of the Kurie plot and a recalculation and replotting of a theoretical (N/I) *vs.* I curve, we have compared the areas under the continuous beta-spectrum and the areas under the two conversion electron regions. We find for 35-day columbium 95 the ratio of the conversion electrons to the continuous beta-particles is 2.4 $\times 10^{-3}$.

A source for study of the gamma-spectrum was prepared in a manner similar to that described above. The amount of active columbium taken was increased $\sim$50 fold, and the precipitated columbium oxide was mounted in the spectrometer and data obtained using first a uranium and