LETTERS TO THE EDITORS

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Measurements of the Energy of Beta- and Gamma-rays with a Scintillation Counter

Broser and Kallmann[1] have shown that mono-energetic alpha-particles give pulses of the same height in a scintillation counter, and that the pulse-height is proportional to the energy of the alpha-particles. It is found in studying the pulses for some beta-radiating substances that there is proportionality between pulse-height and energy also in this case. The same result is obtained when studying the pulse-height from the gamma-rays emitted by different substances. There is, in this case, a continuous distribution of pulses from zero to a certain maximum height which corresponds to the continuous distribution of Compton electrons produced in the absorption of the gamma-rays. By determination of the end-points of the distributions, a rough measure is given of the energy of the gamma-rays. Recently Jordan and Bell[2] have published some measurements of that kind. This method gives rather uncertain results, especially for gamma-spectra with more than one energy. I have therefore tried to determine the pulse-height corresponding to those photo-electrons which are created at the absorption of the gamma-rays in the phosphor.

If one uses in the scintillation counter a phosphor which contains elements of high atomic weight, a fairly large number of photo-electrons will be created; and those electrons should give a maximum in the distribution of pulse-height, which would be easier to determine than the end-point of the Compton distribution. A number of gamma-radiating substances have been investigated and the maxima corresponding to the photo-electrons have been found in every case. A sodium (thallium) iodide phosphor was used; the pulses from the photo-multiplier (R.C.A. 1P21) were amplified by a linear amplifier and the pulse-height was studied by means of a discriminator. An example is given in Fig. 1, which shows the curve obtained for sodium-24. The number of counts in a small pulse-height interval is plotted against the pulse-height. The maxima corresponding to the two energies 1·4 and 2·8 MeV. can be seen.

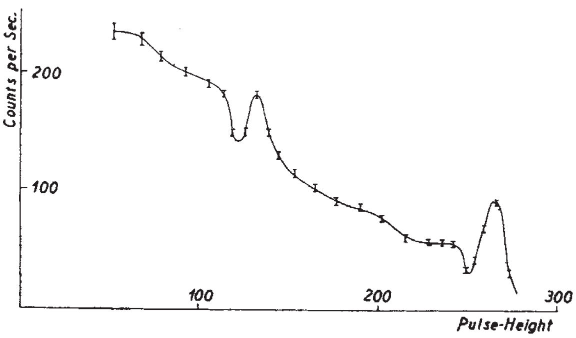

Fig. 1

To use this apparatus for the measurement of gamma-energies, it must be calibrated with known[3] gamma-spectra. Fig. 2 shows this calibration curve. The pulse-height corresponding to the photo-electrons from different gamma-rays has been plotted against the energy of the rays. The diagram shows that the pulse-height is proportional to the energy, and also gives an indication of the accuracy that can be attained with this method. The uncertainty seems to be of the order of 2–3 per cent.

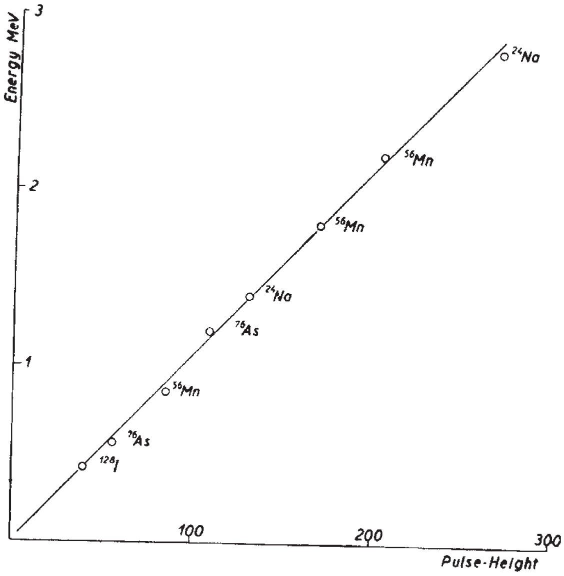

Fig. 2

The calibration curve of Fig. 2 applies to the photo-electrons of the gamma-rays. It should be possible, however, to use it for the measurement of electrons in general, for example, from a beta-emitting substance. As a check on the calibration curve, the pulse-height distribution was measured for a number of beta-emitters: manganese-56, iodine-128 and radium E. By means of the Fermi plots from these measurements and the calibration curve, the maximum energy of the beta-rays was found. The following values were obtained (the corresponding values according to Mattauch[3] are given in brackets for comparison): manganese-56, $2·82 \pm 0·05$ MeV. (2·84); iodine-128, $2·04 \pm 0·04$ MeV. (2·02); radium E, $1·19 \pm 0·03$ MeV. (1·17). It is thus possible to measure beta-spectra with a comparatively good accuracy by means of scintillation counters. The method will be more useful, however, for the measurement of gamma-rays, because of the possibility it affords of measuring very weak samples.

A more detailed account of this work will be published elsewhere.

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[1] Broser, I., and Kallmann, H., *Nature*, 163, 20 (1949).
[2] Jordan, W. H., and Bell, P. R., *Nucleonics* (Oct. 1949).
[3] Mattauch–Flammersfeld, "Isotopenbericht" (1949).