

Boltzmann populations for the 6^3D states of Hg, as assumed by these authors for their Hg doped carbon arc.

Details will be published elsewhere.

- ¹ W. Elenbaas, *Physica* 1, 211 (1934).
² C. Kenty, *Rev. Sci. Inst.* 11, 377 (1940).
³ W. Elenbaas, *Philips Research Reports* 2, 20 (1947).
⁴ R. B. Brode, *Rev. Mod. Phys.* 5, 243 (1933).
⁵ W. Elenbaas, *Physica* 2, 757 (1935).
⁶ B. Yavorsky, *Comptes Rendus U.S.S.R.* 48, 175 (1945).
⁷ W. Schouten and J. A. Smit, *Physica* 10, 661 (1943).

The Gamma-Rays from $\text{Be}^9(\alpha, n)$

R. W. PRINGLE, K. I. ROULSTON, AND S. STANDIL
Physics Department, University of Manitoba, Winnipeg, Canada
 April 17, 1950

WE have recently applied a scintillation gamma-ray spectrometer¹ to the study of high energy gamma-rays which give rise to electron pairs in the scintillation element of NaI (Tl), as a result of their interaction with the I atoms in the crystal lattice. The total kinetic energy of the pairs ($E_\gamma - 1.02$ Mev) appears as the energy of pair production lines when the differential pulse-height distribution of the crystal scintillations is examined in an arrangement similar to the one which we have been using in the lower energy region.¹ Used in this manner the device might be termed a scintillation pair spectrometer.

A satisfactory resolution has been achieved as a direct consequence of the high energies involved and of certain improvements to the original equipment, and we wish to report some interesting results which have been obtained with the very weak gamma-rays produced in the bombardment of beryllium with polonium alpha-particles. These gamma-rays are attributed to the de-excitation of the excited levels of the residual C^{12} nucleus which is formed in the reaction. Previous measurements of these gamma-ray energies² have yielded somewhat confusing results, but much work has been done on the level scheme involved by a study of the neutron groups which are produced.³ It was therefore thought to be of interest to investigate the gamma-rays with the scintillation pair spectrometer, which is ideally suited to a study of very weak sources.

The ThC'' gamma-ray of 2.62 Mev was used for the purpose of calibration (Fig. 1), and a small pair production peak, A, due to this gamma-ray can be identified at 1.60 Mev on the pulse-height scale. This is superimposed on a well-defined Compton distribution, B. As the pair production cross section is relatively

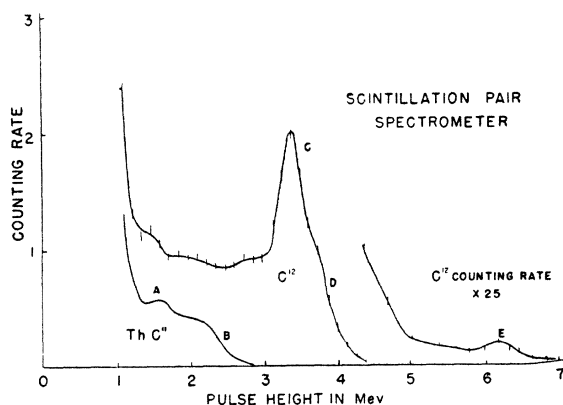


FIG. 1. Differential pulse-height distributions, showing the pair production peaks obtained with high energy gamma-rays. The ThC'' 2.62-Mev gamma-ray has been used to calibrate the pulse-height scale. A. Pair production due to ThC'' 2.62-Mev gamma-ray. B. Compton edge due to ThC'' 2.62-Mev gamma-ray. C. Pair production due to C^{12} gamma-ray (4.40 Mev). D. Compton edge due to C^{12} gamma-ray (4.40 Mev). E. Pair production due to weak C^{12} gamma-ray (7.2 Mev).

low for this gamma-ray energy, an accurately known gamma-ray of somewhat higher energy, if available, would be better suited for calibration purposes. The source used was about 10 grams of thorium nitrate, which illustrates the extreme sensitivity of the device. The Po-Be source strength was not known accurately but was believed to give approximately 5×10^3 neutrons/sec. The direct effect of these neutrons on the crystal was shown to be small and the pulse-height distribution curve obtained with this source is substantially due to gamma-rays alone. The predominant feature of the C^{12} curve is the pair production peak, C, corresponding to a gamma-ray energy of 4.40 ± 0.05 Mev superimposed on a sharp Compton distribution, D. The resolution of this line, defined in terms of its full width at half-height, appears to be about eight percent. This sharply resolved peak gives us confidence that the linear relation¹ between pulse height and energy extends to this region, as otherwise a broad distribution would be obtained as a result of the nature of the pair production process. No significant gamma-ray of energy in the range 2 to 4 Mev is found. However, there is evidence for the existence of a very weak gamma-ray at approximately 7.2 Mev. A detailed study of this region was difficult because of the weakness of the available source, and the low relative intensity of the gamma-ray which has been estimated as about one percent of the lower energy component.

The existence of an excited level of C^{12} at 4.40 ± 0.05 Mev and the absence of other levels except the weak high energy 7.2-Mev level is in complete agreement with results which have been obtained recently by Bradford and Bennett³ from a study of the neutron groups involved.

A considerable amount of work has been done on the study of the photo-electron lines produced by low energy gamma-rays in the scintillation spectrometer and a report of this work will be published shortly. The National Research Council of Canada has given us support in this project.

¹ Pringle, Roulston, and Taylor, *Rev. Sci. Inst.* 21, 216 (1950). Pringle, Standil, and Roulston, *Phys. Rev.* 77, 841 (1950); 78, 303 (1950). R. W. Pringle, *Physics in Canada* (1950). P. R. Bell and J. M. Cassidy, *Phys. Rev.* 77, 409 (1950).

² See W. F. Hornyak and T. L. Lauritsen, *Rev. Mod. Phys.* 20, 191 (1948). T. L. Lauritsen, *Nuclear Science Series*, No. 5.

³ C. E. Bradford and W. E. Bennett, *Phys. Rev.* 77, 753 (1950).

Can the Rectifier Become a Thermodynamical Demon?

L. BRILLOUIN

International Business Machines Corporation, New York and Poughkeepsie, New York

April 17, 1950

A RESISTOR R , maintained at the absolute temperature T , is a source of random electromotive forces e_v ,

$$\langle e_v^2 \rangle_{\Delta\nu} = 4RkT d\nu \quad (1)$$

for a small frequency interval $d\nu$. This is the well-known Nyquist formula. Let us connect the resistor in series with a rectifier. It seems as if the rectifier should rectify these random oscillations and produce a direct voltage. With a large number of such circuits in series one might obtain a voltage high enough to charge a battery. This means a possibility of doing work with just one source of heat at one temperature, in obvious contradiction with the second principle of thermodynamics.

Let us investigate how this problem can be solved. We consider the circuit of Fig. 1 with an impedance, at frequency ν ,

$$Z = R + jX \quad (2)$$

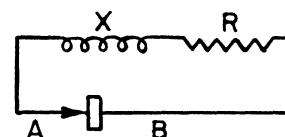


FIG. 1. Circuit with rectifier.