

to colour centres at strongly disturbed regions of the lattice; these might possibly be the *R*-centres of F. Seitz².

A more detailed account will be given in the *Wien. Ber.* and the *Acta Physica Austriaca*.

N. ADLER

II. Physics Institute,
University of Vienna,
Jan. 5.

¹ Przi Bram, K., *Wien. Ber.*, IIa, 138, 483 (1929).

² Seitz, F., *Rev. Mod. Phys.*, 18, 384 (1946).

Scintillation Counters Using Organic Compounds

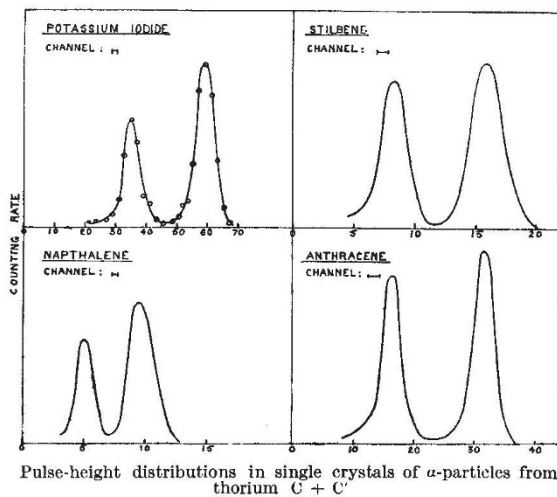
SEVERAL papers have recently been published¹⁻⁴ on the efficiency of naphthalene, anthracene and other organic phosphors used in conjunction with photomultipliers as detectors of ionizing radiations. In view of the conflicting nature of some of these results, we have carried out experiments with these substances, particular attention being paid to their purity. The phosphors investigated were naphthalene, anthracene and stilbene, and the measurements were made using an EMI Type 4140 photomultiplier with a single-channel pulse analyser to record pulse-height distributions.

The effects of various purification methods were at first investigated by measuring the pulse distributions from cobalt-60 γ -rays, using the phosphors in powder form. This method was found to be quite sensitive to the degree of purification employed and enabled us to make fairly rapid tests of the purity. However the continuous nature of the pulse distribution was such that it was difficult to make any definite comparisons of the ultimate efficiencies of the different phosphors for light production.

Distributions obtained with α -particles offered a more promising means of comparison⁵, and measurements were therefore made with α -particles from polonium (5.3 MeV.) and from thorium C+C' (6.04 and 8.78 MeV.). For these measurements thin crystals about 2 mm. square and 15 mgm./cm.² thick, selected for uniformity and transparency, were used in order that the β - and γ -ray background should be negligible. The accompanying graphs show pulse-height distributions obtained with naphthalene, anthracene and stilbene, exposed to α -particles from thorium-active deposit. A similar curve obtained with potassium iodide + thallium is included for comparison; we are indebted to Mr. J. Sharpe of this Establishment for providing this crystal. The substances used for these curves were in the purest form we have thus far obtained.

The purification methods attempted were sublimation, repeated crystallization and co-distillation, the last being by far the best, both as to ease and purity obtained. For example, in the case of anthracene, one co-distillation of the commercial product with ethylene glycol was found to give better results and a much higher yield than four sublimations. Co-distillation with ethylene glycol was used for anthracene and stilbene, and with water for naphthalene. It was found slightly advantageous to perform two such distillations, after which crystals were grown from solution: anthracene from ethyl acetate, stilbene from ether, and naphthalene from alcohol.

The curves shown were taken under the same conditions, and the ratios of pulse-heights for the thorium C' α -particle group are approximately



8 : 4 : 2 : 1 for potassium iodide, anthracene, stilbene and naphthalene, respectively. It is felt that these ratios, obtained from monochromatic α -particle groups, are more reliable than those obtained with β - or γ -rays. We found, however, that anthracene gave larger pulses than stilbene with both γ -rays and α -particles.

Further preliminary measurements indicate that whereas potassium iodide + thallium gives a linear relation between pulse-height and α -particle energy, the organic phosphors do not. However, it is hoped that the non-linearity will be much less pronounced with protons having a lower ionization density, and that organic phosphors may therefore be used to detect and measure the energy of fast neutrons producing recoil protons in the phosphors.

G. N. HARDING
B. H. FLOWERS
J. S. EPPSTEIN

Atomic Energy Research Establishment,
Harwell.
March 28.

¹ Bell, *Phys. Rev.*, 73, 1405 (1948).

² Irvine and Sangster, *Bull. Amer. Phys. Soc.*, 24, No. 2, 9 (1949).

³ Gittings, Taschek, Ronzio, Jones and Maslin, *Phys. Rev.*, 75, 205 (1949).

⁴ Kallmann, *Phys. Rev.*, 75, 623 (1949).

⁵ Broser and Kallman *Nature*, 163, 20 (1949).

Slow Neutron Monitoring with Boron- and Lithium-loaded Nuclear Emulsions

THE rapid development of atomic energy in progress all over the world has posed a major problem in radiation hazard control. Knowledge of the safe dose-levels is, in some cases, not as quantitative as could be desired. Doses of both slow and fast neutrons are in this category¹, and it is therefore important to improve this situation by obtaining a history of the doses received by those individuals exposed to neutrons in the course of their work.

For such purposes a simple detection device, similar to the film badge long used for X- and γ -radiation, is desirable. Development of the technique of particle detection by photographic plates² has provided a method of measuring a slow neutron flux by using emulsions loaded with a known mass of a suitable element of known cross-section. Thus J. S. Cheka³, at the Clinton Laboratories, employed the N¹⁴ np C¹⁴