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"Twin" Scintillation Fast Neutron Detector*

I. B. BERLMAN AND L. D. MARINELLI
Radiological Physics Division, Argonne National Laboratory, Lemont, Illinois
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Two organic scintillating solutions, containing the same total number of electrons, but differing by more than a fourfold in the total number of hydrogen atoms, are used to detect neutrons in the presence of a gamma-ray background. By suitable adjustments of their luminescence their pulse-height spectra can be made to coincide in the presence of gamma radiation; hence by subtracting the spectrum of one solution from that of the other it is possible to obtain the pulse-height spectrum due to the excess of proton recoils in the latter. Although refinements in the interpretation of its response must wait for basic information on the luminescent efficiency of both protons and electrons of various energy, this detector is simple to build, stable in time, isotropic in response, and suitable to evaluate radiation hazards in the presence of mixed radiations. Typical responses to gamma radiation, D-D, and D-T neutrons are presented.

I. INTRODUCTION

LIQUID and solid organic scintillators rich in hydrogen are intrinsically highly efficient detectors of fast neutrons. In the presence of gamma rays, however, they fail to discriminate one type of radiation from another unless they are specifically designed for that purpose; namely, to respond selectively to the higher specific energy losses of recoils, to the time of flight, or to the energy release available in neutron capture. Another possibility of separating these radiations which is considerably simpler and more efficient than most proposed hitherto, is the "twin" scintillation method developed in our laboratory.

Essentially, the method involves the use of two organic scintillators of equal electron but dissimilar hydrogen content. By suitable compensation of the different efficiencies in light emission, the electron pulse-height spectra from the two solutions can be made to coincide with good accuracy under the action of gamma rays of widely different energies. In the presence of neutrons, however, the proton pulse-height spectra will differ because of the different number of proton recoils produced in each of the phosphors.

II. GENERAL DESCRIPTION

Because of the ease with which the various parameters can be varied, liquid scintillators, consisting of ordinary xylene and 1,4 bis-(trifluoromethyl) benzene as solvents and of 2,5-diphenyloxazole as solute, were chosen. Although the luminescent efficiency of the fluorocarbon (*F*-xylene) is about one-third that of xylene, when both contain 4g/l of solute, their response to Co^{60} gamma ray can be equalized by first reducing the solute content of the latter until approximately equal responses are obtained, and by correcting later any resulting mismatch with slight adjustments of the photomultiplier voltage. The detector volumes were chosen in the inverse ratio of electron density and they

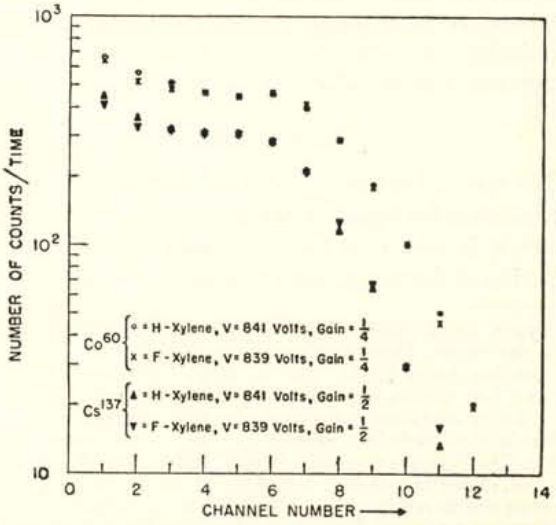

FIG. 1. The response of the two organic scintillating solutions to the gamma-rays from Co^{60} and Cs^{137}.

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