Lawrence Berkeley National Laboratory

Recent Work

Title

THE ""COSMIC RAY"" EFFECT IN PHOTOMULTIPLIER TUBES

Permalink

<https://escholarship.org/uc/item/8j9792g9>

Authors

Baker, E.M.

Tolbert, B.M.

Publication Date

1954-06-01

UNCLASSIFIED

UNIVERSITY OF
CALIFORNIA

*Radiation
Laboratory*

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

BERKELEY, CALIFORNIA

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

THE "COSMIC RAY" EFFECT IN PHOTOMULTIPLIER TUBES

Elton M. Baker and B. M. Tolbert

June, 1954

Berkeley, California

THE "COSMIC RAY" EFFECT IN PHOTOMULTIPLIER TUBES

Elton M. Baker and B. M. Tolbert

University of California Radiation Laboratory*
Berkeley 4, California

* The work described in this paper was sponsored by the U. S. Atomic Energy Commission.

ABSTRACT

The phenomenon of increased background when two photomultiplier tubes are used in coincidence is explained as a cosmic ray effect due to the latter being absorbed in glass with the resultant emission of light.

THE "COSMIC RAY" EFFECT IN PHOTOMULTIPLIER TUBES

Elton M. Baker and B. M. Tolbert

University of California Radiation Laboratory*
Berkeley, California

* The work described in this paper was sponsored by the U. S. Atomic Energy Commission.

When two photomultiplier tubes are used in a coincidence circuit to count solid or liquid scintillator samples, a higher background is noted for the two tubes when they can "see" each other than when they are carefully shielded from each other. We have observed this phenomenon when the photomultiplier tubes are either facing each other, or at right angles (see Table I).

This phenomenon has been noted by other workers¹ and since they observed the effect only when the photomultiplier tubes were facing each other, it was called a "light-dark current" and was ascribed to light emission by a sensitive electrode of one of the photomultiplier tubes when electrons were ejected during the normal functioning of the tube.

This increase in background, as noted above, may be explained as due to cosmic ray absorption in materials that are only weakly fluorescent, such as the glass of the photomultiplier tubes. This concept has been verified using extra shielding, glass block scintillators, various geo-

(1) F. N. Hayes, R. D. Hiebert and R. L. Schuch, Science, 116, 140 (1952).

metrical arrangements and pulse-height discrimination.

Experimental

Two DuMont 6292 photomultiplier tubes² were connected to individual preamplifiers and set in a light-tight box, where they could be set either in line facing each other or at right angles. This entire assembly was placed in a deep-freeze unit which opened from the top and which was maintained at -15° C.

The photomultiplier tubes were operated at 1750 volts between the photocathode and the last dynode. The signal from the preamplifiers was sent to a coincidence circuit having a resolving time of 5μ seconds and which was adjusted to respond to pulse heights greater than that due to tube noise. The resulting signal was counted on a standard scale of 64.

Results

As indicated in Table I, column 2, the background for the uncovered photomultiplier tubes is approximately the same whether the tubes face each other or are at right angles and is appreciably larger than when the tubes are covered with black paper. Since the tubes can still "see" each other at right angles this does not disprove the secondary electron light emission theory.

When a glass block, 2-1/4 in. by 2-1/4 in. by 2-1/2 in. was placed between the tubes, about a 100% increase in background count rate was observed, again of comparable value either with the tubes in line or at right angles. Seventy-two hours of light and temperature aging was used to insure against phosphorescent effects in this experiment. Although the ratio of volume of glass in the photomultiplier tube ends to the total glass

with the glass block inserted is about 12 cc. to 220 cc., the observed increase in background pulse rate ascribed to glass fluorescence was only from 150 cts/min. to 508 cts/min. Since the absorption of light by a block of glass such as this is quite large, this lack of proportionality is not surprising. We also are not certain that the fluorescent efficiency of the two types of glass are the same.

Shielding the photomultiplier tubes and sample box with lead 2 inches thick resulted in a significant reduction in the background count rate, which would be expected if cosmic rays were the primary cause for this background phenomenon. Furthermore an analysis of the pulse heights produced by these photomultiplier tubes with the glass block inserted showed these pulses to be much larger than those derived from the dark current alone, and even to be generally larger than those from C^{14} β -rays in an α -naphthylphenyl-oxazol-diphenyloxazol-toluene scintillation solution.

On the basis of these experiments, it is suggested that the increase in background count rate between self-light shielded and unshielded photomultiplier tubes in coincidence circuit scintillation counting is actually a cosmic ray background, and should be so called. One factor has not been explored, and that is the contribution of cosmic ray shower effects on the background of paired, but light-shielded, photomultiplier tubes. This would also be a cosmic ray background but rather difficult to distinguish from the normal dark-current coincidence count rate.

Table I

Counting Rate (in cts/5 min.) for Two Photomultiplier Tubes
in a Coincidence Circuit

	Faces Covered	Faces Uncovered	Glass Block Inserted Unshielded	Lead Shielded
Photomultiplier tubes at right angles to each other.	1008	1760	3536	2928
	1056	1696	3536	2960
	1024	1776	3616	2992
	<u>960</u>	<u>1744</u>	<u>3424</u>	<u>3056</u>
Average	1012	1744	3528	2984
Photomultiplier tubes facing each other.	976	1792	3536	3040
	992	1728	3536	3072
	944	1776	3584	2992
	<u>1040</u>	<u>1760</u>	<u>3568</u>	<u>2960</u>
Average	988	1761	3542	3000