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On the Efficiency of the γ-Ray Counter

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Abstract

The efficiency, i.e. the probability of the electric discharge per one quantum, of the γ-ray counter ~~[illegible]~~ with thick wall was computed by making various simplifying assumptions for several energies between 0.2 and 5 MEV in the case of Al and between 1 and 10 MEV in the case of Pb. The efficiency of the thin walled counter was also discussed.

§1. Introduction

In order to infer the absolute intensity of the γ-ray from the measurement by means of a counter, it is always necessary to have a reliable knowledge of the efficiency of the counter. Whereas it can not easily be determined experimentally, the theoretical evaluation of it is possible at least in principle, since, under favourable conditions, it is approximately ~~the same as~~ equal to the probability that, when a γ-ray quantum falls on the counter, a secondary electron or a pair of a positi~~ve~~ron and a negat~~ive~~ron ~~electron~~ is produced in the wall and is emitted into

Especially, for the thin counter, it is ~~possible~~ indispensable that ~~we can not~~ the ~~effect of~~ secondary electrons, ~~which are~~ was produced ~~to~~ in the substances ~~[illegible]~~ out of ~~the counter~~ ~~other than~~ the wall of the counter, ~~was~~ not ~~considered~~ (described) in detail by Chao and Kung, ~~have~~ ~~a~~ ~~will~~ contribute more or less ~~will be important~~ may not ~~considerable contribution~~ to give rise to ~~be~~ responsible for the ~~counter~~ discharges.

is

(2)

the inner space.

We can not expect, however, to obtain a result, which is valid

at once for wide range, because the above probability will depend

on the material, the shape and the thickness of the wall as well as

the energy of the γ-ray quantum in a complicated manner. Further,

the effect of multiple scattering of the secondary electron in the

wall prevents us from rigorous calculation. Hence, approximate

numerical computations were performed for several energy in the cases

of Al- and Pb-counters on various simplifying assumptions.[1] (§3, §4)

§2. The Walled Counters

if we assume the counter to have the cylindrical

the thickness of the wall to be small compared with the range of

most of the secondary electrons, we can easily show that the number

of discharge of the counter per one quantum falling on it is

approximately equal to

$$\frac{\pi d}{2}\left(\tau_c + \tau_p + \beta\tau_M\right),$$

where d is the thickness of the wall and of the γ-ray,

coefficients of absorption due to the Compton effect, the photo-

electric effect and the pair creation respectively.

1) A semi-empirical formula of the efficiency of the brass counter

was obtained by v. Droste, Zeits. f. Phys. **100**, 529, 1936.

(10)

Table 2.　The Efficiency of the Pb-Counter

γ-Ray Energy	1	2.5	5	10 MEV
Eff.	2.9	4.7	9.3	$21.3 \times \delta'$%

The numerical factor appreciably smaller than 1 (was) necessary, as we used the theoretical range of the electron in Pb, which was surely too large on account of neglecting altogether the effect of scattering. According to the experimental results in Kikuchi's laboratory, the ratio of the efficiencies of Al- and Pb-counter for the hard γ-ray of ThC" is about 1:1.4, whereas it is $\delta : 1.8\,\delta'$ according to the above results. Thus, $\delta = 0.62$ seems to be a reasonable value corresponding to $\delta = 0.8$, so that the efficiency was plotted as the function of the energy in Fig. 3 by using this value for δ'. The curve shows that it is approximately proportional to the energy as the energy becomes larger owing to the rapid increase of the cross section of the pair creation. It will increase further for the whole range above considered.

In conclusion the authors desire to express their gratitude to Prof. K. Kikuchi and Mr. H. Aoki for valuable discussions and helpful suggestions.　湯川

Fig. 3.

1) Similar experiment was made by Chao and Kung, Chinese Jour. Phys. 1, 56, 1934, but their results can not be compared immediately with ours, as the counters used by them were too thin. In this case, the efficiency ought to be computed from the formula (1).