THE ACCURACY IMPROVEMENT
OF THE CORRELATION FACTOR $\text{erg/cm}^2\text{R}$
FOR LOW-ENERGY X-RADIATION*)

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In this paper the results of calorimetric measurements of the correlation factor $\text{erg/cm}^2\text{R}$
for filtered and unfiltered X-radiation in the energy region up to 220 keV are given. The value of
the correlation factor for X-radiation filtered by 3 mm Cu measured by a calorimeter is compared
with the values of the correlation factor calculated by an independent method from the energy
spectra of the same radiation. The initial spectra are obtained by means of a numerical graphical
method from transmission curves measured by means of an ionization chamber in copper and tin.

This comparison has shown very good agreement between the calorimetric value of the corre-
lation factor $3.45 \times 10^3 \text{ erg/cm}^2\text{R}$ and those calculated by using White's values of the corre-
lation factor depending on the X-radiation energy, provided the average energy required to produce
an ion pair in air is 34.0 eV. The experimental results thus obtained enable us also to evaluate the
amount of average effective energy of the measured X-radiation which is equivalent to the energy
of monochromatic X-radiation having the same correlation factor, in comparison with the effec-
tive energy, currently determined by ionization measurements of the half-value layers.

1. INTRODUCTION

To characterize X and gamma beams of ionizing radiation, it is usual and advan-
tageous to use a ratio of the energy flow $F \ [\text{erg/cm}^2]$ and the exposure $X \ [\text{R}]$ of
the given radiation. This correlation factor $A$, the unit of which is consequently
$\text{erg/cm}^2\text{R}$, can be determined from a simple relation

$$A = \frac{F}{X} = \frac{E_g}{\tau_a + \sigma_a + \chi_a},$$

where $E_g$ is the energy in ergs absorbed in one gram of standard air and according
to 1 R, $\tau_a$, $\sigma_a$, $\chi_a$ are mass energy-absorption coefficients for air [cm$^2$/g] referred to
the photoeffect, Compton effect and pair production.

The amount of $E_g$ depends on the amount of average energy necessary to produce
an ion pair in air $W_i$ and it is equal to 83.7 erg/gR for $W_i = 32.5 \text{ eV}$ and 87.6 erg/gR
for the value $W_i = 34.0 \text{ eV}$ which was recommended by ICRU in 1961 for X and
gamma radiation of the photon energy region from 20 keV to 3 MeV [1].

W. V. Mayneord used relation (1), with earlier values of the mass absorption coef-
ficients, for calculation of the correlation factor $A$ depending on the photon energy $E$
up to 100 MeV, and published the well-known and now almost classic curve $A(E)$

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The accuracy improvement of the correlation factor \( \text{erg/cm}^2 \text{ R} \) for low-energy X-radiation [2]. As this calculation has been carried out for the monoenergy X-radiation of each energy, it is necessary to carry out the integration over a given energy region in order to apply this curve to the X-ray spectrum.

![Graph](image)

Fig. 1. Dependence of correlation factor \( A \) on photon energy \( E \) up to 2 MeV according to Mayneord (1a, 1b) and to White (2a, 2b).

The correlation factors \( A \), determined by using the latest and now most commonly used G. R. White coefficients [3], have been published for the energy region up to 20 MeV [4]. The difference between earlier and later values of the correlation factors is evident when comparing the graphs in Fig. 1. The primary Mayneord function of the correlation factor for \( W_i = 32.5 \text{ eV} \) against the photon energy up to 2 MeV is plotted in graph 1b, graph 1a represents the same function for \( W_i = 34.0 \text{ eV} \), graph 2b represents the White function for \( W_i = 32.5 \) and finally graph 2a represents the same function for the new value \( W_i = 34.0 \text{ eV} \). It is evident from the comparison that the maximal difference between the values of correlation factor \( A \) can be found in the energy interval about 100 keV where both groups of curves attain the first maximum, being more conspicuous in the White function. The aim of the series of experimental works mentioned below is to verify the correlation factor for the different energy regions of X and gamma radiation. In some papers, where the results