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Studies on attenuation cross sections of several elements at 1.280 and 1.330 KeV.

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ABSTRACT

Measurements of the values of Total attenuation cross sections of several elements have been measured for 1280 and 1330 KeV photons by using formula $\sigma_{tot} = \mu/\rho\ (A/N) \times 10^{24}$, the values are compared with the values calculated from the data of Hubbell for the individual elements. The radioactive sources used in the experiments were Na22 and Co^{60}. Total attenuation cross sections for several elements have been measured for gamma rays from 1280and 1330 keV photons using the well type scintillation spectrometer. by using a narrow collimated beam method which effectively excluded correction due to small angle and multiple scattering of photons. The values of Total attenuation cross sections are computed theoretically by J.H. Hubell and S.M. Seltzer [Table of X-Ray Mass Attenuation coefficients {1995}]. .

Keywords: Attenuation coefficient, Total attenuation cross sections, NaI (Tl) Scintillation detector.

INTRODUCTION

The Total Attenuation of photon through material is of wide interest in industrial, medical and agriculture studies. The Total attenuation cross for photon radiation in several materials are needed in solving various problems in radiation physics and radiation dosimetry. Photon Radio isotopes are being increasingly used in radiation therapy and oncology. Therefore a through knowledge of the photon interaction cross sect ions of the above energy sources for Na^{22} and co^{60} desirable field, because of high energy with its optimal long life. Data on the total attenuation cross of elements $Na^{22}$and Co^{60} are quite useful [1-13]. With this end in view we have calculated the photon cross sections of several elements using Ba^{133} and Na^{22} sources. The values are compared with the values calculated from XCOM programe of Hubbell J.H. for the individual elements and found to be in agreement with it.

MATERIALS AND METHODS

Accurate values of photon attenuation cross sections mass and linear attenuation coefficients in several materials are needed in solving various problems in radiation physics and other related areas. In the present work, the photons were detected by organic scintillates and total absorption proportional counters. In the present work the total cross-section values for 1280 and 1330 keV photons are determined in six elemental solids of atomic numbers ranging from 12 to 82 through photon transmission measurements. The monoenergetic photon radiation required for these measurements was derived from $Na^{22}$and Co^{60} radionuclide .The source was procured as a sealed source from BARC, Trombay, Mumbai. The photon transmission measurements were done under a narrow beam counting geometry employing high resolution NaI(Tl) solid state detector. The NaI (Tl) detector utilized in the present work is of 30.3 cc active volume and was obtained from Nucleonix systems Hyderabad India.. Schematic construction of a Scintillation detector as shown in figure1 is a Schematic construction of photon counting system. With the present experimental system, it was established from the photon spectrum that the energy of transmitted photons did not change appreciably due to scatter or fluorescent radiation from the collimators. A provision was made midway between the collimators to introduce absorbers which were in the form of thin foils. The entire system was arranged vertically over the NaI(Tl) detector, ensuring that the central axis of the collimators coincided with the central axis of the detector. Radioactive source of $Na^{22}$and Co^{60} had thin beryllium windows for the exit of photon radiations. The source was kept in a lead container which was provided with an aperture for the exit of photons. The source container assembly was then kept over the collimator so as to allow a narrow, well collimated photon beam from the collimator incident normally on the absorbers. The source and the detector were well aligned with the collimators. The incident energy of photon radiations from the source was known accurately from the photon spectrum. The chosen absorbers include thin and uniform foils of high purity of Magnesium, Nickel, Zinc, Silver and Gold.
These foils were weighed accurately using a digital balance, and from their measured area the thickness proportional to the areal density in g cm^{-2} was determined. The absorbers had varying thicknesses of a few mg $cm^{-2}$and higher thicknesses were obtained by stacking the foils together. The presently used absorbers are uniform sheets of Mg,Ni,Zn,Ag,Au,Pb. These sheets/foils were weight accurately and from their measured area, the thickness (t) in gm cm^{-2} was determined in each case. The absorbers had varying thicknesses of a few mg cm^{-2}. The higher values of thickness were obtained by stacking required number of foils together. The absorbers used were of nuclear grade of specified purity of the order of 99.95%. No further attempts were made to ascertain the purity of these absorbers.

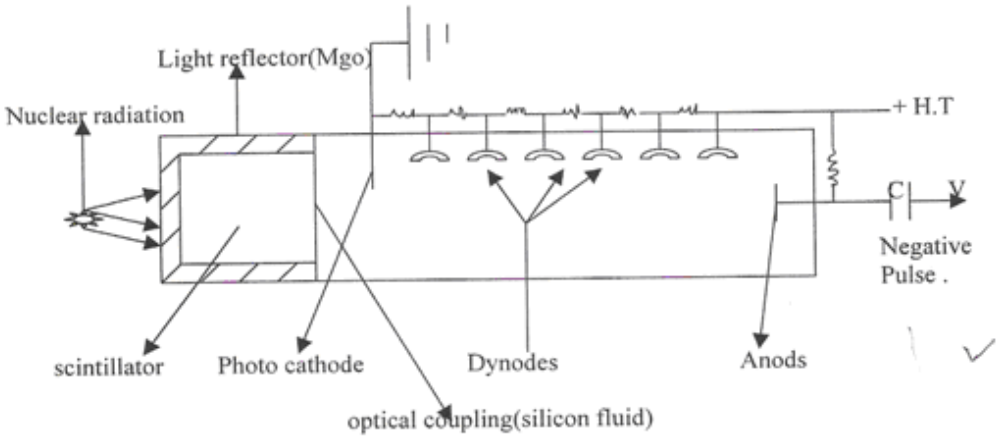

Figure1. Schematic construction of a Scintillation detector

The experimental setup used and the procedure followed were the same as described earlier [14].Transmission ratio I_0/I for various thicknesses (gm/cm2) of several elements at 1280 and 1330 MeV, as shown in Table1. Where I_0 is the number of particles of radiation counted without absorber, and I is the number of particles of radiation counted with absorber.

Table 1. Total Attenuation Cross Sections (barn/atom) of Several Elements at 1280 and 1330 KeV.

S. No	Elements	Atomic Number	Energy (keV)	
			1280	1330
1.	Mg	12	0.97 0.96	0.95 0.94
2.	Ni	28	2.37 2.38	2.26 2.27
3.	Zn	30	2.49 2.50	2.43 2.42
4.	Ag	47	3.97 3.98	3.90 3.91
5.	Au	79	8.00 8.01	7.21 7.22

First Line: Experimental values of total attenuation cross sections
Second Line: Theoretical values of total attenuation cross sections from J.H.Hubbell

RESULTS AND DISCUSSION

From Table 1 it is observed that total attenuation cross sections of several elements at 1280 and 1330 KeV goes on increasing with increasing atomic number. It is also observed that with increasing photon energy the values of total attenuation cross sections goes on decreasing.

APPLICATIONS

The measured total attenuation cross sections of element are useful for dosimetry and radiation shielding purpose.
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CONCLUSIONS

The theoretical values of total attenuation cross sections for elements are available from [15] and the author carried out the work of their experimental measurement with excellent accuracy. The agreement of the author so measured values with theory confirms the theoretical considerations of the contribution of various processes such as photoelectric effect, the Compton scattering and the pair production. From the results of the present study, it is observed that the errors quoted are due to mainly counting statistics, since the sample impurity corrections are negligible. The agreement seems to be good within experimental error. The results are in good agreement [16-17].

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