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GROUP PROJECT

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PHOTON ATTENUATION COEFFICENTOF Al,Cu AND Fe USING 0.662 MeV GAMMA RAYS

Submitted To

RAJARSHI SHAHU MAHAVIDYALAYA (AUTONOMOUS)
LATUR.

A Project Report Submitted in Partial Fulfillment For
The Award of The Degree of
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PHYSICS
UNDER THE FACULTY OF SCIENCE
BY

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|| आरोह तमसो ज्योतिः ||

CERTIFICATE

This is to certify that the project report entitled " PHOTON ATTENUATION COEFFICENTOF Al,Cu AND Fe USING 0.662 MeV GAMMA RAYS" which is being submitted herewith is the result of the project work completed by BHOJANE PRADIP MANOHAR RLS2244203 Under my supervision and guidance.

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DECLARATION

I hereby that the project " PHOTON ATTENUATION COEFFICENTOF Al,Cu AND Fe USING 0.662 MeV GAMMA RAYS " submitted to department of physics, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur during the year 2021-2022 as a part of partial fulfillment of degree of Master of Science In Physics is completed by me and has not previously been formed on the basis for the award of any degree or diploma or similar title of this or any other university, or examining body.

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1.INTRODUCTION

A scientific study of interaction of radiation with matter demands a proper characterization and assessment of penetration and diffusion of ray in the external medium. The attenuation coefficient is important parameters, which widely used in industry, agriculture, science and technology part of research in radiation chemistry and physics.

With wide spread of radiation and radioisotopes medicines, industry and basic sciences, the problem of radiation has becomes important aspect. While handing radiation source and radiation generating equipment. Section of materials for radiation shielding and protection needs accurate assessment of interaction. Parameters these parameters are of immense importance for photons being highly penetrating radiation as compared to particulate radiation.

Accurate values of photon interaction parameters like mass and linear attenuation coefficient in several materials are needed in solving various problem in and radiation physics and other related areas. In the last five decades there has been an increasing interest in accurate measurement of attenuation coefficient of element or compounds for x-rays and low energy gamma rays this is mainly due to fact that careful measurement of attenuation coefficient allow important information about the composition of materials or tissues or at least allow discrimination between materials which have a very similar composition.

Nuclear radiation normally consists of energetic particles or photons. The interaction of radiation with matter is useful in applications of nuclear physics-detectors, material modification, analysis, radiation therapy. The interaction can damage the materials, especially leaving tissues and therefore is considered as dangerous. The effects of interaction depend greatly on the intensity, energy and type of the radiation as well as on the nature of absorbing material.

The interaction with matter of all types of nuclear radiation: charge particles, photons and neutrons. In the case of uncharged radiations (y-rays or neutrons) there is first transfer of all part of the energy to charge particles before there is any measurable effect on the absorbing medium. The interaction of gamma rays with matter is markedly different from that of charge particles such as a or b particles. The difference is obvious; the y-ray have much greater penetrating power and obeys different absorptions laws.

Gamma radiation also known as gamma rays are electromagnetic radiation of high frequency and therefore high energy with very short wavelength and therefore they have no electric charge and cannot be deflected by electric and magnetic fields. Gamma rays are ionizing radiation and are thus biologically hazardous. Gamma rays are produced from the decay from high energy states of (highly unstable) of atomic nuclei. They can also be created in other process. Gamma rays are produced from naturally occurring radioactive isotopes and secondary radiations from atmospheric interactions with cosmic rays, particles. Gamma rays are produced by number of astronomical process in which very high energy of electron are produced that in turns cause secondary gamma rays by the mechanism of Brehmsstrahlung, inverse Compton scattering and Synchrotron radiation. Gamma rays typically have frequencies above 10 exa-hertz (or > 10" Hz) and therefore have energies above 100 KeV and wavelengths less than 10 pico-meters (less than the diameter of an atom). Gamma rays from radioactive decay are defined as gamma rays no matter what their energy. Gamma decay commonly produces energies of a few hundred KeV and almost less than 10 MeV.

A knowledge of y-ray interactions is important to the nondestructive assayist in order to understand y -ray detection and attenuation. A gamma ray must interact with a detector in order to be seen." Although the major isotopes of uranium and plutonium emit y-rays at fixed energies and rates, the y -ray intensity measured outside a sample is always attenuated because of y -ray interactions with the sample. This attenuation must be carefully considered when using y -ray NDA instruments.

As gamma particles pass through matter, they interact with the material and get absorbed. Suppose y particles are incident from the left on a slab, and the slab has a thickness of x. After passing through the slab of material, the y particles emerge on the right.

Let the intensity of the gammas incident from the left be denoted as I,, the initial intensity. Let the intensity of the gammas that emerge of the right, after passing though the slab, be denoted as I(x), the intensity. The unit for intensity, I, and I(x), is (number of gamma particles)/area/time. For units of intensity we could also use energy/area/time. Either type of unit could be used in our applications, but since our detectors measure counts, we will use (number of gammas)/time. As the slab gets thicker, x gets larger, and I(x) becomes smaller. As x increases, more radiation is absorbed in the material and less passes through and emerges on the right side.

How does I(x) depend on x? To a very good approximation the number of gammas that pass through the slab decrease exponentially with thickness:

$$I(X) = Ioe- \ldots\ldots (1)$$

This equation is referred to as Lambert's law, and is applicable for linear attenuation. The geometry for linear attenuation is that the material is a rectangular slab, and the gamma's are incident perpendicular to the slab. The attenuation is in a "line" and is uniform in the plane of the slab. The units of are (1/distance) since yx is unit less. In practice x often has units of cm, so a will have units of cm . The parameter is called the linear attenuation coefficient.

In areas where people are likely to encounter ionizing radiation, it is often necessary to provide shielding to reduce exposure to gamma radiation. Common forms of shielding include rigid materials with limited portability, such as high density concrete, lead bricks, steel plates and cooling pools filled with water. The gamma attenuation of these materials has been widely studied, and the attenuation data is available in resources such as the Nation Institute of Standards and Technology database. In addition to these classic, well characterized shielding materials, composite materials are becoming increasingly available from shielding manufacturers. These composite materials range from simple advances, such as

lead wool blankets with protective plastic covers, to more advanced materials, such as custom molded components constructed from high density metals dispersed in organic polymers. When evaluating the merits of these composite materials relative to the more classic forms of shielding, it is important to understand the basic principles that lead to gamma ray attenuation.

Put simply, shielding, or the attenuation of gamma radiation, occurs through the interaction of the gamma radiation with matter. The degree to which gamma radiation is attenuated is dependent upon the energy of the incident gamma radiation, the atomic number and density of the elements in the shielding material, and the thickness of the shielding. Composite materials may offer additional benefits in chemical resistance, physical durability, and portability. However, the composite material will not exceed the gamma attenuation characteristics of an equal mass of the components used in its construction. This principle is often referred to as "mass in the path". For example, a square foot of solid lead sheet will have essentially the same attenuation as a square foot lead wool blanket, as long as the two shields contain the same mass of lead. However, the lead wool blanket will be physically thicker than the solid lead sheet.

1.1 SURVEY ON ATTENUATION

Radiation protection is necessary, because radiation is all around us, in the air, the water, the food we eat. It causes us to feel unwell, and it can contribute to the eventual onset of disease. That's why we need effective ways of protecting ourselves from this bombardment. And nature has provided a ready-made solution. Gemstone and noble metal combinations in jewelry are far superior technology for protection from radiations. Gems need to be worn in contact with the skin, and the larger the surface area in contact the better.

In today's world, irradiation is routinely used to color a number of gemstones. The process by which irradiation changes color is fairly straightforward. Radiation causes electrons to be knocked off some atoms, leaving them free to be absorbed by others. This has the effect of creating "color centers" which in turn alter the light-absorbing pattern of the gemstone and by extension its color. Generally it is gamma rays from radioactive elements such as cobalt which labs use to irradiate gemstones. Gamma rays leave no residual radioactivity. Radium by contrast, does and is hence dangerous to human health.

Garnet series gem stones are good materials which are at low cost and easily available and protect from radioactive radiations. The study of absorption of gamma rays in the gem stones has become an interesting and exciting field of research. The photon mass attenuation coefficients are the basic quantities required in determining the penetration of x-rays and gamma photons in matter.

The mass attenuation coefficient (up) is a measure of probability of interaction that occurs between incident photons and matter per unit mass per unit area. The knowledge of mass attenuation coefficients of X rays and gamma photons in biological, chemical and other important materials is of significant and practical interest for industrial, biological, agricultural, different and medical applications. Accurate values of photon mass attenuation coefficients are required to provide essential data in diverse fields such as nuclear diagnostics (computerized tomography), nuclear medicine, radiation protection, radiation dosimetry, gamma ray fluorescence studies, radiation physics, shielding, security screening and etc.

The mass attenuation coefficient values of partial photon interaction processes such as photoelectric effect, Compton scattering, pair production and total are available in the form of software package from Berger and Hubbell by substituting the chemical composition/weight fraction of compound/mixture, the mass attenuation coefficient of the shielding materials will be generated in the energy range 1 Kev - 100 GeV. Hubble are published tables of mass attenuation coefficients and the mass energy absorption coefficients for 40 elements and 45 mixtures and compounds for 1 keV to 20 MeV in 1982.Hubbell and Seltzer replaced these tables in form of tabulation for all elements having 1 $<Z<92$ and for 48 additional substances for dosimetric interest. The reports on attenuation coefficients measured by researchers reported for different energies for various samples in solid, liquid, stones and alloys.

Physical interactions leading to attenuation

Shielding of gamma radiation primarily involves the interaction of gamma radiation with matter via three main processes photoelectric effect, Compton scattering, and pair production. In the photoelectric effect, a gamma ray interacts with an atom resulting in the ejection of an electron from the atom. The electron receives all of the energy of the gamma ray, minus its atomic binding energy, and may induce secondary ionization events. The probability of the photoelectric effect is proportional to the atomic number (2) of the absorbing element and inversely related to the energy of the gamma ray. Therefore, the photoelectric effect is most important for low energy gamma rays interacting with heavy elements such as lead and tungsten.

Storage of tea using gamma rays sometimes effect on the structure of antioxidant. In addition, radiation treatments of food can kill and sterile insects as well as they can prevent reproduction of food-born parasites. However, the effect of the irradiation of gamma rays on the antioxidant of plants has not been deeply investigated yet Ganapathi, etal., 2008. Moreover, changes may be happened on the structure of carotene. Therefore, the aim of this work is to investigate the change on the structure of carotene at different dose of gamma radiation. The effect of irradiation on the structure of carotene was determined by using infrared spectroscopy.

Put simply, shielding, or the attenuation of gamma radiation, occurs through the interaction of the gamma radiation with matter. The degree to which gamma radiation is attenuated is dependent upon the energy of the incident gamma radiation, the atomic number and density of the elements in the shielding material, and the thickness of the shielding. Composite materials may offer additional benefits in chemical resistance, physical durability, and portability. However, the composite material will not exceed the gamma attenuation characteristics of an equal mass of the components used in its construction. This principle is often referred to as “mass in the path”. For example, a square foot of solid lead sheet will have essentially the same attenuation as a square foot lead wool blanket, as long as the two shields contain the same mass of lead. However, the lead wool blanket will be physically thicker than the solid lead sheet.

The contributions of Compton scattering, photoelectric absorption and pair production to the total mass absorption coefficient (u) for each type of shielding, calculated using the NIST database. The sum of these interactions is plotted as the total mass absorption coefficient. Represent the calculations, while data points correspond to experimental measurements obtained as described later in the manuscript. Shielding of 200-1500 keV gamma radiation with materials containing high Z components, such as lead and tungsten, is achieved with a significant contribution from both Compton scattering and photoelectric absorption. However, shielding with materials containing low Z components, such as iron and water, is achieved primarily with Compton scattering.

Gamma ray attenuation for shielding materials constructed from solid lead and steel sheets, quilted lead wool, tungsten and iron suspended in a silicone polymer, and water were measured. Lead wool blankets, tungsten suspended in polymer, iron suspended in polymer, and a blend of tungsten and iron suspended in polymer were obtained from Nuclear Power Outfitters. The energy of incident gamma radiation was varied using several gamma emitting sources: Ba-133 (355.99 keV)4, Sr-85 (513.99 keV), Cs-137 (661.66 keV), Co- 60 (1173.23 and 1332.50 keV) and Eu-152 (40.18, 121.77, 344.29, 778.92, 964.11, 1085.89, 1112.08, and 1408.00 keV). Gamma radiation was measured using a high purity germanium (HpGe) detector (Ortec, Dspec Jr, 6 cm, 13% relative efficiency, liquid nitrogen cooled detector), and the apparatus depicted. Using the measured I/ Io and d (g/cm2), the u values for each type of shielding at the discreet gamma energies were calculated. Experimental il values were compared to theoretical values calculated using the database. The experimental u values and theoretical p values calculated using the database. In general, there is very good agreement between the experimental and theoretical u values.

The photoelectric effect, the Compton scattering and the pair production processes are the predominant interactions between the photons and atoms apart from other types over a wide range of energies. With wide spread utilization of radiation and radioisotopes in medicine industry and basic sciences, the problem of radiation protection has become important aspect while handling radiation sources and radiation generating equipment. Selection of materials for radiation shielding and protection needs accurate assessment of interaction parameters. These parameters are of immense importance for photons being highly penetrating radiation as compared to particulate radiations. A survey of other relevant measurements reported shows that in many of these measurements the experimental results for the same elements at the same energies are somewhat inconsistent.

Appreciable discrepancies between the experimental and theoretical values were observed in some of these measurements. In view of this situation a series of accurate and consistent measurements of Y -ray mass attenuation coefficients was undertaken by author. The results of these measurements covering Al element at three photon energies. A possible effect due to multiply scattered photons from thick attenuators on the measurements has been minimized to a great extent by using extremely narrow-beam collimation and selected attenuator thicknesses.

Nuclear radiations (Q, B, y-rays) have been used for a long time and serious accidents leading to confirmed and suspected deaths of persons arising from direct and indirect effects of radiations have occurred. In different applications of radiations it is observed that, over-exposure is harmful and under-exposure is ineffective. Gamma rays and ultraviolet radiations, for instance, produce electrons through the well-known mechanism of photoelectric, Compton and pair production. In Photoelectric effect Absorption of x-rays occurs when the X-ray photon is absorbed, resulting in the ejection of electrons from the outer shell of the atom, and hence the ionization of the atom. Subsequently, the ionized atom returns to the neutral state with the emission of an x-ray characteristic of the atom. This subsequent emission of lower energy photons is generally absorbed and does not contribute to (or hinder) the image making process. Photoelectron absorption is the dominant process for x-ray absorption up to energies of about 500 KeV. Photoelectron absorption is also dominant for atoms of high atomic numbers. In Compton scattering when the incident gamma-ray photon is deflected from its original path by an interaction with an electron. The electron gains energy and is ejected from its orbital position. The x-ray photon loses energy due to the interaction but continues to travel through the material along an altered path. Since the scattered x-ray photon has less energy, it therefore has a longer wavelength than the incident photon. The event is also known as incoherent scattering because the photon energy change resulting from an interaction is not always orderly and consistent

The energy shift depends on the angle of scattering and not on the nature of the scattering medium. Pair production occurs when an electron and positron are created with the annihilation of the X-ray photon. Positrons are very short lived and disappear (positron annihilation) with the formation of two photons of 0.51 MeV energy pair production is of particular importance when high-energy photons pass through materials of a high atomic number. The gamma rays are highly penetrating and can therefore, reach easily the internal organs of the body. Therapy of deep-sited tumors is, therefore amenable to gamma rays. Gamma rays have different penetration depths in different materials.

Lead is the most efficient absorber of gamma rays. Gamma ray shielding is usually described in terms of a parameter known as the half value layer (HVL) of the absorber. HVL is the absorber thickness that reduces the original gamma ray intensity 10 to half, the transmitted intensity. It of the gamma ray beam from a material containing.

To become acquainted with the operation and characteristics of the Geiger-Müller (GM) counter. To determine the best operating voltage and the resolving time of a Geiger counter. The resolving or dead time is used to correct for coincidence losses in the counter. A typical Geiger-Müller counter consists of a cylindrical gas filled tube, a high voltage supply, a counter and timer. A large potential difference is applied between the tube body which acts as a cathode (negative potential) and a wire down the tube axis which acts as an anode (positive potential). The sensitivity of the instrument is such that any particle capable of ionizing a single gas molecule in the GM tube (thus producing an electron-ion pair) will initiate a discharge in the tube. What happens next depends on the voltage across the gas-filled tube. For the lowest applied voltages, only the ions created by direct interaction with the incoming radiation are collected. In this mode, the detector is called an ion chamber. For higher voltages, the ions created are accelerated by the potential difference gaining sufficient energy to create more ion pairs. This results in a localized avalanche of ions reaching the wire.

This is the proportional region. The pulse height (or voltage of the signal) is proportional to the number of initial ion pairs created by the incoming radiation. This in turn is proportional to the energy of the incoming radiation. For even higher voltages, the new ions can create additional photons which move out of the local region and further down the tube; essentially the discharge propagates an avalanche of ionization throughout the entire tube, which results in a voltage pulse--typically a volt in amplitude. Since the discharge is an avalanche and not a pulse proportional to the energy deposited, the output pulse amplitude is independent of the energy of the initiating particle and, therefore, gives no information as to the nature of the particle.

This is the Geiger-Müller region. In spite of the fact that the GM counter is not a proportional device, it is an extremely versatile instrument in that it may be used for counting alpha particles, beta particles, and gamma rays. Such a large output signal obviates the need for more than a single stage of amplification in the associated electronic counter. Geiger-Mueller tubes exhibit dead time effects due to the recombination time of the internal gas ions after the occurrence of an ionizing event. The actual dead time depends on several factors including the active volume and shape of the detector and can range from a few microseconds for miniature tubes, to over 1000 microseconds for large volume devices. When making absolute measurements it is important to compensate for dead time losses at higher counting rates. The mass attenuation coefficient values of partial photon interaction processes such as photoelectric effect, Compton scattering, pair production and total are available in the form of software package from Berger and Hubbell by substituting the chemical composition/weight fraction of compound/mixture, the mass attenuation coefficient of the shielding materials will be generated in the energy range 1 Kev - 100 GeV. Hubble are published tables of mass attenuation coefficients and the mass energy absorption coefficients for 40 elements and 45 mixtures and compounds for 1 keV to 20 MeV in 1982.

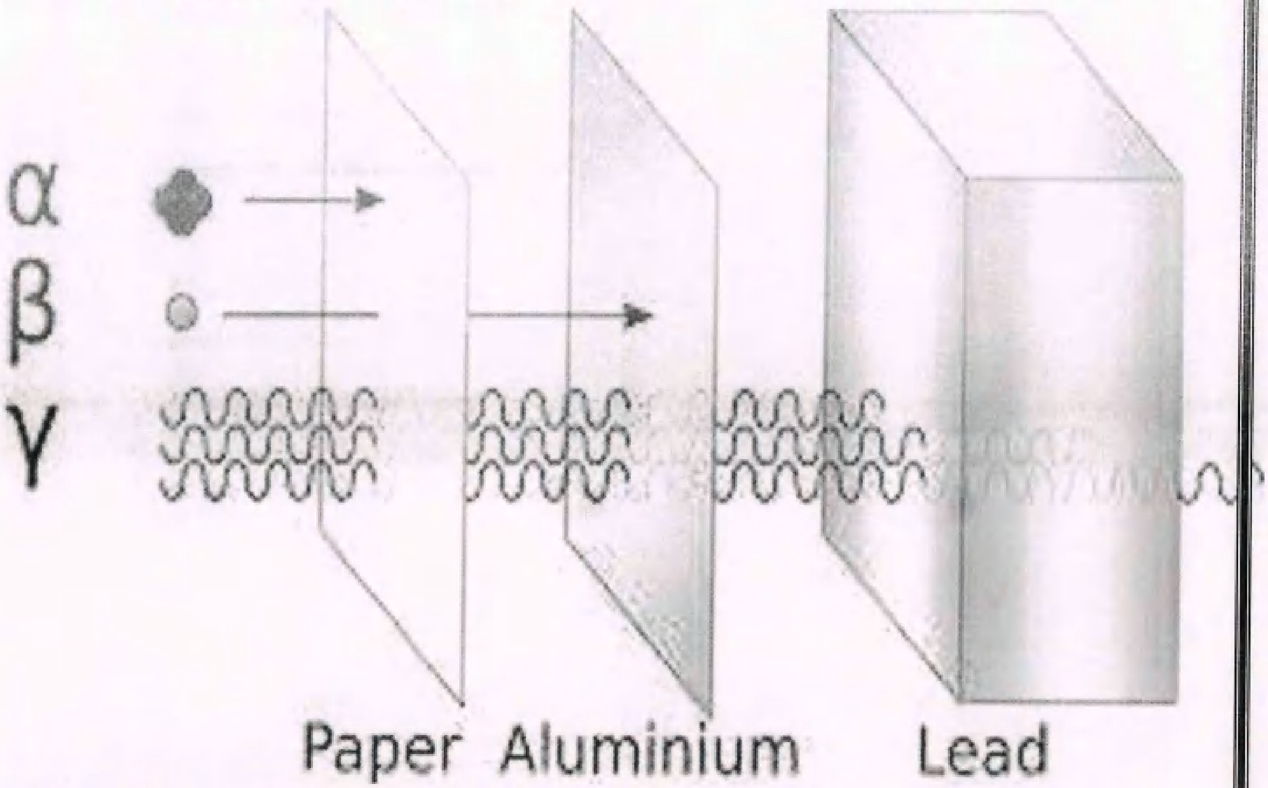
1.2 THEORETICAL BACKGROUND

In nuclear science two source of electromagnetic radiation are of interest, gamma ray and x-ray. The former have their origin in the nucleus and are emitted when energetically excited nuclei decay to a lower energy level. This de-excitation emission of gamma ray is analogous to the emission of x-ray which occurs when a transition takes place between an excited atomic state and one of lower energy. Since nuclei exists in discrete energy levels, a de-excitation process will occur between such a two levels and resulting gamma ray will have definite, discrete energy. X-ray energies are the usually on the order 0-50 kev while gamma ray energies rang for several kev to several Mkv.

The mode of interaction with matter will be the same for x-ray as for gamma rays and it is a strong function of the energy. The average specific will be only 1/10 to 1/100 as grater as electron and consequently, practically all the ionization by gamma ray is secondary in nature energy absorption in medium can be calculated by will established formulae if certain constant like attenuation coefficient, absorption coefficient, effective atomic number etc. known.

With the increasing use of gamma ray emitting isotopes in industry, medicine, agriculture etc. the study of the absorption of gamma radiation in materials has become an important subject. There are four mechanisms for interaction of gamma rays or x-rays with matter as discussed in detail below. We can never know the true value of something through measurement. If we make a large number of measurements under (nearly) identical conditions, then we believe this sample's average to be near the true value. Sometimes the underlying statistics of the randomness in the measurements allows us to express how far our sample average is likely to be from the real value. Such is the situation with radioactive decay, with its probability for decay, 2, that is the same for identical atoms. Radioactive materials disintegrate in a completely random manner. There exists for any radioactive substance a certain probability that any particular nucleus will emit radiation within a given time interval.

1.2.1 Properties of α, β, γ :



a) Properties of Alpha Rays:

The a particle is a helium nucleus (24He) emitted with a discrete energy and a characteristic half-life from each a emitter. Rutherford and Rods showed that the a particle is a helium nucleus by collecting a particles from radon in a glass tube with electrodes. When a discharge in the tube occurred, the light spectrum obtained showed characteristic helium lines. Examination of cloud-chamber photographs have revealed these properties of a particles:

1) Most alphas have the same range in a given gas.

2) The alphas travel along straight tracks.

3) Some are scattered near the end of their path.

4) A few are scattered at distances closer to the source. The first property mentioned above shows that almost all the particles emitted by a given radionuclide have about the same discrete energy. The other properties imply that scattering of the alphas occurs infrequently, most often near the end of the path of the particle. Alpha particles are ejected from naturally occurring radioactive atoms with speeds of the order of one-twentieth that of

the speed of light. Because of their large mass and relatively high speed, they have large kinetic energies. Alpha particles from naturally radioactive nuclei usually have energies in the range from 4 to 9 MeV. The energy of an a particle is lost mainly by ionization and excitation of the atoms of the traversed substance.

b) Properties of Beta Rays:

Beta particles (B-) are electrons from the nucleus and are ejected by some radio nuclides during a form of radioactive decay called beta-decay. The emission of the electron's antiparticle, the positron or beta plus particle (B+), is also called beta decay. Beta-decay normally occurs in nuclei that have too many neutrons to achieve stability. It occurs commonly in the radioactive products of nuclear fission and occurs in natural radioactive decay chains following one or more alpha-decays.

Beta particles have a much smaller mass which is half of one thousandth of the mass of a proton and carry a single negative charge. Beta particles are much less ionizing that alpha particles and generally do less damage for a given amount of energy deposition.

These are singly negatively charged (negatrons) or singly positively charged (positrons) electrons. They typically have energies from a few KeV to a few MeV and a mass of an electron which is 1/1836 the mass of a proton. The rest masses of electrons, neutrons and protons are: 9.191 x 1028g, 1.675 x 1024g and 1.673 x 1024g respectively. From Einstein's equation E=mc these are equivalent to 0.511 MeV, 939.6 MeV and 938.3 MeV respectively. The range of beta particles is. greater than alpha particles, and it requires a few mm of Al, or tissue, to stop beta particles of a few MeV energy. (example P-32 beta decay of 1.7 MeV). Because they are relatively light, beta particles do not travel in straight lines but follow a random path through material. This makes the definition of range much more difficult. Beta particles lose energy in matter by ionization.

c) Properties of Gamma Rays:

A gamma ray is a packet of electromagnetic energy (photon) emitted by the nucleus of some radio-nuclides following radioactive decay. Gamma photons are the most energetic photons in the electromagnetic spectrum. Their emission commonly occurs within a fraction of a second after radioactive decay but sometimes occurs several hours later.

Gamma rays are a form of electromagnetic radiation (EMR). They originate from the nucleus. Electromagnetic radiation can be described in terms of a stream of photons, which are massless particles each traveling in a wave-like pattern and moving at the speed of light. Each photon contains a certain amount of energy, and all electromagnetic radiation consists of these photons. Gamma-ray photons have the highest energy in the EMR spectrum and their waves have the shortest wavelength. Having no charge they are unaffected by magnetic and or electric fields. The high energy of gamma rays enables them to pass through many kinds of materials, including human tissue. Very dense materials, such as lead, are commonly used as shielding to slow or stop gamma photons.

1.2.2 Radioactive Decay:

It is a process that takes place when a radioactive nuclide undergoes alpha beta disintegration and gamma emission. Radioactive decay is a random process. The rate of radioactive decay cannot be influenced by any physical or chemical process. Still over time a radioactivity pattern that varies from one element to another may be observed. This is referred to as the half-life.

The half-life is a phenomenon that is unique for each and very radioactive element and can vary from a few milliseconds to thousands of years according to the radioactive material in question. The number of nuclei decays on a time unit is proportional to the number of all nuclei in the sample. The quantity of the number of decays in the period of time in which they proceeded is called the activity of the radioactive source and is represented by the formula:

$$dN/dt = -AN$$

dN/dt is equivalent to the number of disintegrations per unit time also referred to as the activity A of the radioactive material in question. N is equivalent to the number of radioactive particles present 2 (units seconds s) is the activity constant equal to 0.6931/T1/2.

1.2.2 Attenuation of Gamma-Rays:

The attenuation of gamma radiation (shielding) can be described by the following equation:

$$I=I_0e^{-\mu pt} \quad \text{or } I=I_{0e}^{-\mu d}..........1$$

I= intensity

I_0= incident intensity

u = mass absorption coefficient (cm/9)

d=thickness of absorber (g/cm^2)

p= density of absorber (g/cm^3)

t = physical thickness of absorber (cm)

In practical terms, I is the intensity of gamma radiation after interaction with the shielding material. I is dependent on Io, the initial intensity of the gamma radiation (before shielding), u, the mass absorption coefficient for the shielding material, and d, the "thickness (g/cm)" of the shielding material (alternatively written as a product of the density (g/cm") and the physical thickness (cm) of the shielding material).

The mass absorption coefficient is dependent on the energy of the incident gamma radiation and the elemental composition of the shielding material. Mass absorption coefficients can be determined by measuring I and Io for a shielding material of known thickness (d) and are available for a wide range of elements and composite materials from the National Institute for Standards and Technology database. Once the mass absorption coefficient is known, the physical thickness (cm) of a given type of shielding material required to reduce the gamma radiation intensity to a desired level (ratio of I/Io) can then be calculated by solving the shielding equation for t:

$$t= \log(I/10)/(-\mu p) \text{........ } 2$$

Comparing the thicknesses of different materials needed to achieve the shielding requirements for a particular application, along with other factors, such as the cost, weight, and chemical and physical durability of the materials, will then allow one to choose the most appropriate type of shielding.

The remote sensing of environmental radioactivity is achieved mainly through the detection of gamma radiation. Gamma rays are the most penetrating radiation from natural and manmade sources. Individual radionuclides emit gamma rays of specific energies that are characteristic for an element and isotope. Gamma ray measurements can be conducted in two modes. Total count measurements register gamma rays of all energies. These are used to monitor the gross level of the gamma radiation field and to detect the presence of anomalous sources. Spectrometers, on the other hand, measure both the intensity and energy of radiation, and this enables the source of the radiation to be diagnosed. Gamma ray spectrometry is thus a powerful tool for monitoring the radiation environment.

1.2.3 Units and Radiation Measurement

Physical quantities in atomic and nuclear physics are defined and expressed in units that have been adopted by the International Organisation for Standardization (ISO), and are described in ISO (1992). Further references for quantities and units are recent publications of the International Commission on Radiological Protection (ICRP, 1991, 1993) and the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR, 1993). Apart from the SI units of nuclear physics, other units in common use in the field of radioactivity and the environment can be found in IAEA (1979) and IAEA (1989). This section describes a selection of SI and conventional units in common use in these fields.

The symbols of the basic parameters used in the published ISO standards and literature are as follows:

Z= atomic number (number of protons)

A= mass number (number of nucleons)

N= number of entities (counts)

N= frequency of events (count rate), (1/s)

λ =decay constant

T=1/2 half-life

σ =effective cross section (m^2)

σ = standard deviation ($\sigma(n)$) - standard deviation of a count rate)

E= energy (eV), 1 eV = 1.602×10^{-19} J

µ=linear attenuation coefficient (m^{-1})

µ/p= mass attenuation coefficient (m^2 /kg)

p=density (kg/m^2)

G.M COUNTER

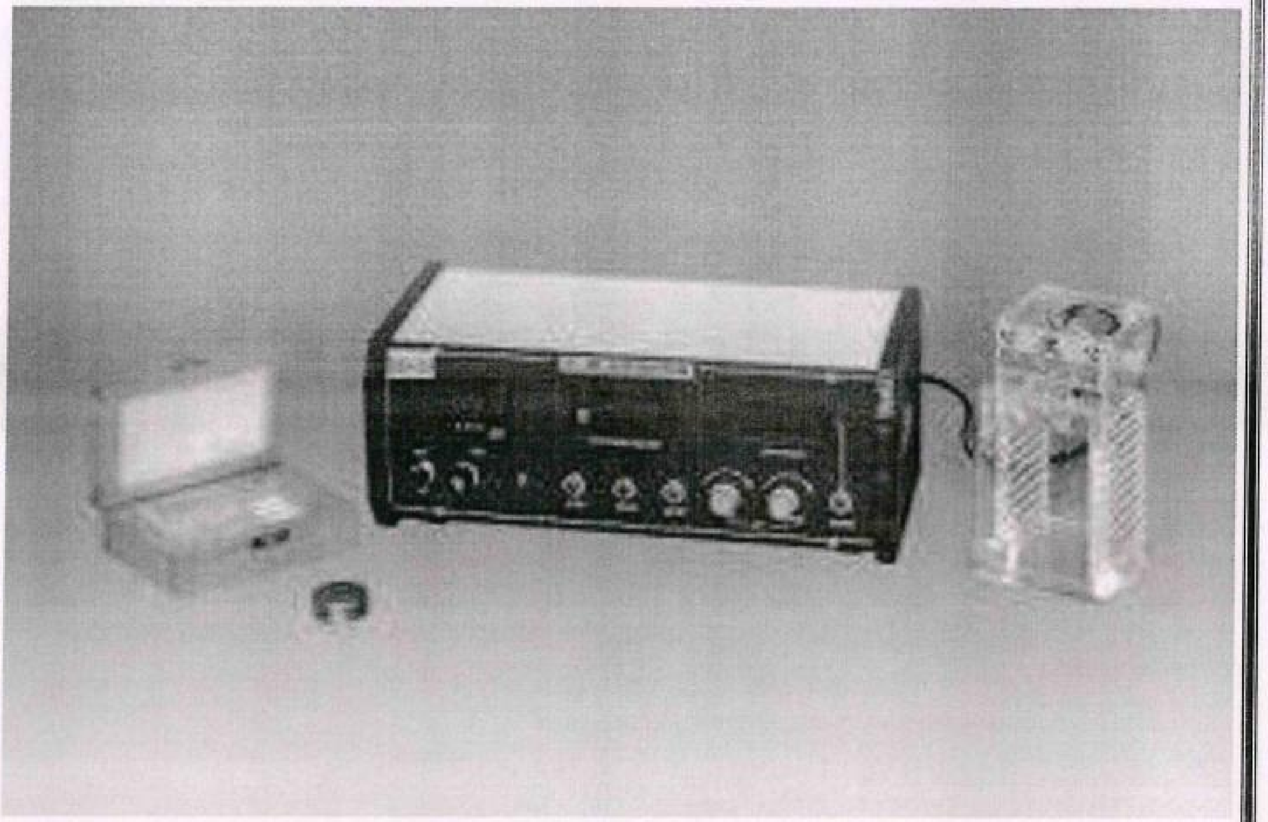
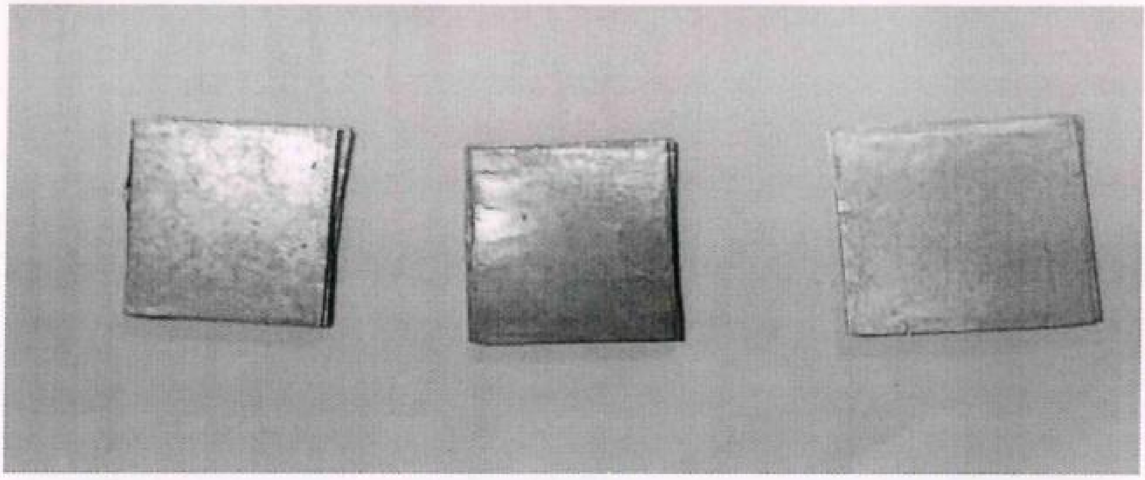


Fig.G.M. COUNTER SYSTEM SET UP

USED MEATLE IN THE PROJECT



IRON **COPPER** **ALUMINIUM**

In 1908, Hans Geiger would develop a machine that was capable of detecting alpha particles. Geiger's student, Walther Mueller, would go on to improve the counter in 1928 a way that would allow the counter to detect any kind of ionizing radiation. And thus, the modern Geiger-Mueller counter was born and the techniques in radiation detection were forever changed. The Geiger-Mueller tube, or GM tube, is an extremely useful and inexpensive way to detect radiation.

While the GM tube can only detect the presence and intensity of radiation, this is often all that is needed. It is the purpose of this lab to become acquainted with this. device and explore it's uses in detecting radiation and also to explore it's limits. Using this device as a tool, it is also the purpose to explore attenuation coefficients through a gamma attenuation experiment.

2. EXPERIMENTAL SET-UP

2.1 Experimental Setup:

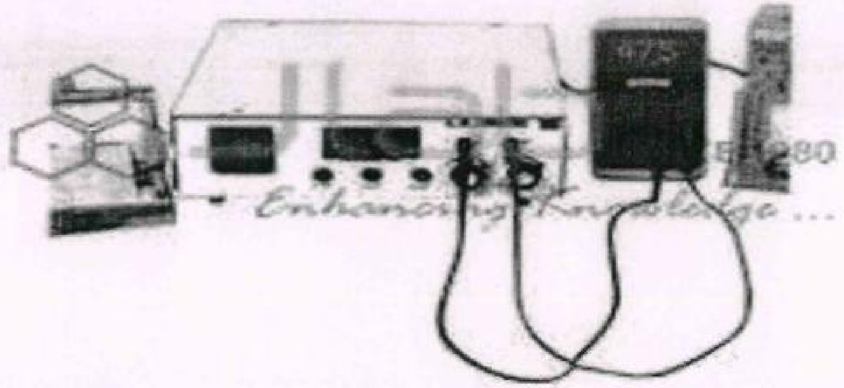


Fig.experimental setup of G.M.Counter

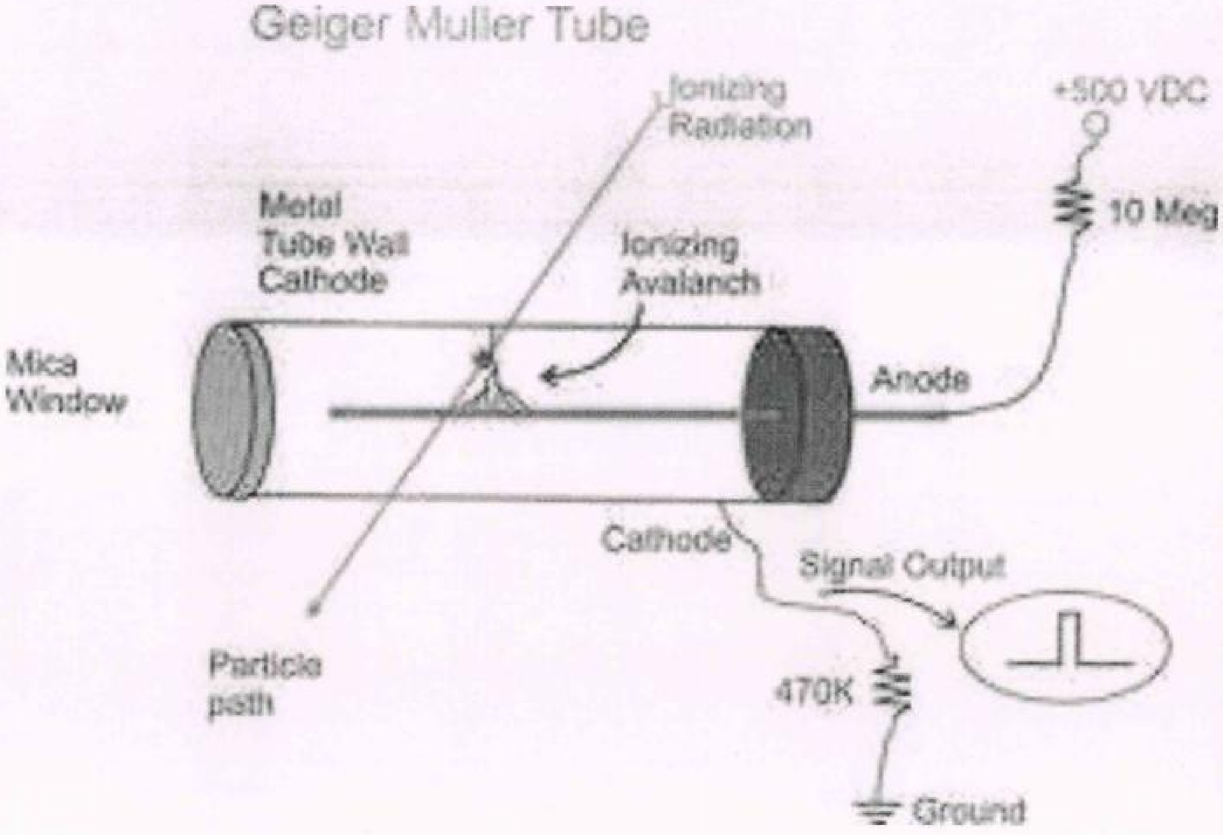
A typical Geiger-Müller counter consists of a cylindrical gas filled tube, a high voltage supply, a counter and timer. A large potential difference is applied between the tube body which acts as a cathode (negative potential) and a wire down the tube axis which acts as an anode (positive potential). The sensitivity of the instrument is such that any particle capable of ionizing a single gas molecule in the GM tube (thus producing an electron-ion pair) will initiate a discharge in the tube. What happens next depends on the voltage across the gas-filled tube. For the lowest applied voltages, only the ions created by direct interaction with the incoming radiation are collected.

In this mode, the detector is called an ion Chamber For higher voltages, the ions created are accelerated by the potential difference gaining sufficient energy to create more ion pairs. This results in a localized avalanche of ions reaching the wire. This is the proportional region. The pulse height (or voltage of the signal) is proportional to the number of initial ion pairs created by the incoming radiation. This in turn is the energy of the incoming radiation. For even higher voltages, the new ions can create additional photons which move out of the local region and further down the tube; essentially the discharge propagates an avalanche of ionization throughout the entire tube, which results in a voltage pulse--typically a volt in amplitude. Since the discharge is an avalanche and not a pulse proportional to the energy deposited, the output pulse amplitude is independent of the energy of the initiating particle and therefore, gives no information as to the nature of the particle.

This is the Geiger-Müller region. In spite of the fact that the GM counter is not a proportional device, it is an extremely versatile instrument in that it may be used for counting alpha particles, beta particles, and gamma rays. Such a large output signal obviates the need for more than a single stage of amplification in the associated electronic counter. Geiger-Mueller tubes exhibit dead time effects due to the recombination time of the internal gas ions after the occurrence of an ionizing event. The actual dead time depends on several factors including the active volume and shape of the detector and can range from a few microseconds for miniature tubes, to over 1000 microseconds for large volume devices. When making absolute measurements it is important to compensate for dead time losses at higher counting rates.

For this experiment, we used the same equipment setup and settings that were used in Section of this lab. We used(CS 137) as our beta source and placed it inside the G-M chamber in the second tray position from the top. The (CS 137) source was chosen because it emit any gamma radiation. We then varied our timer settings so that we were getting several thousand counts per minute from the beta source. We used a 900 second count on the counter to take all measurements. After taking a background measurement and a measurement of just the beta source, data taken with aluminum absorbers of varying thickness placed on top of the beta source.

Accurate values of photon electric cross section from photon radiation in several material are needed in solving various problems in radiations. Meatl sampal is,has been identified as source in figure



Geiger Muller Tube

- Gamına radiation
- Neutrons: no gas ionization

  neutron-sensitive tubes:
- boron or contain boron trifluoride

or helium-3 gas

- neutrons interact with the boron nuclei, producing alpha particles or with the helium-3 nuclei producing hydrogen and tritium ions and electrons Window
- Glass-mantle; beta radiation and X-rays Mica: alpha radiation

2.2 Method and Observation:

There are various instruments G.M detector, Nal(Ti) detector or etc. to study gamma attenuation coefficients. Using the experimental arrangement with gamma ray source of energy 662 kv and G.M. counting system available in our laboratory. We have to obscrve and study an attenuation coefficient of Al,Cu,Fe meatl.

By increasing the Thickness of sheets (in centimeter) of gamma ray though Al,Cu,Fe, meatal gamma radiation of said energy allowed to pass for particular time to determine the lincar attenuation coefficient and mass attenuation coefficient of 6 sheets . Linear and mass attenuation coefficient will be determine by using the Cácoretical bac groud of ionization and penetration of gamma rays through 11lalter.Again, by keeping Thicknessof meatal of gamma radiation through meatal can constant and varying the irradiation time (in 900 sec), we have to observe and study Stlich irradiation time is useful for fast .

Then by inserting the meatl sample in container lcm to 6cm etc. the number of counts I of gamma particle 900 sec was measured repeated for different moth bean sample for energy 662 kev. Firstly, the graphs of N_0/N vs thickness of meatl for meatal sample are plotted.

The experimental values linearly increases with increasing thickness. The linear graphs are fitted by the least square method. The stop of this graphs this values of the linear absorption coefficient. Straight linens obtained for each sample and each counting slope (m) and intercept on Y-axis (c) are noted for each straight line for the calculation of lincar and mass attenuation cocfficicnt. The slope from the graphs gives the values of linear absorption coefficient which indicates the equation,

$$\mu = m\,\rho_s + C\text{.......}1$$

where, m- slope, p-density of moth bean and c-intercept on the 1, /1 axis.

Then measured container size by using vernier caliper. First inside container then the volume of a cylinder by using formula,

$$V= \pi r^2 h \ldots\ldots\ldots\ldots 2$$

Then,

$$\text{mass attenuation} = \mu_{linear}/D_{density}$$

A gamma photon that passes through any inaterial, including the sample in which it is generated, undergoes with a given probability, specific interactions. In these interactions the photon is either absorbed or scattered, losing energy, in any case it cannot contribute to the peak count rate. The linear attenuation coefficientu. depends in turn on material density. The attenuation of a gamma ray flux passing through a path length x in a sample with linear attenuation coefficient can be expressed as:

$$I=I_{0e-ux}$$

3.1 CALCULATIONS

3.1.1 Linear Attenuation Coefficient:

Linear attenuation coefficient (μ_1) = ($m\ \rho_s + c$) cm^{-1}

= 12.1548 cm^{-1}

3.1.2 Mass Attenuation Coefficient:

Mass attenuation coefficient (μ_m) = $\frac{\text{Linear attenuation coefficient } (\mu_1)}{\rho_s}$

= 1.5406 cm^2/gm

3.1.3 Attenuation Coefficient of Gamma Particle:

In areas where people are likely to encounter ionizing radiation, it is often necessary to provide attenuation to reduce exposure to gamma radiation.

OBSERVATIONS,
GRAPHS

Electrical conductivity of Al,Cu and Fe.

1) Electrical Conductivity of Iron sheet

Sr no	Voltage (v)	Current (I)	R=I/V	Resistivity ρ =R*A/l	Conductivity σ =1/ ρ
1	0	0	0	0	0
2	0.05	70	0.71	0.1542*10^6	1.542*10^7
3	0.1	120	0.83	0.1803*10^6	1.803*10^7
4	0.15	270	0.55	0.1195*10^6	1.195*10^7
5	0.2	350	0.57	0.128*10^6	1.28*10^7

Mean value= 0.625*10^7

2) Electrical Conductivity of copper sheet

Sr no	Voltage (v)	Current (I)	R=I/V	Resistivity ρ =R*A/l	Conductivity σ =1/ ρ
1	0	0	0	0	0
2	0.05	110	0.454	$0.72*10^6$	$1.368*10^7$
3	0.1	230	0.434	$0.69*10^6$	$1.449*10^7$
4	0.15	300	0.5	$0.8*10^6$	$1.251*10^7$
5	0.2	430	0.465	$0.74*10^6$	$1.351*10^7$

Mean value=$4.3725*10^7$

3) Electrical Conductivity of Aluminium sheet

Sr no	Voltage (v)	Current (I)	R=I/V	Resistivity ρ =R*A/l	Conductivity σ =1/ ρ
1	0	0	0	0	0
2	0.05	70	0.714	$1.67*10^6$	$0.598*10^7$
3	0.1	120	0.834	$1.95*10^6$	$0.512*10^7$
4	0.15	200	0.75	$1.75*10^6$	$0.571*10^7$
5	0.2	300	0.645	$1.509*10^6$	$0.662*10^7$

Mean value =$2.088*10^7$

Sr no	Standard value at 20^0c	Obtained value at 38^0c
1 Fe	$1.0*10^7$	$0.610*10^7$
2 Al	$3.5*10^7$	$2.088*10^7$
3 Cu	$5.96*10^7$	$4.37*10^7$

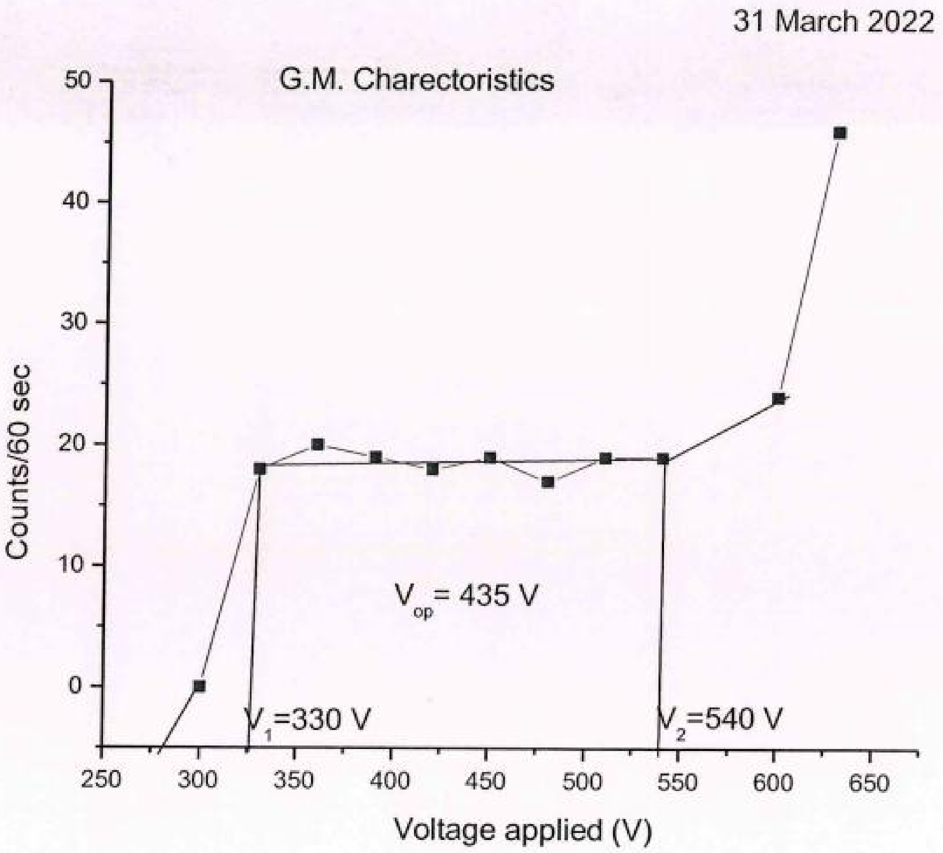
We studied different type of metal to find G.M. counter photon attenuation of Al, Cu, and Fe using 0.662 MeV Gamma Rays"

First we caluculated operating voltage to identifiy the reading for different type of metal.

OBSERVATION TABLE OF OPERATING VOLTAGE G.M. TUBE

SR NO	VOLTS (v)	Correted counts (60 sec) Nc
1	0	0
2	300	0
3	330	18
4	360	20
5	390	19
6	420	18
7	450	19
8	480	17
9	510	19
10	540	19
11	600	24
12	630	46

Graph of operating voltage :

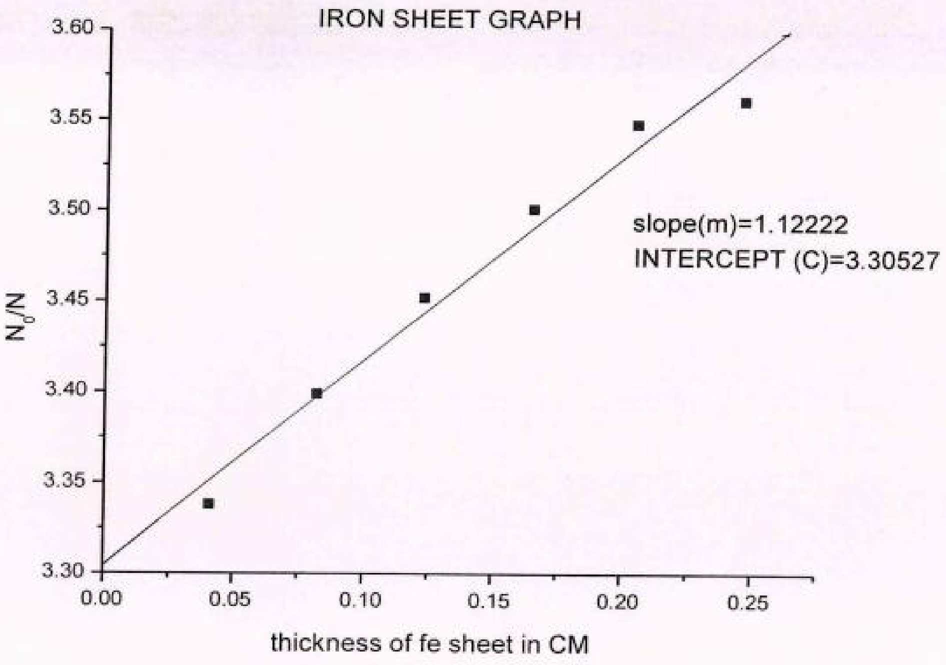


OBSERVATION TABLE OF IRON SHEET

N_0=10046.5 MEAN (ρ)=7.8863

SR NO	THICKNESS OF SHEETIN CM	NO OF COUNTS (900 sec)		MEAN	No/N	N/No	ρ	Intercept (c) on (Y-axis)	Slop (m)	**μ=m ρ+c** cm^{-1}	**μ_m = μ /ρ** **cm^2/gm**
		I	**II**								
1	0.041	3098	2920	3009	3.338	0.299	7.85	3.3052	1.1222	12.1548	1.5406
2	0.082	2941	2969	2955	3.399	0.2941	7.90				
3	0.123	2870	2895	2882	3.185	0.2882	7.89				
4	0.164	2866	2872	2869	3.501	0.2855	7.908				
5	0.205	2828	2834	2831	3.548	0.2817	7.85				
6	0.246	2815	2827	2821	3.561	0.2807	7.92				

GRAPH OF IRON SHEET :

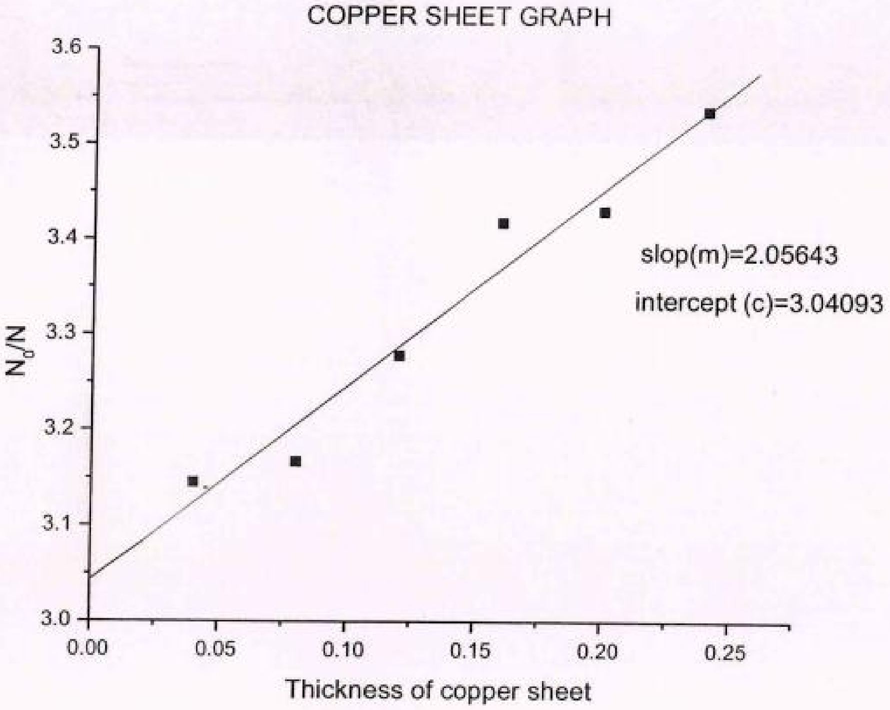


OBSERVATION TABLE OF COPPER SHEET:

N_0:10060.5 MEAM(ρ)=5.7191

SR NO	THICKNESS OF SHEETIN CM	NO OF COUNTS (900 SEC)		MEAN	No/N	N/No	ρ	Intercept (c) on (Y-axis)	Slop (m)	μ=m ρ+c cm^{-1}	μ_m = /ρ cm^2/g n
		I	II								
1	0.040	3224	3176	3200	0.310	3.145	4.76	3.0409	2.0564	13.6912	2.643
2	0.08	3168	3186	3177	0.315	3.167	4.95				
3	0.12	3072	3065	3068.5	0.305	3.278	5.60				
4	0.16	2931	2955	2943	0.292	3.418	5.05				
5	0.2	2918	2948	2933	0.291	3.430	5.05				
6	0.24	2826	2865	2845.5	0.282	3.535	5.66				

GRAPH OF COPPER SHEET :

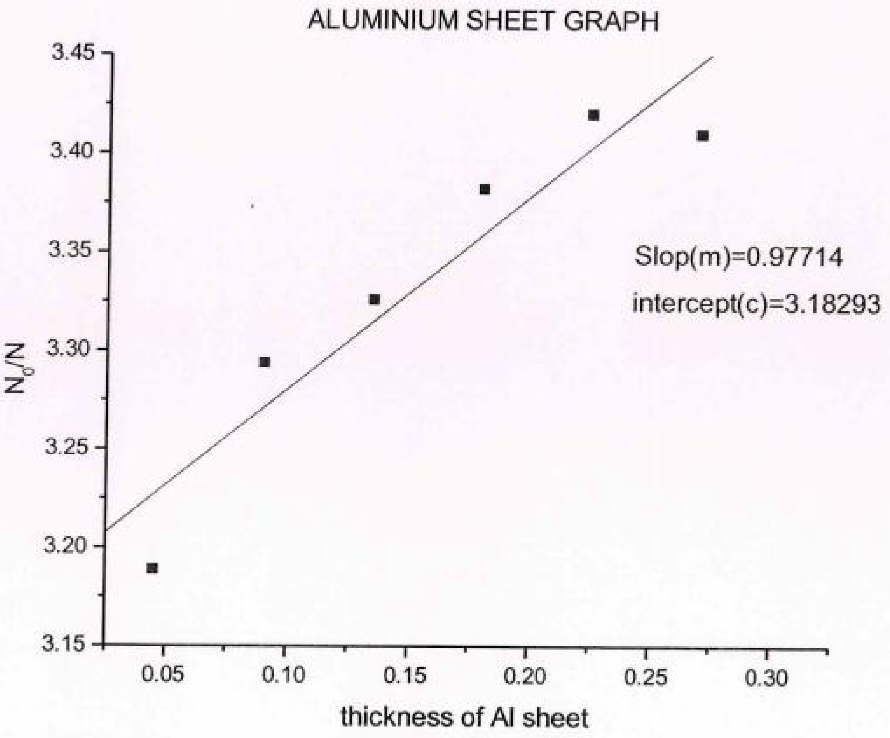


OBSERVATION TABLE OF ALUMINIUM SHEET

N_0:10116.5 MEAN (ρ)=2.64

SR NO	THICKNESS OF SHEETIN CM	NO OF COUNTS (900 SEC)		MEAN	No/N	N/No	ρ	Intercept (c) on (Y-axis)	Slop (m)	μ=m ρ+c cm^{-1}	μ_m = /ρ cm^2/g n
		I	II								
1	0.045	3165	3178	3171.5	3.189	0.313	2.73	3.1829	0.9771	5.7624	2.182
2	0.09	3063	3078	3070.5	3.294	0.3034	2.75				
3	0.135	3024	3058	3041	3.326	0.3005	2.61				
4	0.18	2980	3002	2991	3.382	0.2956	2.64				
5	0.225	2940	2975	2957.5	3.420	0.2923	2.58				
6	0.27	2963	2970	2966.5	3.410	0.2931	2.53				

GRAPH OF ALUMINIUM SHEET:



3.4 RESULTS

In this experiment we calculate the mass attenuation coefficient μ_m and also we calculate the linear attenuation coefficient μ and also find the densitiy of all used metal in this experiment

Metal use in experiment	Electrical conductivity of each metal we calculate	Mass attenuation coefficient (μ_m)
Al	**2.088*10^7**	**2.1827**
Cu	**4.37*10^7**	**2.6435**
Fe	**0.610*10^7**	**1.5406**

We first calculate the operating voltage for G.M.Counter system with source ***Cs 137*** 662 KeV ,We are plotted the graph of operating voltage its 435 v.

For radiation purpose, we give the six sheet each metal like we use Al,Cu, and Fe.their different type of thickness in cm.after completing this set we keep the different type of thickness and give the radiation for metal sample such as 15minute,30minute,45minute,1hour respectively 1 day ,2 day,3 day ,4day For another set take to radiation for metal sheets respectively.

Then we complet the radiation process for different radiation samples. Then we get our reading to procrss next step of the project.Then we plot the graph of each different metal we get the straight line graph .

3.5 REFERENCE

REFERENCE:

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