Inverse Square Law of Radiation Intensity Variation

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March 7, 2022

1 Introduction

Many concepts in the physics curricula can be explained by the inverse square law. Point-like sources of gravitational forces, electric fields, light, sound, and radiation obey the inverse square law. This law is also present in nuclear physics, where the intensity of the radiation is inversely proportional to the distance, $I \propto r^{-2}$:

$$I(r) = \frac{I_0}{4\pi r^2} \tag{1}$$

where $I_0/4\pi$ is the constant of proportionality describing the total emitted photons per second over the surface area of a unit sphere.

2 Experimental Setup & Procedure

We first set up the geiger tube and connected it to the interface to get the counts, then we took the cesium sample and made it as close to the tube as possible. The distance required a correction which is done by deducting half the length of the tube.

2.1 Geiger Plateau Curve

First thing we fixed the distance of the sample and started to vary he voltage supply of the tube, we started at 300V where we recieved no counts, and kept increasing it with steps of 20V until we reached 480V. This was done to determine the operating voltage of the tube for the next part of the experiment.

2.2 Dependence of Radiation Intensity on Distance

From the previous part, we found out that the Geiger tube was operating at 420V. The interface was set to take the counts per ten seconds. The source was varied at distances from $0 - 4$ cm with steps of 0.5 cm away from the tube's end.

3 Data & Analysis

3.1 Geiger Plateau Curve

Voltage (V)	Count per Second					N avg
	N1	N2	N3	N4	N5	
300	0	0	0	0	0	0
320	0	0	0	0	0	0
330	172	190	162	172	179	175.00
340	759	760	747	763	745	754.80
360	886	898	829	860	879	870.40
380	853	886	882	903	917	888.20
400	857	935	867	873	902	886.80
420	882	886	830	865	876	867.80
440	803	812	840	859	822	827.20
460	813	836	814	841	840	828.80
480	814	809	816	789	801	805.80

Table 1. Number of counts measurements while varying the tube voltages, $\Delta t = 1$ s, $r = 0$ cm.

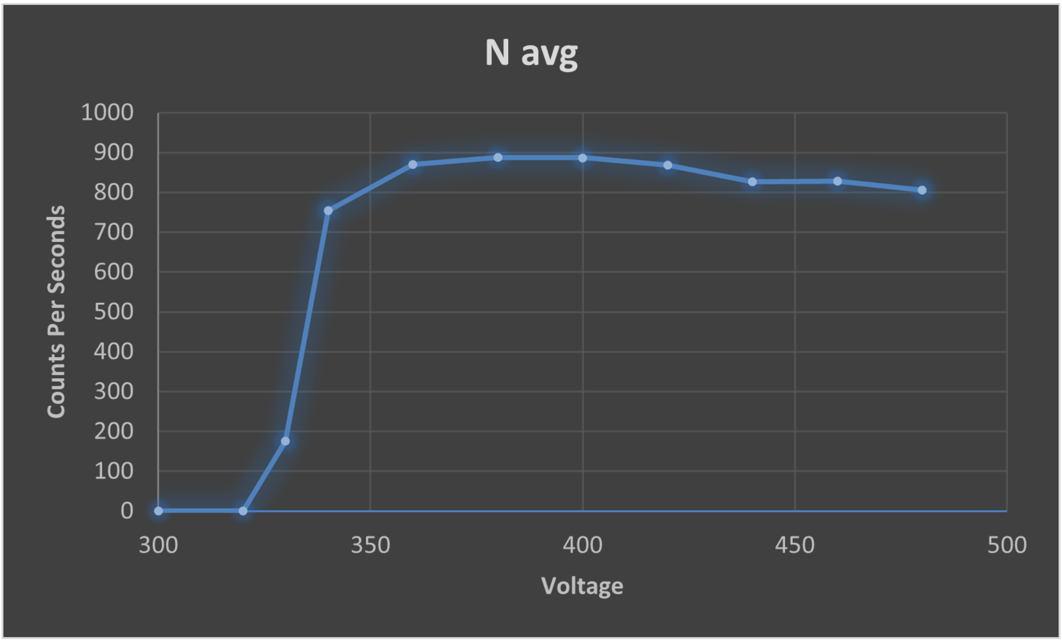

Figure 1. Counts versus tube voltage, $\Delta t = 10$ s, $r = 0$ cm.

The operating voltage for Geiger tube was found to be about 360V.

3.2 Dependence of Radiation Intensity on Distance

Trial #	D	D-D0	ln(D)	N1	N2	N3	N4	N5	N (avg)
1	1.6	0	0.47	8645	8777	8649	8684	8751	8701.2
2	2.1	0.5	0.74	7630	7546	7559	7442	7422	7519.8
3	2.6	1	0.96	4712	4780	4722	4739	4708	4732.2
4	3.1	1.5	1.13	3285	3364	3289	3314	3287	3307.8
5	3.6	2	1.28	2276	2239	2272	2227	2200	2242.8
6	4.1	2.5	1.41	1625	1648	1582	1600	1650	1621
7	4.6	3	1.53	1197	1239	1212	1270	1292	1242
8	5.1	3.5	1.63	990	939	969	963	973	966.8
9	5.6	4	1.72	679	679	687	655	660	672

Table 2. The gathered data after conducting the experiment. with $r_0 = 1.6$ cm

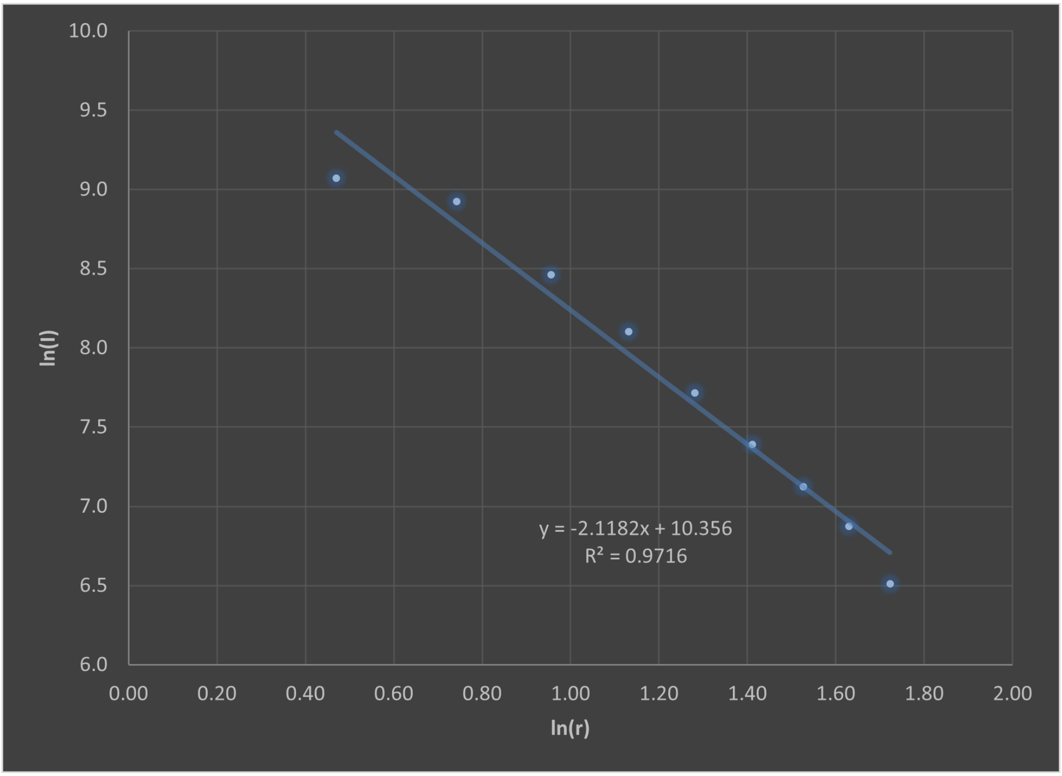

Figure 2. $\log(I)$ vs. $\log(r)$ plot. $\Delta t = 10$ s, $r_0 = 1.6$ cm

The plot shows a slope of -2.12. This value is close to the expected value of 2.00, with around 6% relative error.

4 Conclusion

The strength of gamma radiation emitted by a Cesium source was shown to be dependent on the separation distance using the Geiger-Miller tube. The inverse-square law of radiation intensity was confirmed with a relative inaccuracy of 6%.