PHY 411 : Virtual Lab 2 : Verifying Inverse Square Law

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Roll no: MS18033

Aim: To verify the Inverse Square Law, $I = \frac{S}{4\pi r^2}$

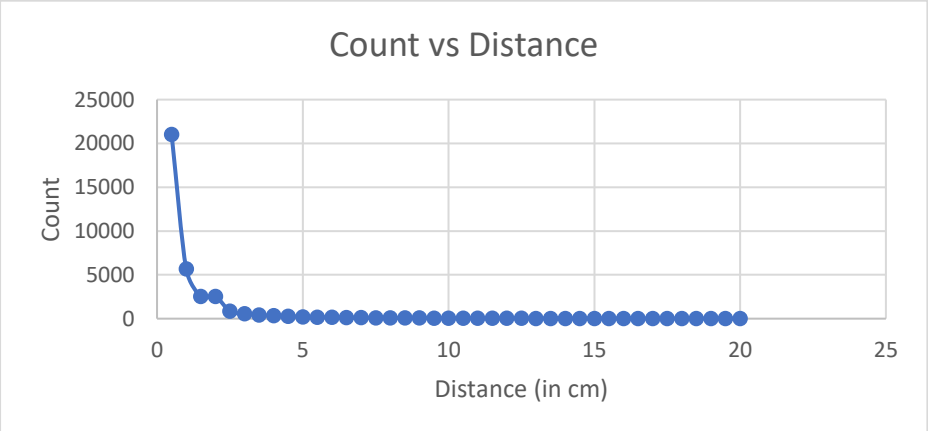
Data Taken

The count was noted by varying the distance between the source and detector from 0.5 cm to 20 cm in steps of 0.5 cm.

Distance (in cm)	Count
0.5	21009
1	5687
1.5	2532
2	2532
2.5	866
3	572
3.5	424
4	326
4.5	278
5	209
5.5	165
6	141
6.5	119
7	107
7.5	89
8	76
8.5	79
9	71
9.5	59
10	53

Distance (in cm)	Count
10.5	46
11	44
11.5	41
12	37
12.5	33
13	30
13.5	30
14	27
14.5	23
15	22
15.5	23
16	21
16.5	19
17	17
17.5	18
18	14
18.5	16
19	13
19.5	14
20	12

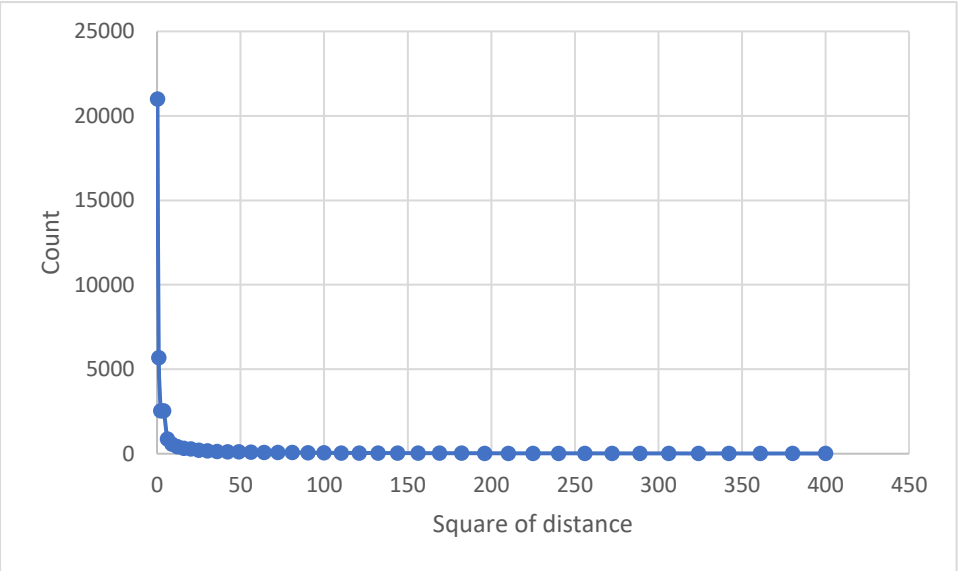
Plot of Count as a function of distance



The count vs square of distance data is as follows:

Square of distance (in cm)	Count
0.25	21009
1	5687
2.25	2532
4	2532
6.25	866
9	572
12.25	424
16	326
20.25	278
25	209
30.25	165
36	141
42.25	119
49	107
56.25	89
64	76
72.25	79
81	71
90.25	59
100	53
110.25	46
121	44
132.25	41
144	37
156.25	33
169	30
182.25	30
196	27
210.25	23
225	22
240.25	23
256	21
272.25	19
289	17
306.25	18
324	14
342.25	16
361	13
380.25	14
400	12

Plot of Count as a function of square of distance



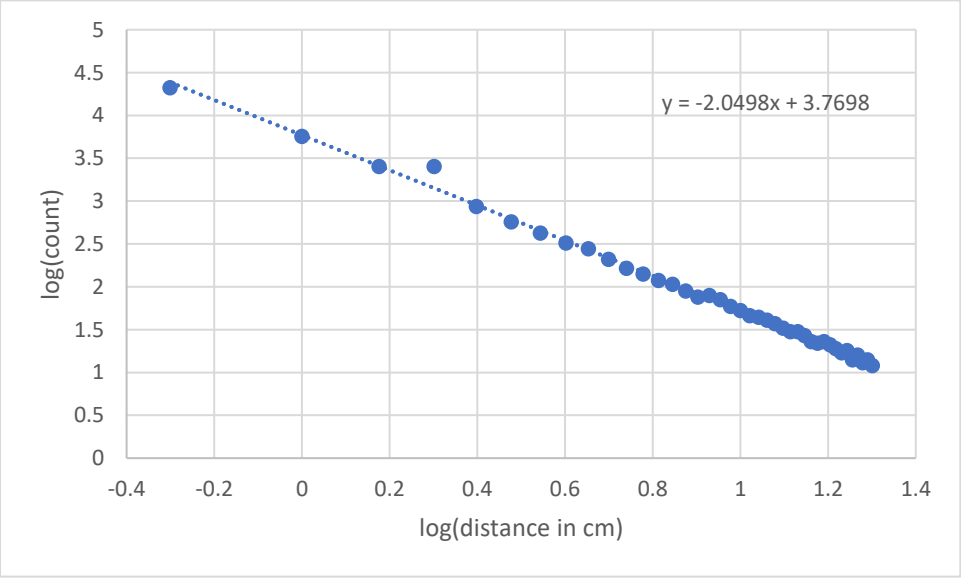
This is the expected plot as count $\propto \frac{1}{r^2}$

In log-log scale, the data is as follows:

log(distance in cm)	log(Count)
-0.30103	4.322405
0	3.754883
0.176091	3.403464
0.30103	3.403464
0.39794	2.937518
0.477121	2.757396
0.544068	2.627366
0.60206	2.513218
0.653213	2.444045
0.69897	2.320146
0.740363	2.217484
0.778151	2.149219
0.812913	2.075547
0.845098	2.029384
0.875061	1.94939
0.90309	1.880814
0.929419	1.897627
0.954243	1.851258
0.977724	1.770852
1	1.724276

1.021189	1.662758
1.041393	1.643453
1.060698	1.612784
1.079181	1.568202
1.09691	1.518514
1.113943	1.477121
1.130334	1.477121
1.146128	1.431364
1.161368	1.361728
1.176091	1.342423
1.190332	1.361728
1.20412	1.322219
1.217484	1.278754
1.230449	1.230449
1.243038	1.255273
1.255273	1.146128
1.267172	1.20412
1.278754	1.113943
1.290035	1.146128
1.30103	1.079181

Plot of Count as a function of distance in log-log plot



The slope of this graph = -2.05, as obtained from the linear fit. A linear plot is expected with a slope -2 as, log(I) = log $(\frac{S}{4\pi})$ - 2log(r).

The slope of this plot was chosen to be calculated, as it gives the power of the distance term in the Intensity-distance equation.

Error Estimation

For Co-60 and Cs-137, 50 observations of the count were made at 500 V with 4 cm distance between the source and the detector.

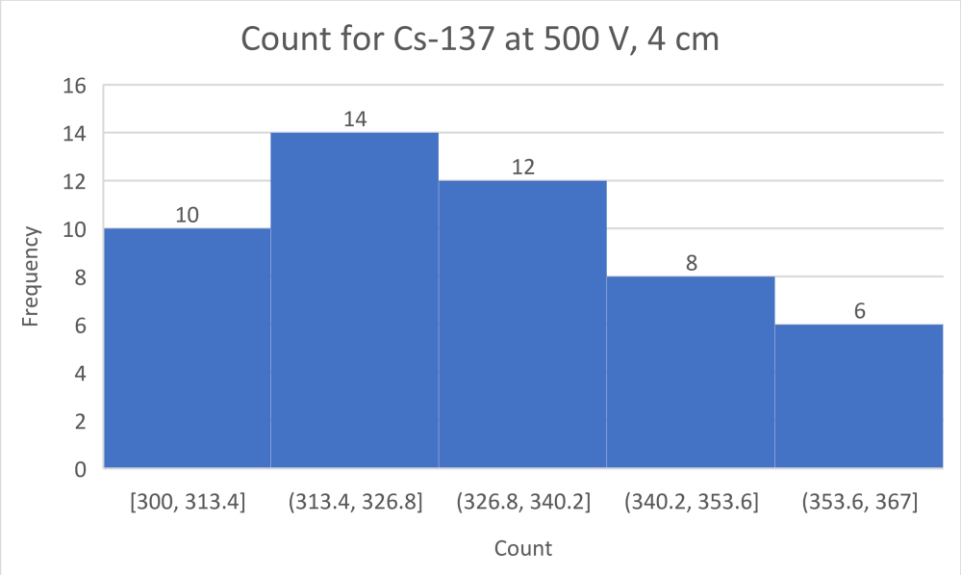
Count for Cs-137

Sl.no	Count	Sl.no	Count
1	334	26	306
2	305	27	332
3	306	28	306
4	321	29	347
5	316	30	327
6	354	31	322
7	345	32	349
8	339	33	326
9	344	34	367
10	353	35	344
11	311	36	357
12	314	37	351
13	329	38	300
14	339	39	328
15	323	40	319
16	360	41	326
17	328	42	302
18	341	43	306
19	335	44	318
20	329	45	355
21	334	46	338
22	302	47	325
23	315	48	319
24	325	49	303
25	354	50	319

Count for Co-60:

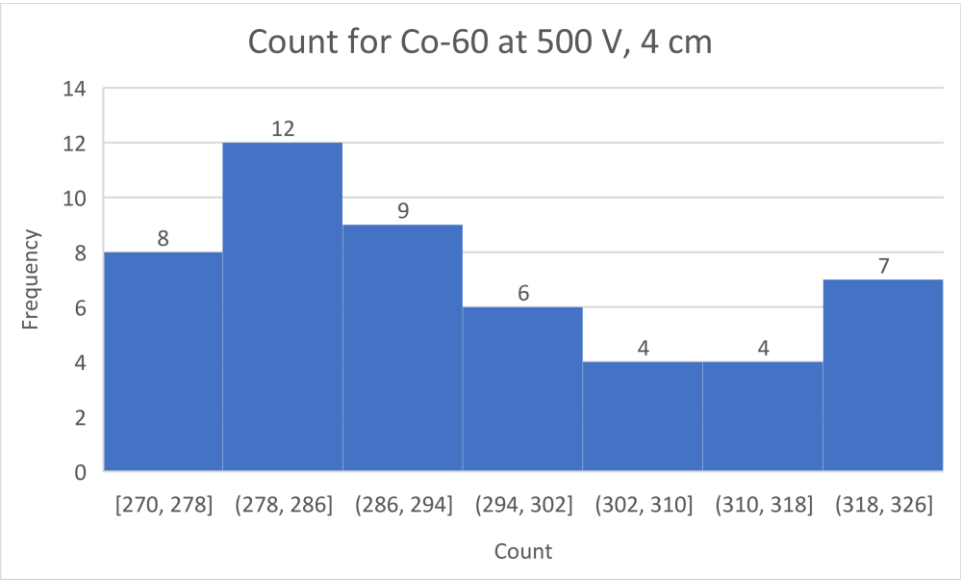
Sl.no	Count	Sl.no	Count	Sl.no	Count	Sl.no	Count	Sl.no	Count
1	298	11	271	21	307	31	282	41	292
2	286	12	317	22	271	32	292	42	320
3	281	13	326	23	270	33	298	43	281
4	292	14	320	24	282	34	307	44	319
5	283	15	283	25	293	35	290	45	295
6	292	16	288	26	318	36	319	46	274
7	274	17	298	27	282	37	319	47	273
8	280	18	293	28	305	38	316	48	290
9	270	19	321	29	315	39	297	49	309
10	279	20	279	30	298	40	273	50	281

The histograms for frequency distribution of Count were plotted.



For this data (Cs-137),

- Mean = 328.96 V
- Standard Deviation = 17.51
- Error (in percent) = $\frac{Standard\ Deviation * 100}{Mean}$ = $\frac{17.51*(100)}{328.96}$ = 5.32 %



For this data, (Co-60),

- Mean = 293.98 V
- Standard Deviation = 16.51
- Error (in percent) = $\frac{Standard\ Deviation*100}{Mean}$ = $\frac{16.51}{293.98} * 100$ = 5.62 %

Results

The following plots were made:

- Count as a function of distance
- Count as a function of square of distance
- Count as a function of distance in log-log plot

A linear graph was obtained for the log-log plot of distance vs count, and the slope obtained was -2.05. This verifies the inverse square law within the limits of experimental error.

The error estimated by noting the count at 500 V and at 4 cm distance from the source, was

- 5.32 % for Cs-137
- 5.62 % for Co-60