Chapter V

DISCUSSION AND CONCLUSION

In the determination of the absolute activity of standard Co-60 of 1.113 μCi (on 1st January 1966) by gamma-gamma coincidence method comparing with the calculated activity from labeled activity, the result calculated from the coincidence counts is 0.35 ± 0.03 μCi while the result calculated from the labeled activity is 0.30 μCi. The result calculated from the coincidence method is higher than that calculated from labeled activity about 17%. Taking the deviation in the calculation, the difference from the labeled activity are 27% and 6.7%.

The activity of Co-60 of 10.90 Ci (on 1st January 1968) measured by gamma-gamma coincidence method is 3.29 ± 0.07 Ci and the calculated result from the labeled activity is 3.37 μCi. The result from coincidence method is lower than the labeled activity about 2.4%. The difference from labeled activity are 0.3% and 4.5%, taking into account the deviation of the figure calculated from coincidence counting technique.

The results of the above two sources showed that for the 10.90 μCi Co-60 source, the coincidence technique gives the same value of activity as that calculated from labeled activity. The result of coincidence counting technique gives much higher value of activity than that calculated from labeled activity for 1.113 μCi Co-60 source. Since the coincidence technique gives a very satisfactory result for

10.90 μCi source, the difference between the result of coincidence technique and the labeled activity should be due to the error of the calibration of the 1.113 μCi source.

The Co-60 source of 11.46 μCi produced by The Radiochemical Centre Amersham was measured by coincidence counting with the same geometry (180°, 4 cm.) as the above two sources. The coincidence technique gives result of 6.86 ± 0.21 μCi while that calculated from labeled activity is 8.51 μCi. The coincidence technique result was lower than that from the labeled activity for 20%. This deviation is in contrast with the 1.113 μCi source. Since this source is much stronger than the above two sources (11.46 μCi on 1st October 1974), several geometries of detectors arrangements had been tested in order to study the effects of the count rates and the angles between the two detectors. The results of the study are summarized in Table 15.

The measurements by different geometries showed that the activity measured by 180° geometry is higher than the 90° geometry and no significant difference of the measured activities due to source to detectors distance of 4, 5, 6 and 7 centimetres. The activity measured by 180° geometry are higher than that of the 90° geometry because of the angular correlation of the gamma rays of Co-60 that the probability of finding the coincidence events of the 1.17 and 1.3 MeV gamma rays in 180° geometry is greater than that of 90° geometry by a factor of 1.1 approximately. The activities shown in Table 15 were corrected for angular correlation and the

results were tabulated in Table 16.

The activity calculated from the labeled activity is higher than the activities calculated from the coincidence technique about 20%. Since there are no significant differences in the activities due to source to detectors distance and the figures are rather precise, the differences of the activities from the labeled activity may be due to some errors in the calibration of the 11.46 μCi Co-60 source. Although the coincidence counting technique gives results different from that calculated from labeled activity, the differences were not greater than 20%.

The absolute activities of Mn-56 sources produced by irradiation of manganese dioxide with 5Ci Pu-238/Be neutron source were 0.067±0.012 μCi and 0.082±0.008 μCi for the detector geometry arrangements of 180°, 3 cm. and 90°, 3 cm. respectively. The thermal neutron flux at the position of irradiation calculated from these two values of activities were 8.06×10^{4} and 9.9×10^{4} n/cm.^{2} sec^{1}. These values of neutron flux were not the corrected values. There were interferences from other samples loading surround the neutron source. The activity of Mn-56 may be also produced by epithermal neutrons since the position of irradiation is very close to the neutron source. Taking into account the activity due to activation by epithermal neutrons, the neutron flux at the position of irradiation should be lower than the reported values.

Since there is difference between the neutron flux measured by the 180° and 90° geometry, the correction for the effect of angular correlation was done for 180° geometry normalized to $W(90^{\circ}) = 1$ as, $W(\theta) = (1+a_2 \cos^2\theta + a_4 \cos^2\theta)^6$. According to the decay scheme of Mn-56 and the Table of the Angular Correlation Coefficient for Some Dipole and Quadrupole Gamma-Gamma Cascade Transitions,[7] the neutron flux which was calculated from the measurement of the absolute activity of Mn-56 with 180° geometry was 1.15×10^5 n/cm.^{2} sec. This corrected value is higher than the value which was calculated from 90° geometry about 15%. The errors due to chance coincidence in the coincidence counting of gamma rays fo Co-60 may be naglected since the cascade of gamma rays which were selected sor coincidence counting is 99% of the disintegrations. Although the cascade of 1.81 and 0.84 MeV gamma rays of Mn-56 is only 30% of the disintegrations the effect of the chance coincidence may also be neglected since the activity of Mn-56 was very low.

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[6]Robley D. Evans, The Atomic Nucleus, (New York: McGraw-Hill Book Co., 1955). p. 238.

[7]Ibid., pp. 240.

Table 15

Activities of 11.46 μCi Co-60 source measured by coincidence technique with different geometries

Source to Detectors Distance (cm.)	Absolute Activity (μCi)		Activity Calculated From Labeled Activity (μCi)
	180°	90°	
4	6.86 ± 0.21	7.48 ± 0.15	8.51
5	6.66 ± 0.14	7.44 ± 0.25	
6	6.66 ± 0.35	7.49 ± 0.26	
7	6.64 ± 0.22	7.54 ± 0.20	

Table 16

Activities of 11.46 μCi Co-60 source, Corrected for the effect of angular correlation

Source to Detectors Distance (cm.)	Absolute Activity (μCi)		Activity Calculated From Labeled Activity (μCi)
	180°	90°	
4	7.55 ± 0.23	7.09 ± 0.14	8.51
5	7.33 ± 0.15	7.05 ± 0.24	
6.	7.33 ± 0.15	7.10 ± 0.25	
7	7.30 ± 0.2	7.15 ± 0.19	

In conclusion, this setup coincidence counting system is a simple instrument which is useful in measuring the absolute activity of radionuclides emitting gamma rays in cascade. This instrument may also utilize in analytical works such as analyzing some trace elements in neutron irradiated samples. Angular correlation of gamma rays emitting from radionuclides is the other field of study which is possible to perform the experiment by this instrument.