CHAPTER IV

RESULTS

The energy spectrums of the alpha particles emitted by the decay of ^{237}Np, ^{241}Am and the standard source are shown in Figures 4.1 to 4.5. The standard curves used to determine the amounts of neptunium and americium which were electrodeposited on the aluminum foils are shown in Figures 4.6 and 4.7 respectively. The amounts of ^{237}Np and ^{241}Am which were deposited are given in Table 4.1 along with their measured activities. The straight lines present in Figures 4.6 and 4.7 represent a linear least-squares fit of the data.

The background radiations amounted to about 7 cpm in the energy range corresponding to the spectrum range of the ^{241}Am sources. The numbers of counts recorded and the specific activities for each of the ^{237}Np and ^{241}Am samples used are given in Tables 4.2 to 4.5. The activities of the various ^{241}Am sources listed in these tables were determined by comparing the masses of ^{241}Am deposited on each source and 300 μg of pure ^{241}Am in 0.1 mci of standard solution. The specific activities of the ^{237}Np sources were obtained by using equation (2.6.1)

Using the values listed in Table 4.6 in equation (2.4.8), the half-life of ^{237}Np was calculated to be $(2.41 \pm 0.06) \times 10^6$ years. This value was based on the average value of 1387.01 ± 34.37 disintegrations per minute per microgram observed in this investigation.

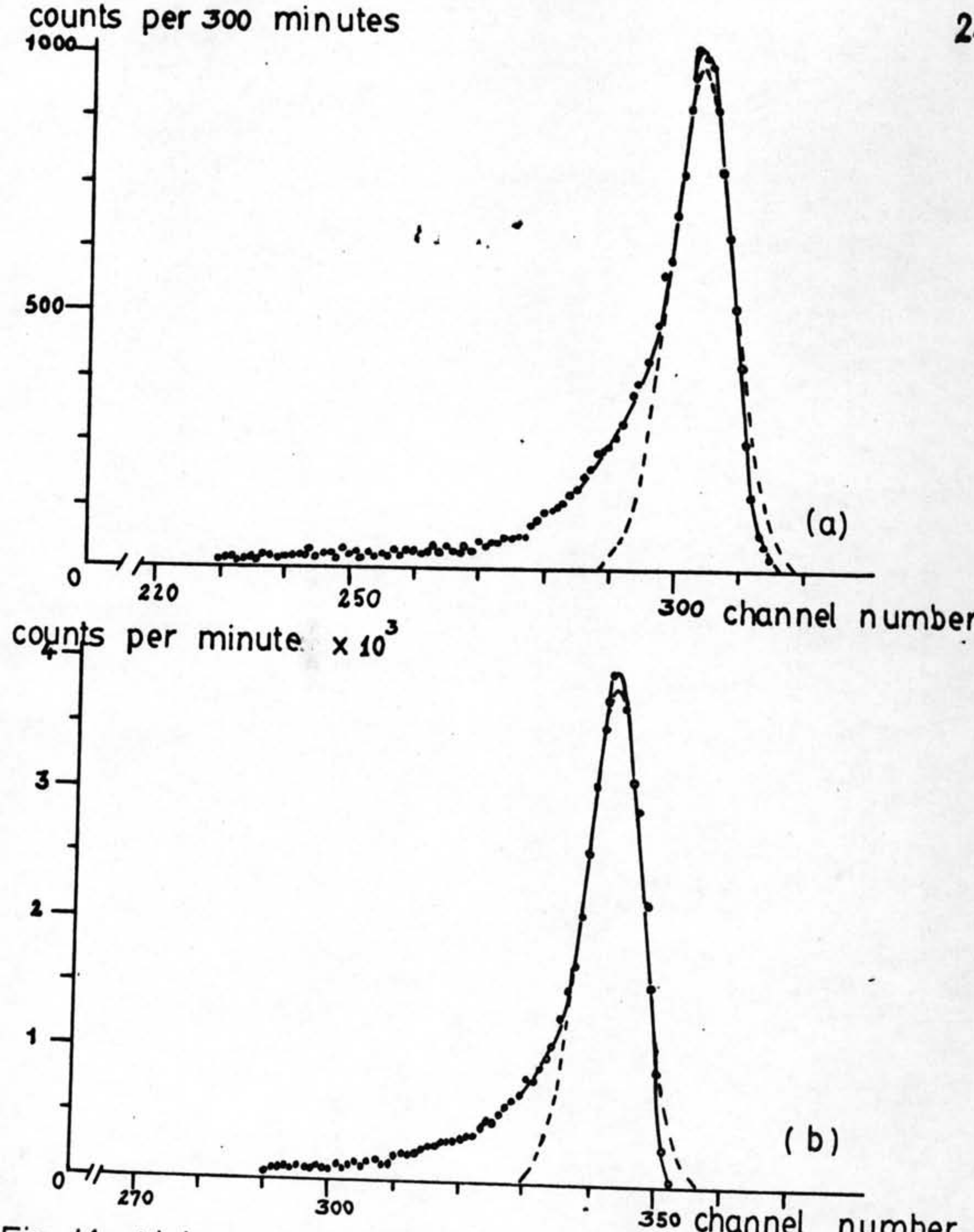

Fig. 4.1 Alpha spectrum of sample No.1 consisted of (a) ^{237}Np sample and (b) ^{241}Am sample. (---) Gaussian shape fit by the use of non-linear least-squares technique.

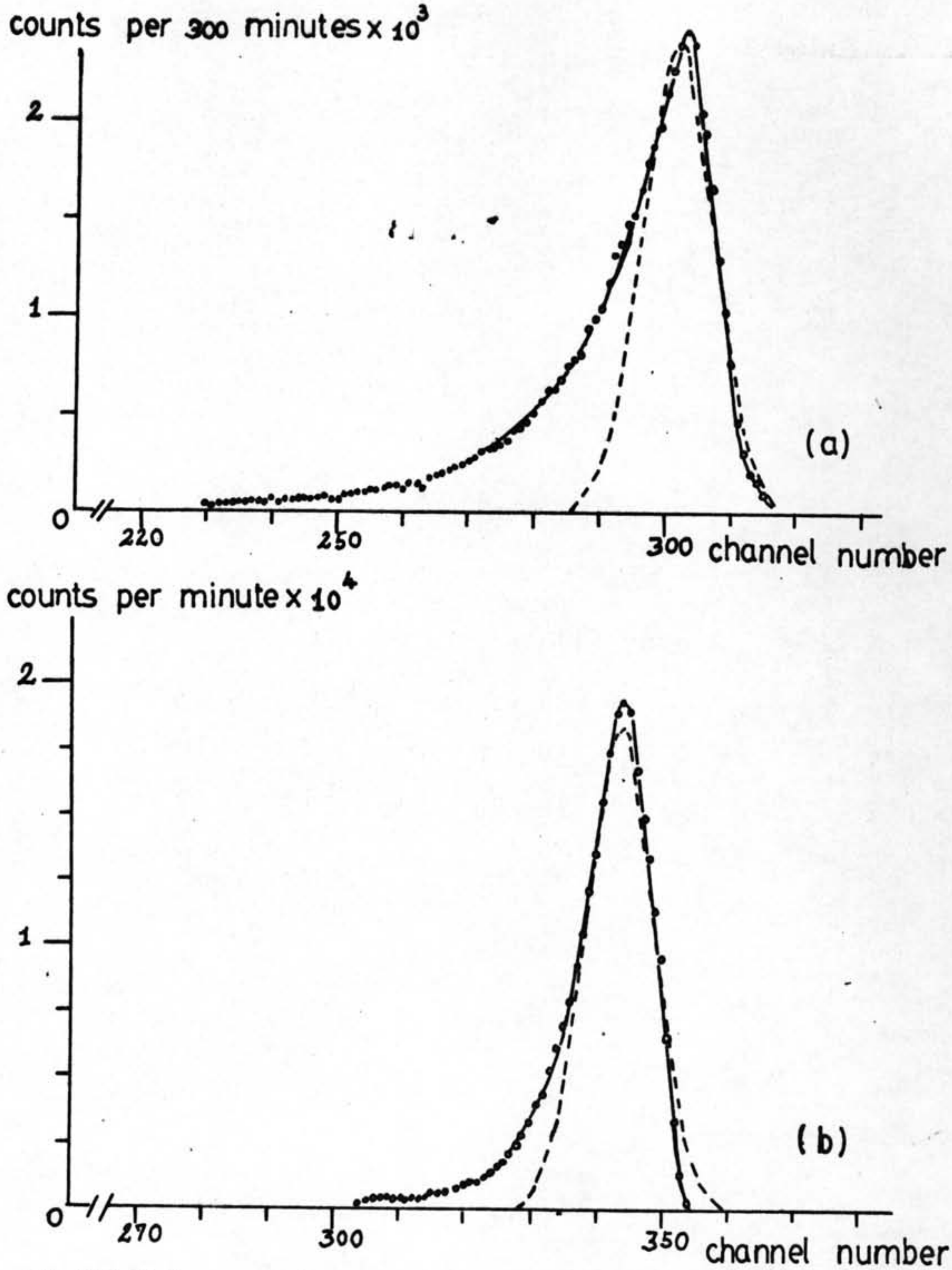

Fig.4.2 Alpha spectrum of sample No.2 consisted of (a) ^{237}Np sample and (b) ^{241}Am sample. (---) Gaussian shape fit by the use of non-linear least-squares technique.

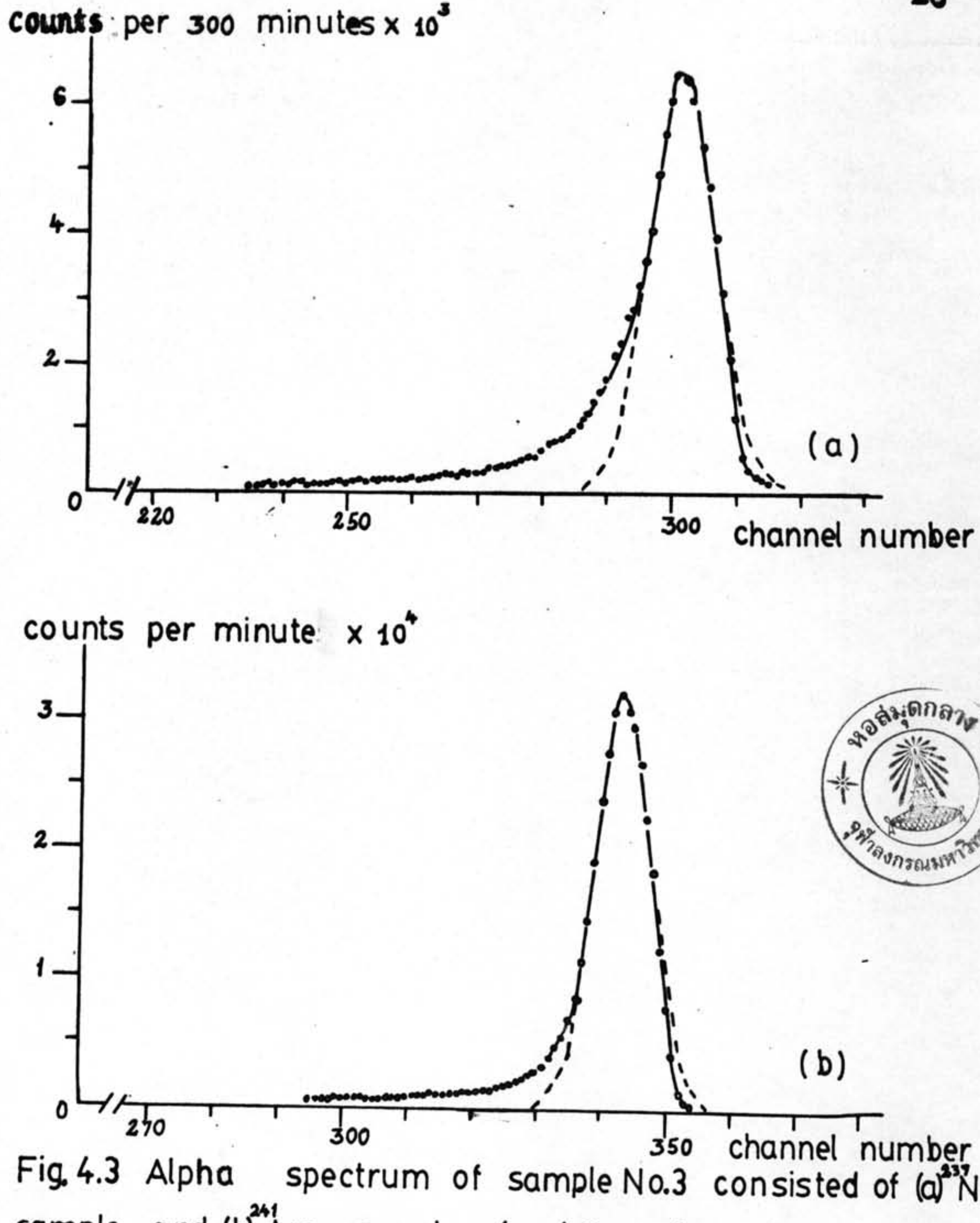

Fig. 4.3 Alpha spectrum of sample No.3 consisted of (a) ^{237}Np sample and (b) ^{241}Am sample. (- - -) Gaussian shape fit by the use of non-linear least-squares technique.

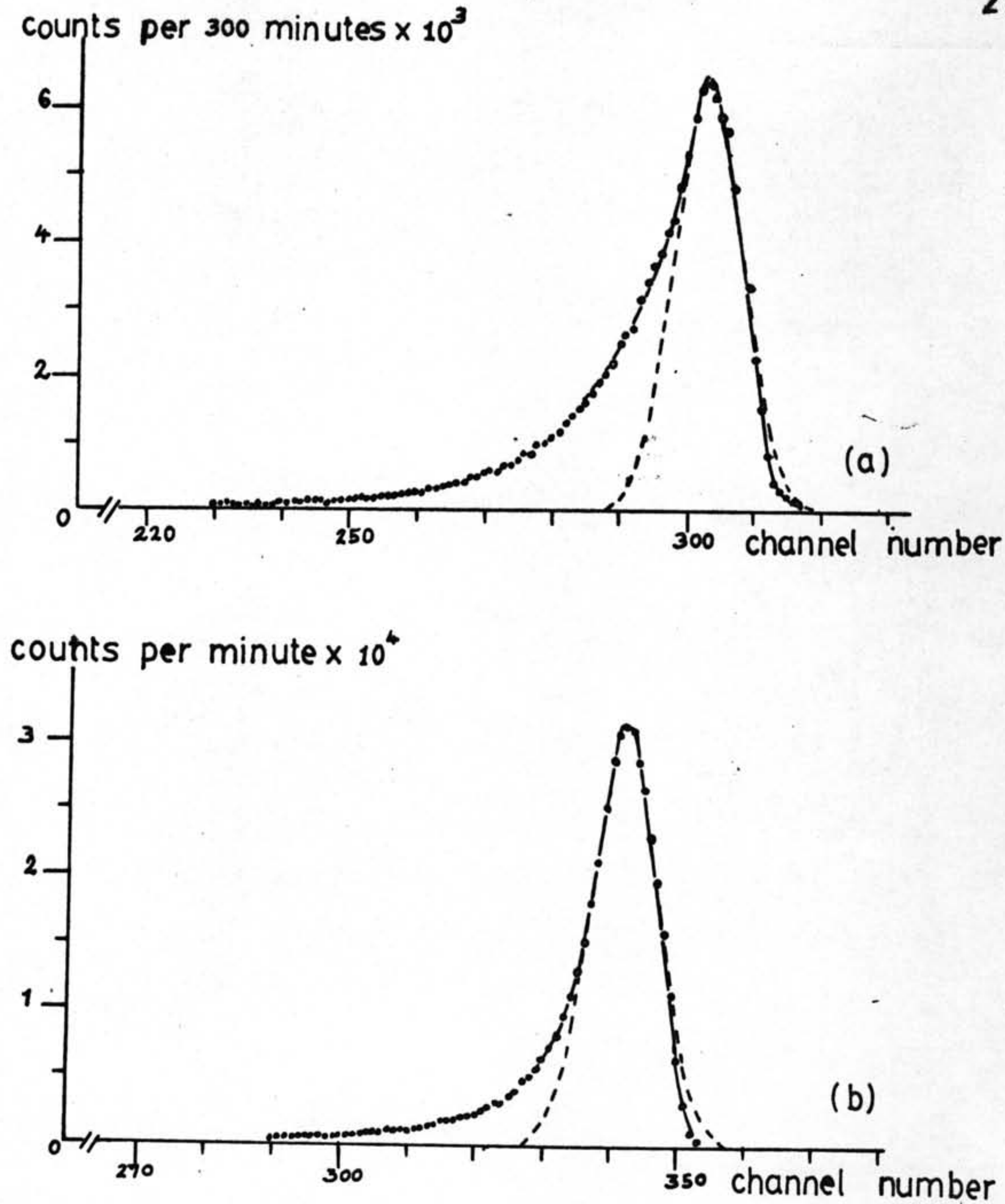

Fig. 4.4 Alpha spectrum of sample No.4 consisted of (a) ^{237}Np sample and (b) ^{241}Am sample. (---) Gaussian shape fit by the use of non-linear least-squares technique

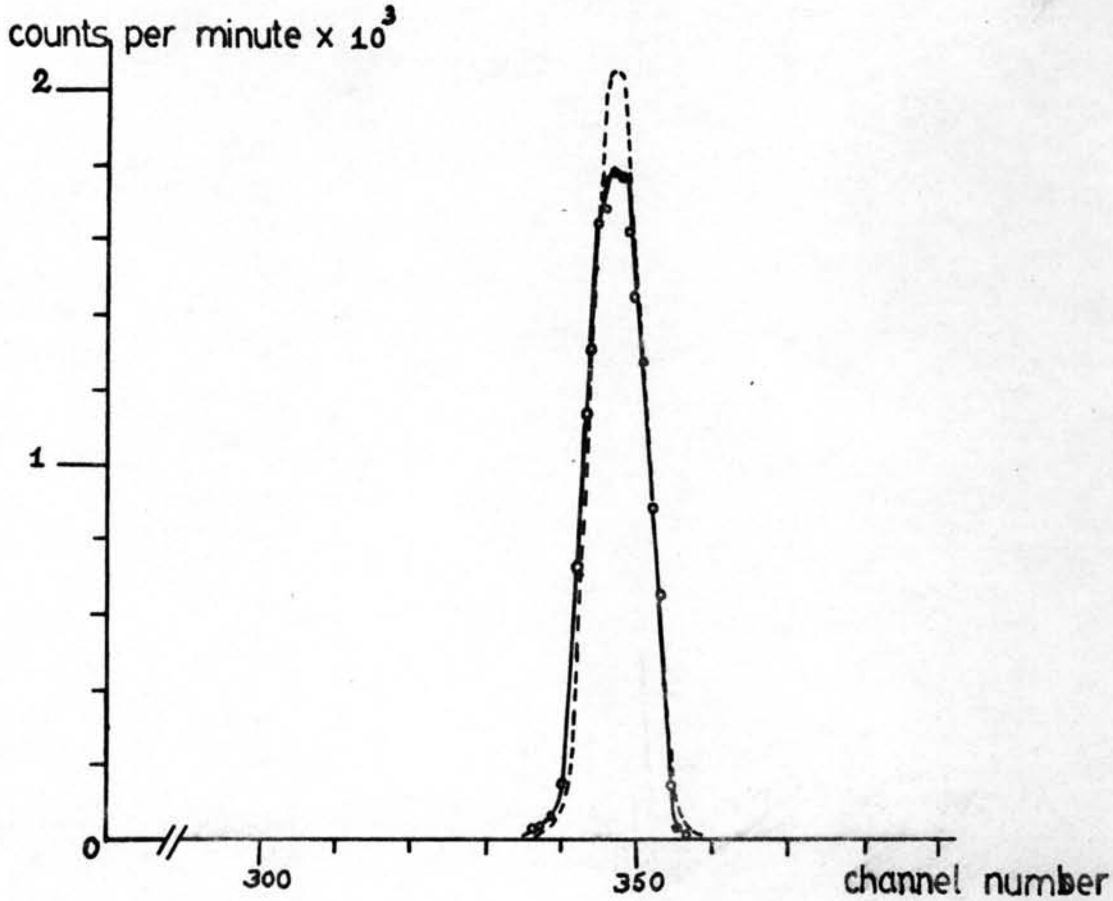

Fig. 4.5 Alpha spectrum of ^{241}Am standard source

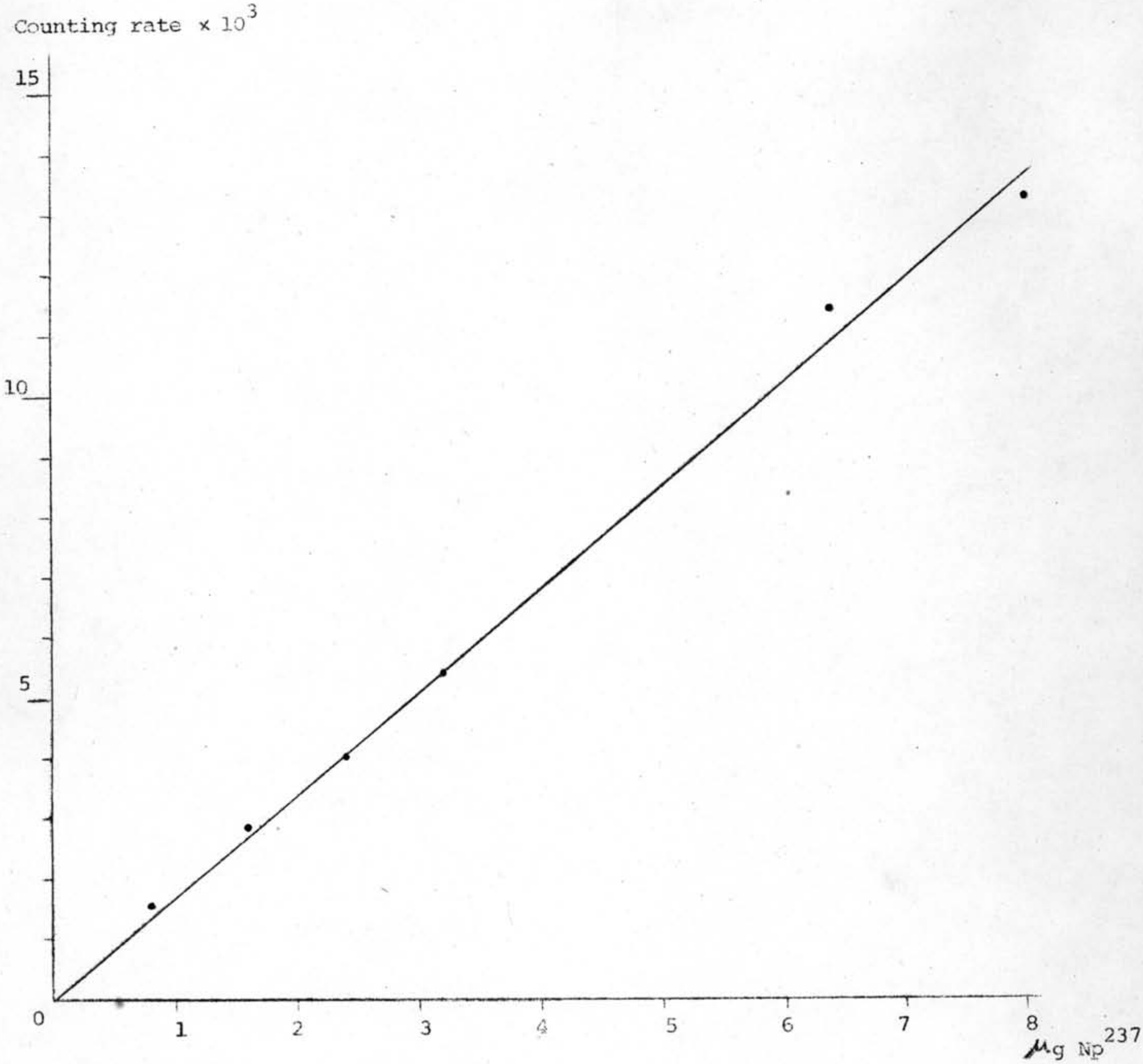

Fig 4.6 The standard curve for Np^{237}

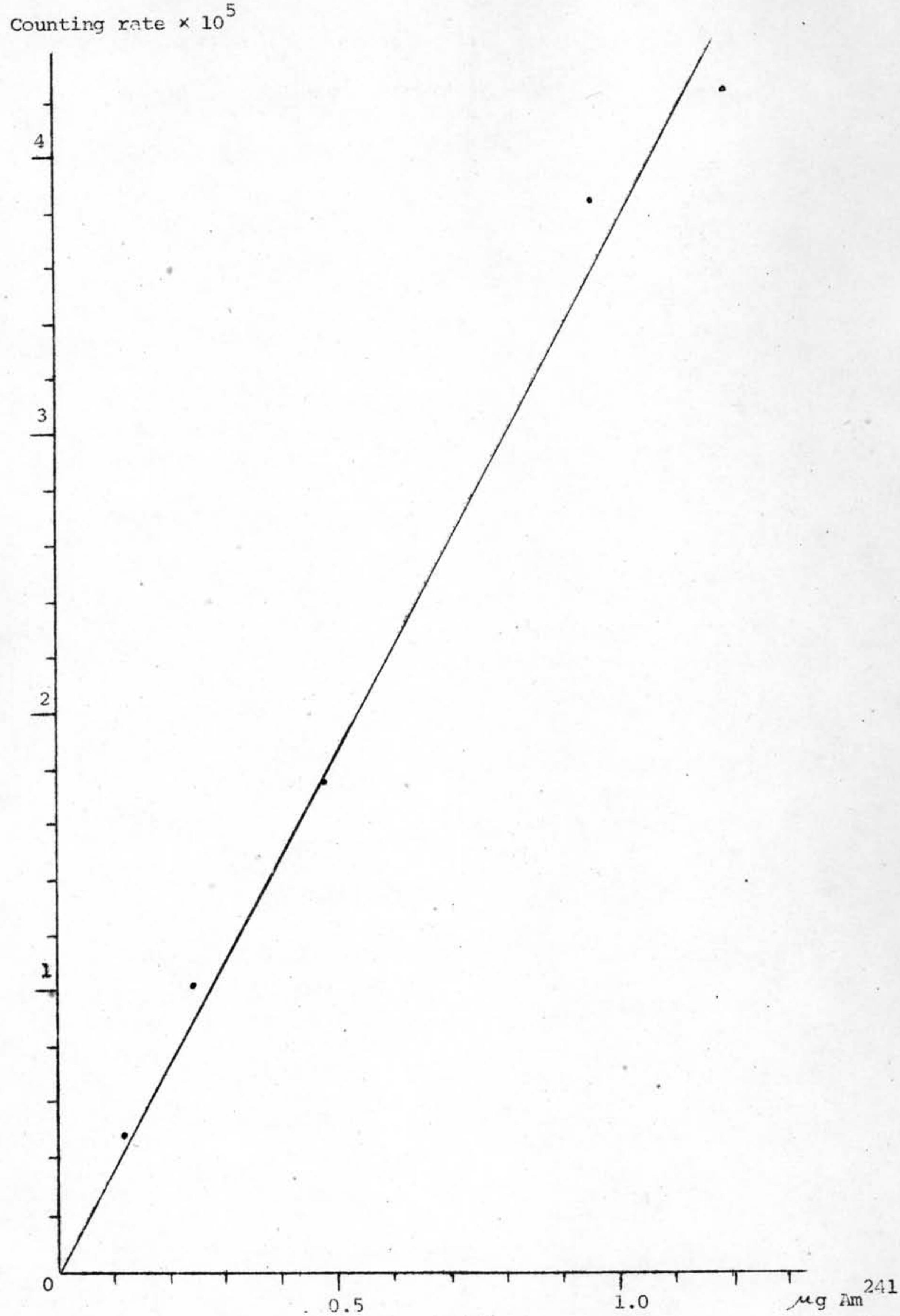

Fig. 4.7 The standard curve for Am^{241}

Table 4.1 The amount of ^{237}Np and ^{241}Am of deposited sample.

sample number	total number of counts of ^{237}Np [a] (c/30 mins)	neptunium mass (μg)	total number of counts of ^{241}Am [b] (cpm)	americium mass (μg)
1	1169.5	0.65	40219	0.115
2	3640	2.15	234533.25	0.635
3	8196	4.75	345876.5	0.92
4	9637.5	5.67	392895.75	1.05

[a,b] total number of counts of ^{237}Np and ^{241}Am are the average value of 2 measurements.

These values of mass are obtained within an estimated error of $\pm$ 0.4 percent.

Table 4.2 Counting data for sample No. 1

No.	total count rate of ^{237}Np (cpm)	total count rate of ^{241}Am [a] (cpm)	^{237}Np disintegration[b] rate (dis/min)	^{237}Np specific activity (dis/min) / μg
1	61.13	53467.25	972.1	1495.5
2	58.51	51555	965	1484.6
3	58.76	51621.5	967.8	1488.9
				Average 1489.67 ± 3.17 [c]

[a] Total count rate of ^{241}Am is the average value of 4 measurements.

[b] ^{237}Np mass 0.65 μg and 383×10^{-6} mci of ^{241}Am are used to calculate the activity

[c] Error $s/\sqrt{3}$ is the standard deviation of the mean, calculated from $s^2 = \sum_{i=1}^{3} (x_i - \bar{x})^2 / 2$

Table 4.3 Counting data for sample No. 2

No.	total count rate of ^{237}Np (cpm)	total count rate of ^{241}Am [a] (cpm)	^{237}Np disintegration rate[b] (dis/min)	^{237}Np specific activity (dis/min) / μg
1	170.45	273871	2925	1360.5
2	172.05	276262.5	2926.9	1361.3
3	172.81	277599	2925.7	1360.8
				Average 1360.87 ± 0.23 [c]

[a] Total count rate of ^{241}Am is the average value of 4 measurements.

[b] ^{237}Np mass 2.15 μg and 2117×10^{-6} mci of ^{241}Am are used to calculate the activity.

[c] Error $s / \sqrt{3}$ is the standard deviation of the mean, calculated from $s^2 = \sum_{i=1}^{3} (x_i - \bar{x})^2 / 2$

Table 4.4 Counting data for sample No. 3

No.	total count rate of ^{237}Np (cpm)	total count rate of ^{241}Am [a] (cpm)	^{237}Np disintegration rate [b] (dis / min)	^{237}Np specific activity (dis/min)/ μg
1	363.84	385600.33	6424.5	1349.7
2	362.16	383782.75	6442.9	1353.6
3	363.38	390070.5	6342.9	1332.5
				Average 1345.27± 6.48 [c]

[a] Total count rate of ^{241}Am is the average value of 4 measurements.

[b] ^{237}Np mass 4.76 μg and 3067×10^{-6} mci of ^{241}Am are used to calculate the activity

[c] Error $s / \sqrt{3}$ is the standard deviation of the mean, calculated from $s^2 = \sum_{i=1}^{3} (x_i - \bar{x})^2 / 2$

Table 4.5. Counting data for sample No. 4

No.	total count rate of ^{237}Np (cpm)	total count rate of ^{241}Am[a] (cpm)	^{237}Np disintegration rate[b] (dis/min)	^{237}Np specific activity (dis/min) / μg
1	428.09	436702.25	7616.7	1343.3
2	433.58	440345.5	7650.6	1349.3
3	425.74	427699.7	7734.4	1364.1
				Average 1352.23 ± 6.18[c]

[a] Total count rate of ^{241}Am is the average value of 4 measurements.

b ^{237}Np 5.67 μg and 3500×10^{-6} mci of ^{241}Am are used to calculate the activity.

[c] Error $s / \sqrt{3}$ is the standard deviation of the mean, calculated from $s^2 = \sum_{i=1}^{3} (x_i - \bar{x})^2 / 2$

Table 4.6 Constants used in calculating half-life.

Atomic weight ^{237}Np	= 237.048[a]
Avogadro's number	= 6.0226×10^{23} per mole
1 year =	5.2595×10^{5} min.

[a] C^{12} as standard

Table 4.7 Half-life and χ^2 - value

sample number	^{237}Np specific activity (dis/min) /μg	^{237}Np half-life (10^6 Yr.)	χ^{2} [a]
1	1489.67 3.17	2.25 0.01	0.04
2	1360.87 0.23	2.46 0.001	0.0002
3	1345.27 6.48	2.49 0.01	0.187
4	1352.23 6.18	2.48 0.01	0.17

[a] χ^2 = 0.211 of 2 degrees of freedom at level of 90 % significance.

For a test of the distribution of the experimental data, a chi-square analysis was performed. The χ^2-value for three measurements corresponds to 2 degrees of freedom. The χ^2-test of the observed specific activities of ^{237}Np listed in Table 4.7 indicates that the distribution of the experimental data is reasonable and that the instruments are operating properly with 90 % significance.