Qatar Univ. Sci. Bull. (1989), 9: 37-52

STUDIES ON THE DECAY OF ^{241}Am

By

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Key words: ^{241}Am, ^{237}Np, Gamma transitions, Energy levels.

ABSTRACT

The gamma-spectrum of ^{237}Np following the α-decay of ^{241}Am has been studied using hyper pure Ge-detector and Ge-NaI(Tl) coincidence spectrometer. Some recently reported weak gamma transitions are confirmed, besides two previously unreported transitions at 840.1 and 904.2 keV are identified and fitted in the level scheme. A level at 946.0 keV is established and three previously unreported levels at 840.0, 904.0 and 930.0 keV are proposed.

INTRODUCTION

The γ-transitions and the level structure of ^{237}Np had been studied by many authors (Baranov *et al* 1963 and 1964, Michaelis 1965, Lederer *et al.* 1966, Yamazaki and Hollander 1966, Genoux-Lubian and Ardisson 1978, Ovechkin and Khokhlov 1984, Ahmad *et al.* 1983, Stanicek and Povinec 1986); yet there exists descrepancies among reported results. Gamma spectrum of ^{237}Np following the α-decay of ^{241}Am was studied (Genoux-Lubian and Ardisson 1978, Ardisson *et al.* 1979) using a hyper pure Ge-detector in the region 13-150 keV and Ge(Li) detectors of 2.5 and 3.5 keV resolution at 1.33 MeV in the region 100-900 keV. Fifty seven new γ-transitions were reported, and four new levels were proposed at 666.5, 770.56, 861.8 and 920.7 keV on energy considerations only. The work of Ovechkin (Ovechkin 1978, Ovechkin and Khokhlov 1984) was done in the energy range 20-1030 keV. Several new γ-transitions were reported, while many previously detected transitions were not observed. In addition, six new levels above 800 keV were proposed on energy considerations only.

Recently, the gamma-ray intensities of ^{241}Am have been investigated, where nine new gamma transitions of energies above 900 keV were observed (Stanicek and Povinec 1986). Though no level scheme was proposed, it was suggested that those high energy transitions might be depopulating new high excited levels in ^{237}Np.

Also, there are still some doubted transitions as well as doubted energy levels in the level scheme of ^{237}Np as reported by Ellis-Akovali (1986) in a recent publication of accumulated results.

Discrepancies in the above mentioned results could be explained by the fact that about 99.9% of the α-decay of ^{241}Am populate the first six lower energy levels of ^{237}Np. Only about 0.1% of the total α -decay give rise to more than 130 γ -transitions populating and depopulating more than 30 energy levels. The majority of these transitions are very weak and the measurements of their energies, intensities and γ - γ coincidence spectra have always poor counting statistics. Hence, long counting time with stable measuring equipments and careful examination of the background and possible source contamination contributions are highly needed for the identification of these transitions. (The sources used by Ovechkin (1978) and Stanicek (1986) were contaminated with Europium.)

Accordingly, it was felt worthwhile to re-investigate the γ -spectrum of ^{237}Np following the α -decay of ^{241}Am using pure ^{241}Am source and detector with better resolution ($\approx$1.8 keV at 1.33 MeV). In addition, contributions due to gamma background spectra are highly eliminated since a complete quantitative analysis of γ -background radiations is available (Al-Houty *et al.* 1987).

EXPERIMENTAL TECHNIQUES

Several sources from different manufacturers have been used. (ORTEC, USA, Isotope Products, Canada and French Atomic Energy Commission, France.) Only data obtained using sources which were found free from impurities were considered.

In the present work, successive gamma singles spectra have been investigated over a period of 2 years using sources of activities ranging from 50 μc to 2 mc placed at different distances from the detector.

Since the major concern of the present work was to detect high energy γ -transitions of very low intensity, different Cu absorbers having thicknesses ranging from 1 to 3 mm were used to attenuate the low energy portion of the spectrum.

The gamma ray spectra over the range 100-1200 keV have been studied using an ORTEC p-type hyper pure Ge-detector. The detector active volume is 56.5 cc while its energy resolution is $\approx$ 1.8 keV at the 1.33 MeV. The obtained spectra were analyzed using a NORLAND 4096 multi-channel analyzer (MCA) Model 5400 with data processor, Model 5430, and an IBM-XT personal computer equipped with a Nucleus 8192 MCA plug-in card.

The system was calibrated for energy and photo peak efficiency using well-known gamma transitions in ^{22}Na, ^{60}Co, ^{133}Ba, ^{137}Cs and ^{226}Ra.

The γ - γ coincidence measurements were carried out by gating the Ge-dectector spectrum with selected energy windows from a Teledyne 3″ x 3″ NaI(Tl) detector of energy resolution ≃ 7.5% at 662 keV. The system includes two timing filter amplifiers (ORTEC 474), two constant fraction discrimenators (ORTEC 473A) and an ORTEC 467 time to amplitude converter (TAC) with a single channel analyzer (SCA), to indicate the presence of a fast coincidence pulse (time resolution ≃ 20 ns).

The NaI(Tl) detector output was amplified by an ORTEC 571 amplifier and the desired energy windows for gating purposes were selected by an ORTEC 551 timing SCA.

A triple coincidence pulse (time resolution ≃0.5μs) was obtained by a universal coincidence (ORTEC 418A). It represents the combination of a proper NaI(Tl) - Ge TAC timing, selected scintillation energy windows and an energy requirement pulse from the energy channel of the Ge-detector. This pulse was used to gate the MCA tc obtain coincidence spectra.

RESULTS AND DISCUSSION

1. The Gamma-Singles Spectrum

A typical gamma-singles spectrum is shown in Fig. la & b. The analysis of the observed spectra has revealed the existence of 127 gamma transitions attributed to the decay of ^{241}Am. Their energies and intensities, together with the previous data (Genoux-Lubian and Ardisson 1978, Ovechkin and Khokhlov 1984, Stanicek and Povinec 1986) are listed in Table 1. The uncertainty in the energies and intensities are within the last digit. The intensities were normalized to that of E_γ = 662.4 keV. Its intensity was taken to be equal 360 photon/10^8 α-disintegration (Brown and Firestone 1986).

Ovechkin (1984) reported that the intensities of the γ -transitions obtained by Genoux-Lubian (1978) were nearly double that obtained by other authors. This observation, however, is misleading since the intensities in that work (Genoux-Lubian 1978) were normalized to that of E_γ = 208.01 keV with intensity equals 160 photon/10^7 α -particle instead of 79 photon/10^7 α -particle. Accordingly, the intensities in Genoux-Lubian's work were renormalized and tabulated in Table 1.

Several conclusions could be drawn from the results presented in Table 1:

1. Two γ -transitions have been observed for the first time. The energies of these γ -transitions are 840.1 and 904.2 keV of intensities 0.10 and 0.16 / 10^8 α-particles respectively.

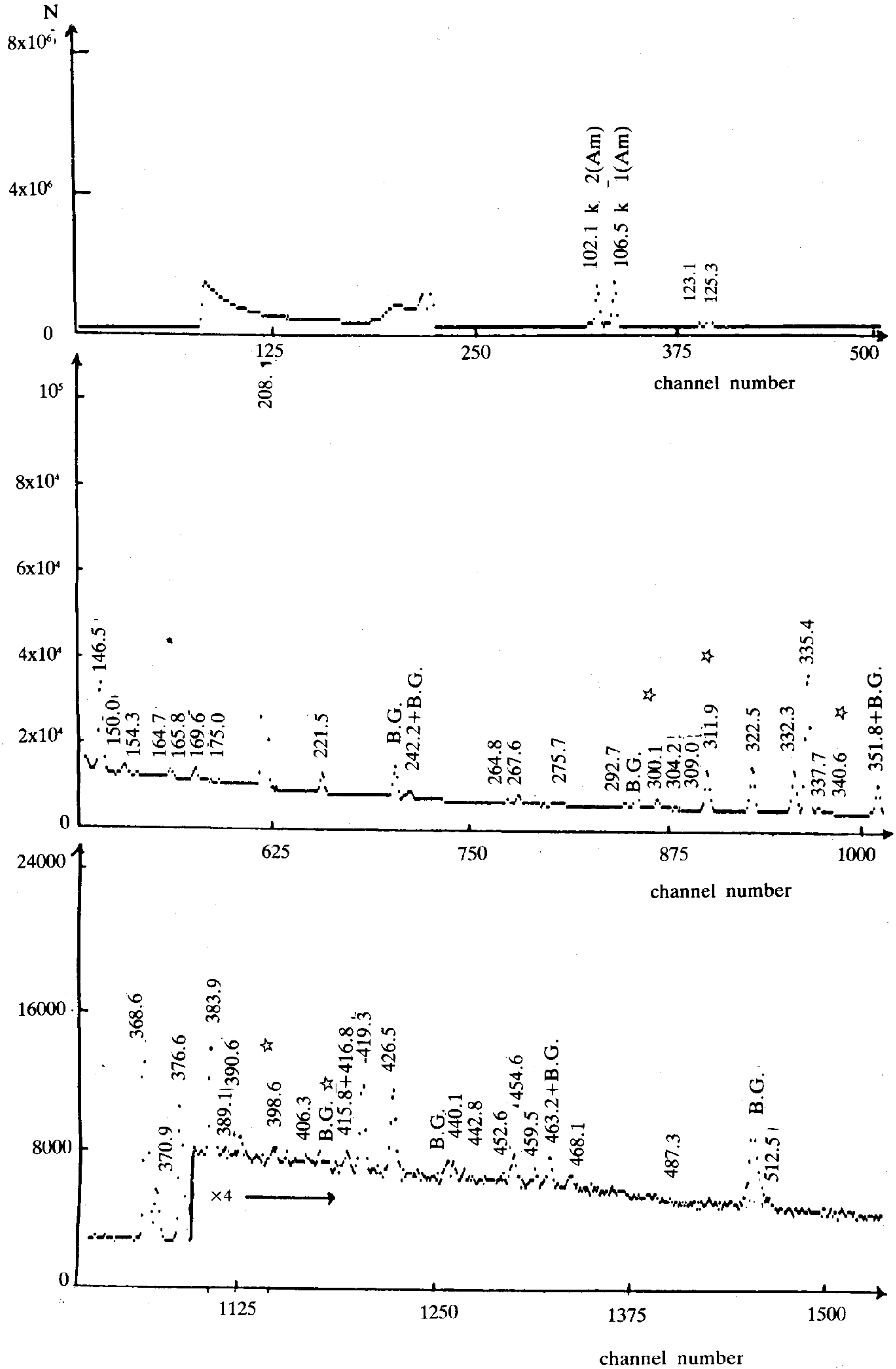

Fig. 1a: Gamma-Singles of ^{241}Am using Ge-detector

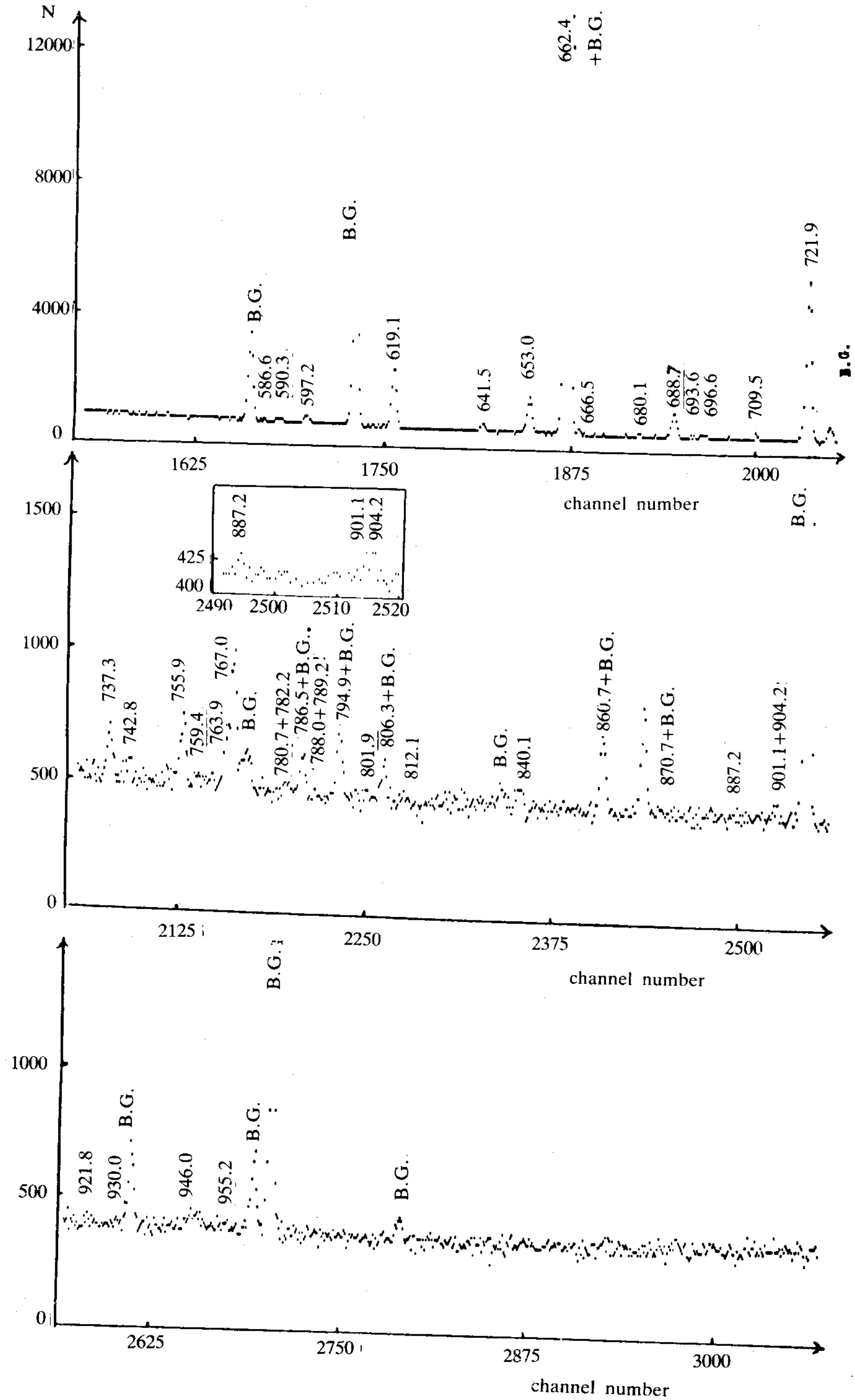

Fig. 1b: Gamma-Singles of ^{241}Am using Ge-detector

Table 1

Energy and intensity values for gamma transitions in ^{241}Am α-decay

Energy (keV)				Intensity (photons /10^8 α-particles)			
Present	Genoux-Lubain	Ovechkin	Stanicek	Present	Genoux-Lubain	Ovechkin	Stanicek
106.4 2	106.42 5			13.5 6	15.3		
109.7 5	109.70 7			4.8 4	4.9		
120.4 7	120.36 8			4.4 4	4.5		
123.1 2	123.01 3	123.0 1		730.5 20	691.25	890 100	
125.3 4	125.3 3	125.3 1		2182.0 80	2152.6	3630 300	
139.2 1	139.44 8			2.4 4	1.92	—	
146.5 2	146.55 3	146.4 2		383.0 60	303.1	460 40	
150.0 1	150.04 3	150.0 3		80.6 40	55.79	59 10	
154.3 2	154.27 20	—		1.0 3	0.59	—	
159.1 4	159.26 20	—		1.0 2	0.79	—	
161.5 1	161.54 10	—		1.0 4	1.53	—	
164.7 1	164.69 4	164.4 3		41.9 20	50.37	61 8	
165.8 1	165.81 6	—		17.8 10	18.77	—	
169.6 2	169.56 3	169.5 2		123.5 20	156.75	140 20	
175.0 2	175.07 4	175.2 2		15.7 20	15.3	12 3	
192.0 1	191.96 4	191.9 2		17.9 6	15.6	21 2	
197.0 3	197.0 2	195.9 2		0.4 1	0.49	8.6 9	
201.7 2	—	—		0.8 1		—	
204.0 3	204.06 6	—		122.4 40	182.69	—	
208.1 2	208.01 3	208.0 2		964.9 90	790.0	770 40	
221.5 2	221.46 3	221.3 2		42.9 20	42.16	37 4	
232.8 1	232.81 5	232.8 2		4.0 10	4.2	4.3 6	
242.2 2	242.2	—		2.6 6	—	—	
246.7 2	246.73 10	246.7 3		1.3 2	1.92	2.0 6	
249.0 2	249.00 15	—		1.1 3	0.54	—	
260.8 1	260.81 15	—		2.0 3	2.47	—	
264.8 2	264.89 6	265.4 4		8.5 6	9.68	9 2	
267.6 3	267.58 5	267.9 5		25.1 10	25.23	29 4	
270.6 2	270.63 15	—		0.6 2	0.45	—	
275.7 2	275.77 8	275.6 4		4.3 4	4.29	6.2 6	
278.0 2	278.04 15	—		0.3 1	0.45	—	
291.3 3	291.30 20	—		1.7 2	3.9	—	
292.7 1	292.77 6	292.5 3		12.6 1	15.0	16 2	
300.1 1	300.13 6	—		7.3 1	9.33	—	
304.2 3	304.21 20	—		0.4 2	1.09	—	
309.0 2	309.05 30	—		1.3 2	1.43	—	
311.9* 1	311.94 3	—		46.0 20	57.3	—	
316.8 2	316.8 2	—		0.2 1	≤0.05	—	
322.3 1	322.52 3	322.2 4		171.6 20	154.05	143 11	
332.3 1	332.35 3	331.8 8		152.8 40	167.4	172 20	
335.4 2	335.37 3	334.7 7		608.0 60	498.7	454 15	
337.7 1	337.7 2	—		1.6 4	1.98	—	

Table 1 Cont.

Energy (keV)				Intensity (photons /10^8 α-particles)			
Present	Genoux-Lubain	Ovechkin	Stanicek	Present	Genoux-Lubain	Ovechkin	Stanicek
340.6* 2	340.56 8	—		3.1 10	4.29	—	
351.8 3	—	—		12.3 4	—	—	
358.3 2	358.25 20	—		0.3 1	1.28	—	
368.6 2	368.65 3	368.3 3		237.6 40	220.2	188 20	
370.9 1	370.94 3	371.0 3		39.8 40	45.72	45 4	
376.6 1	376.65 3	376.4 3		157.0 20	138.28	132 10	
383.9 1	383.81 3	383.7 2		30.9 3	28.14	24 3	
389.1 2	389.05 30	—		2.6 8	0.49	—	
390.6 3	390.62 10	390.8 5		8.4 20	5.38	3.8 8	
398.6* 2	398.64 15	—		2.5 2	1.98	—	
401.3 1	401.30 30	—		0.9 2	0.49	—	
406.3 2	406.35 15	—		1.8 4	1.72	—	
415.8* 2	415.88 10	—		4.3 3	3.06	—	
416.8 3	—	—		2.6 9	—	—	
419.3 1	419.33 4	419.5 6		22.2 2	28.14	29 3	
426.5 3	426.47 4	426.7 2		19.9 3	24.19	24.2 10	
429.9 1	429.94 10	—		3.3 2	1.38	—	
440.1 2	—	—	440.41	0.05 3	—	—	14.0
442.8 3	442.81 7	443.1 4	442.91	0.4 1	0.39	3.5 4	2.8
446.4 2	446.43 15	—	—	0.4 1	0.49	—	—
452.6 3	452.6 2	—	452.38	1.6 4	2.8	—	1.4
454.6 1	454.66 8	454.7 2	454.35	11.6 6	9.33	10.5 12	7.8
459.5 3	459.68 10	460.0 6	459.71	3.7 2	3.35	2.9 4	2.0
463.23 7	463.22 20	—	—	2.4 9	0.98	—	—
468.1 2	468.12 15	467.9 5	467.9	3.1 2	3.11	2.9 8	2.1
—	—	—	477.29	—	—	—	0.92
485.9 2	485.91 20	—	486.14	1.4 2	1.23	—	1.0
487.3 3	487.3 3	—	—	0.9 2	0.44	—	—
512.5 5	512.5 3	—	513.06	1.0 2	1.03	—	3.4
514.2 2	514.0 5	513.7 5	—	1.1 3	1.23	3.1 15	—
522.0 2	522.06 15	—	522.39	0.7 2	0.6	—	0.69
527.6[b] 2	—	—	—	0.6 1	—	—	—
529.2 2	529.17 20	—	529.42	0.6 1	0.46	—	0.3
545.3 3	545.36 30	—	—	1.1 2	0.74	—	—
563.0 1	563.05 30	—	563.7	1.1 2	0.74	—	0.42
573.9 1	573.94 20	—	574.04	3.8 2	1.48	—	0.98
586.6 4	586.59 20	—	586.3	1.0 2	1.53	—	0.82
590.3 6	590.28 15	589.9 6	—	3.7 6	2.7	3.0 6	—
597.2 2	597.48 8	597.6 5	597.43	6.4 6	7.3	7.6 4	3.9
619.1 2	619.01 2	619.2 3	618.83	56.5 20	59.25	52 4	51.0
627.2 2	627.18 20	627.0 5	—	1.5 2	0.71	0.63 15	—
632.9 1	632.93 15	633.1 5	632.86	2.0 4	1.45	1.4 3	0.88
641.5 1	641.47 5	641.5 3	641.34	6.8 4	6.41	6.4 6	6.1
653.0 2	653.02 4	652.8 3	652.79	30.3 20	36.58	34 1	33.0
662.4 3	662.40 2	662.2 1	662.32	360.0 100	366.4	335 10	343.0

Table 1 Cont.

Energy (keV)				Intensity (photons /10^8 α-particles)			
Present	Genoux-Lubain	Ovechkin	Stanicek	Present	Genoux-Lubain	Ovechkin	Stanicek
666.5 5	666.5 3	—	—	0.8 2	0.49	—	—
—	669.83 20	—	—	—	0.83	—	—
676.0 2	676.03 30	676.0 5	675.65	1.0 2	0.72	0.64 8	0.33
680.1 3	680.10 10	680.1 3	680.15	3.9 3	2.97	3.9 2	1.6
688.7 4	688.72 4	688.0 5	688.58	27.2 10	31.7	39 1	21.0
693.6 4	693.62 8	—	—	3.0 3	2.97	—	—
696.6 5	696.60 5	696.1 5	696.3	3.9 3	4.1	8.7 2	2.1
709.5 5	709.45 5	710.0 5	709.26	4.5 2	6.02	8 1	5.3
721.9 7	722.01 3	721.9 1	722.04	172.7 40	198.0	179 6	175.0
729.9 8	729.72 15	730.0 5	729.94	0.4 1	0.83	0.6 2	0.77
737.3 5	737.34 5	737.0 3	737.32	7.4 3	7.94	6.1 2	6.9
742.8 2	742.88 30	—	—	0.3 1	0.34	—	—
755.9 3	755.90 5	755.8 3	755.94	7.3 10	8.3	8.6 2	7.3
759.4 4	759.38 10	—	759.21	2.6 6	1.72	—	1.4
763.9 3	763.9 3	—	—	0.18 5	0.25	—	—
767.0 5	767.00 10	766.8 5	766.81	5.2 8	5.78	5.5 3	1.5
770.5 5	770.57 10	770.8 5	771.26	4.5 2	5.53	6.5 4	2.8
772.5 6	772.4 3	—	—	0.17 4	—	—	—
780.7 2	780.7 2	779.6 5	780.34	0.3 1	0.24	0.28 3	12.0
782.2 5	782.2 5	—	—	0.24 8	0.15	—	—
786.5 5	786.00 15	—	—	1.2 2	0.62	—	—
788.0 5	—	788.6 5	788.3	0.3 1	—	0.31 4	1.0
789.2 6	789.17 25	—	—	0.3 1	0.37	—	—
794.9 5	794.92 20	—	—	1.4 3	0.94	—	—
801.9 2	801.94 20	801.7 4	801.79	1.4 3	1.03	1.3 1	0.9
806.3 4	806.26 30	—	—	0.5 1	0.31	—	—
812.1 5	812.01 30	811.5 4	811.34	0.6 1	0.6	0.5 1	0.36
819.0 7	819.00 10	820.4 5	—	0.4 1	0.4	0.41 4	—
—	—	827.7 3	828.82	—	—	0.15 3	0.16
835.6 8	835.6 10	834.6 8	—	0.18 5	0.21	0.03 1	—
840.1 6	—	—	—	0.10 5	—	—	—
842.5 7	—	841.5 10	—	0.14 4	—	0.04 1	—
—	—	847.4 5	—	—	—	0.27 3	—
851.6 8	851.6 10	852.4 5	—	0.18 5	0.2	0.67 2	—
860.7 9	860.71 50	—	—	0.9 2	1.29	—	—
862.7 5	862.68 50	862.4 3	862.28	0.4 1	0.64	0.84 5	0.41
870.7 7	870.70 30	870.6 3	—	0.3 1	0.46	0.93 5	—
887.2 5	887.30 30	887.4 3	887.5	0.4 1	0.49	0.34 3	0.17
901.1 7	—	901.9 3	—	0.14 5	—	0.25 2	—
904.2 5	—	—	—	0.16 4	—	—	—
—	—	912.3 3	912.0	—	—	0.22 2	0.25
921.8 9	921.5 3	921.5 5	—	0.2 1	0.3	0.16 1	—
930.0 5	—	929.7 10	929.52	0.17 5	—	0.073 5	0.08
946.0 5	—	946.0 7	—	0.17 4	—	0.08 1	—
955.2 5	—	955.7 4	956.26	0.3 1	—	0.53 2	0.36
—	—	1014.7 5	—	—	—	0.064 10	—

* Possible contribution from ^{233}Pa

2. The previously reported γ -transitions of energies 201.7 and 416.8 keV (Cline 1971), the 351.8 and 527.5 keV (Kamoun *et al.* 1968) and the 242.2 keV (Kamoun *et al.* 1968, Genoux-Lubian and Ardisson 1978) have been confirmed by this work. It was possible to estimate the intensity of the 242.2 keV γ -transition and was found to be $2.6/10^8$ α-decay.

3. Gamma -transitions of energies 156.4, 294.9, 477.3, 609.8, 669.8, 827.8, 828.8, 847.4, 912.0 and 1014.0 keV reported by several authors (Kamoun *et al.* 1968, Genoux-Lubian and Ardisson 1978, Ovechkin and Khokhlov 1984, Stanicek and Povinec 1986) could not be confirmed in the present work.

4. All other observed γ -transitions are in agreement with those previously reported.

2. The γ - γ Coincidence Measurements

Gamma-gamma coincidence measurements have been performed using several window sets; only the results from five window sets are considered. These windows are: 25-85 keV, 85-140 keV, 200-270 keV, 312-370 keV, and 395-590 keV.

Although high activity sources were used (up to 2 mc), coincidence counts never exceeded few counts per minute. Therefore, over 3000 hours of counting were performed during which each spectrum was taken several times for a period of several days. Three coincidence spectra which illustrate most of the information needed in the present work are shown in Fig. 2. The results obtained from the other two gates support the ones already illustrated. (Fig. 2)

Analysis of the obtained spectra confirmed the well established levels and gamma transitions as well as revealing the following remarks:

2.1 Gamma Transitions

1. The two γ -transitions identified for the first time in the present γ -singles spectrum were not observed in any of the γ - γ coincidence measurements even when other gates different from the forementioned ones were used.

2. The previously reported γ -transition (Genoux-Lubian and Ardisson 1978, Ellis-Akovali 1986) of energy 300.1 keV which was placed as a doubted transition between the 359.7 and 59.5 keV levels (Ardisson *et al.* 1979, Ellis-Akovali 1986) could not be observed in coincidence with the 59.5 keV transition.

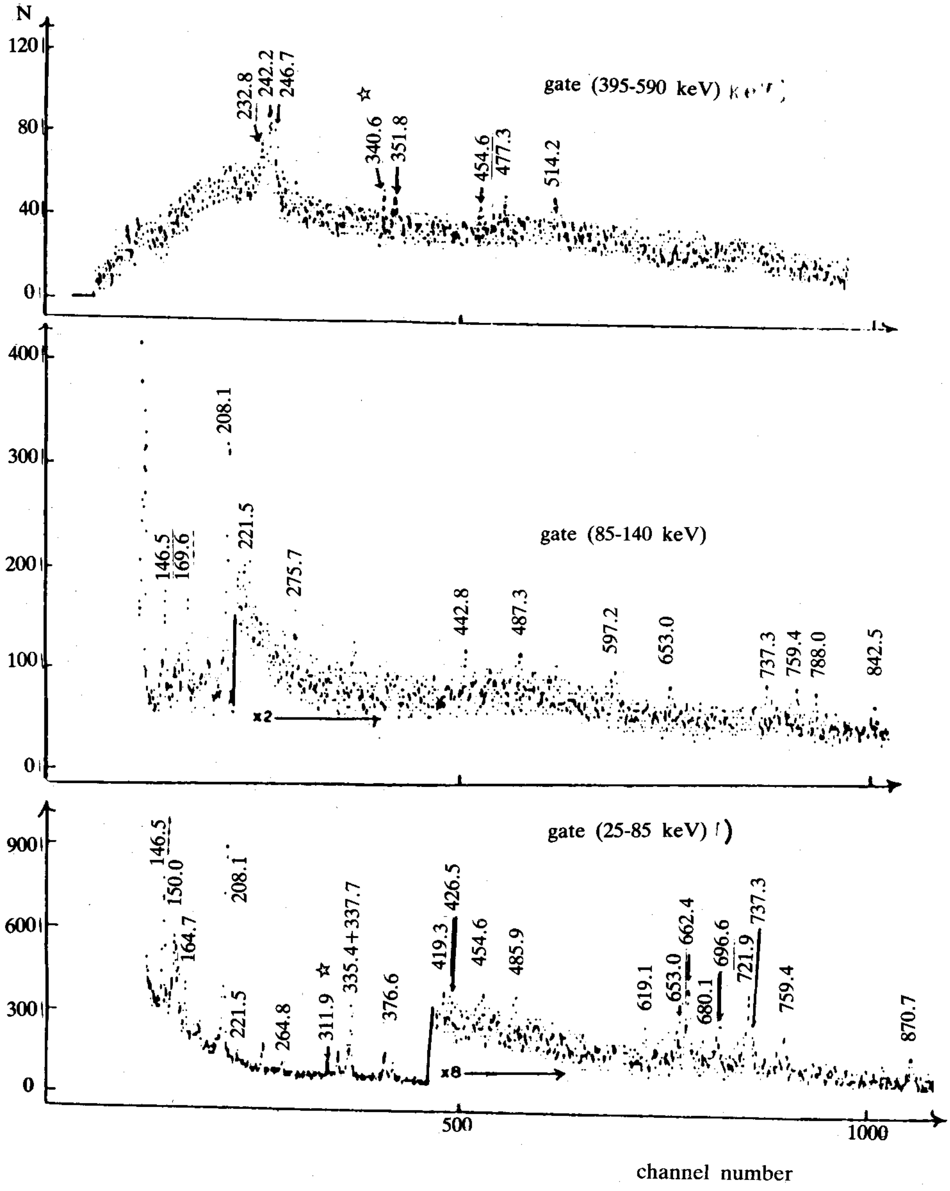

Fig. 2: γ - γ Coincidence Spectra using Ge-NaI(Tl) detectors

3. The previously reported γ -transitions (Genoux-Lubian and Ardisson 1978, Ovechkin and Khokhlov 1984, Stanicek and Povinec 1986, Ellis-Akovali 1986) of energies 442.8 and 485.9 keV are placed in the decay scheme. The 442.8 and 485.9 keV transitions were found to be in coincidence with the 102.9 keV line and the 59.5 keV γ -line, respectively. Hence they are supposed to depopulate the 545.6 keV level.

4. The γ -transitions of energies 311.9, 340.6 and 415.8 keV have been observed in the coincidence spectra. Previous work (Ardisson *et al.* May 1979) completely attributed the above mentioned transitions as well as the 300.1 and 398.6 keV transitions to the decay of ^{233}Pa. However, this conclusion leads to some remarks worth mentioning. First, low energy γ -transitions in ^{237}Np were studied (Genoux-Lubian and Ardisson January 1978) and no contribution from ^{233}Pa was noticed. Furthermore, the 300.1, 311.9, 340.6, 398.6 and 415.8 keV transitions were attributed completely to ^{237}Np (Genoux-Lubian and Ardisson May 1978). If this attribution was wrong (as stated in the work published in May 1979), then, not observing the relatively strong 111.0 keV transition from ^{233}Pa in their work, cannot be explained.

Ovechkin and Khokhlov (1984) also attributed the 311.9, 340.6 and 398.6 keV transitions completely to the decay of ^{233}Pa. However, no data was given for the increase in the intensity of the 311.9 keV transition nor for the possible observation of the relatively strong transitions of energies 20.4, 94.6, 98.4 and 111.0 keV in the decay of ^{233}Pa.

In the present work, the 300.1, 311.9, 340.6, 398.6 and 415.8 keV transitions were detected while the 111.0 keV line was not observed. If these transitions belong completely to the decay of ^{233}Pa, one cannot explain the fact that the 311.9 keV transition only, and not the 340.6 keV transition was detected in the coincidence spectrum gated by the energy window 25-85 keV. The 340.6 keV transition was observed in coincidence with the 426.5 keV transition. Furthermore, the 415.8 keV transition was observed in coincidence with the 232.8 and 246.7 keV transitions (gate 200-270 keV). Moreover, no significant increase in the intensity of the 311.9 keV transition was noticed in the present work.

Simple calculations, however, indicate a possible contribution of ^{233}Pa in the present data. In order to confirm or to estimate the amount of this contribution, further work, especially in the low energy region, is needed. Consequently, the 340.6, 311.9 and 415.8 keV transitions could be placed as doubted transitions.

5. The gamma transitions of energies 242.2, 415.8, 477.3, 788.0, 842.5, 870.7, 840.1, 904.2, 930.0 and 946.0 keV transitions are used to construct four energy levels at 840.0, 904.0, 930.0 and 946.0 keV.

2.2 Level Scheme

The results of the present work have been used in constructing a partial level scheme of ^{237}Np (Fig. 3) from which the following remarks may be considered:

1. Energy levels proposed by Ovechkin (1978) at 820.7, 901.7 and 1014 keV on energy considerations only could not be confirmed in the present work. Three γ -transitions were proposed to depopulate the 820.7 keV level (Ovechkin 1978), from which only the 789.4 keV line was detected in the present work, but was not found in coincidence with the 33.2 keV transition. The 901.7 keV level was supported by the detection of the 901.7 and 842.5 keV transitions (Ovechkin 1978). However, in the present work, only the 842.5 keV transition was observed and was found to be in coincidence with the 102.9 keV transition. While the 1014 keV level was based on three γ -transitions of energies 1014, 955.1 and 911.7 keV depopulating the level. In the present work, only the 955.1 keV transition was detected and was not found to be in coincidence with the 102.9 keV transition.

2. In agreement with Ovechkin (1978), the energy level at 946.0 keV, is confirmed; however, its mode of de-excitation is different. In the present work, this level is supported by the detection of three gamma transitions of energies 946.0, 842.5 and 788.0 keV. The 842.5 and 788.0 keV transitions were observed in the coincidence spectrum gated by the energy window from 85 to 140 keV. Therefore, it is proposed that the 842.5 and 788.0 keV transitions could depopulate the level to the 102.9 keV level and the 158.5 keV level respectively. It is worthwhile to mention that this level was also reported in ^{237}Np(d,d') reactions (Ellis-Akovali 1986).

3. Three levels at 840.0, 904.0 and 930.0 keV are proposed for the first time. The 840.0 keV level is supported by observing the 242.2 and 840.1 keV transitions depopulating the level. Three window sets were used to confirm this level. First, a relatively wide window set (gate 395-590 keV) was selected to cover the 406.3, 468.1 and 522.0 keV transitions which depopulate the 598.0 keV level. The 242.2 keV line was observed in the obtained coincidence spectra. The above mentioned three transitions were also found in coincidence with the 242.2 keV transition (gate 200-270 keV).

The detection of transition of energy 904.2 keV and the observation of the 870.7 keV γ -line in coincidence with the 33.2 keV transition supports the existence of a level at 904.0 keV. This proposed level may be the same level reported in ^{237}Np(d,d') reactions (Ellis-Akovali 1986) to be at 906 keV.

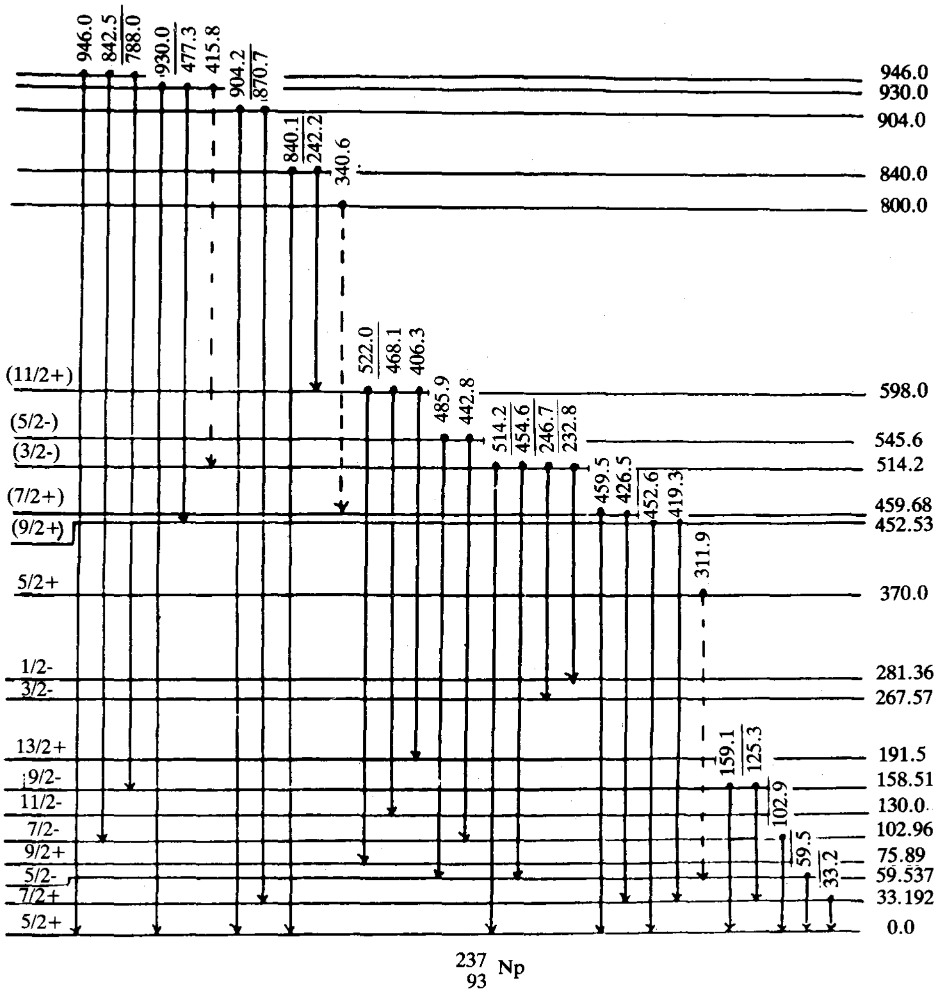

Fig. 3: Partial Level Scheme of ^{237}Np representing levels and transitions added or modified from reported data (Ellis-Akovali 1986)

The level at 930.0 keV is based on the observation of the 930.0, 477.3 and 415.8 keV transitions depopulating it. The level is confirmed by observing the 415.8 keV transition in coincidence with the 246.7 and 232.8 keV transitions (gate 200-270 keV) depopulating the 514.2 level. Also, these two transitions were found in coincidence with the 415.8 keV line (gate 395-590 keV). In addition, the 477.3 keV transition previously reported (Stanicek and Povinec 1986) and not identified in the present γ -singles spectrum, is observed in the coincidence spectrum gated by an energy window from 395 to 590 keV. It is supposed that this transition is in coincidence with the 419.3 and 452.6 keV transitions. Also, the 477.3 keV transition was found to be in coincidence with the 322.5 keV line (gate 312-370 keV). Hence the 477.3 keV transition could depopulate the 930.0 keV level to the well established 452.5 keV level.

The forementioned results were used to place, for the first time, many reported, as well as observed, γ -transitions in the level scheme of ^{237}Np. There are still transitions, which were previously reported as well as observed in the present work, not placed in the level scheme of ^{237}Np. The possibility of the existence of high energy levels up to 1.78 MeV has already been suggested. (Stanicek and Povinec 1986) Their study, however, needs more experimental data with high efficiency detectors and long counting time.

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دراســـات على انحـــلال نواة الأمريسيوم

لطيفـــة إبـراهيم الحوطي - سمـــير يوشع الخميس
و حســـين أبو ليلـــة

يتناول البحث دراسة الطيف الجامي لنواة النبتونيوم ـ ٢٣٧ الناتج من الإنحلال الألفي لنواة الأمريسيوم ـ ٢٤١ وذلك بإستخدام كاشف الجرمانيوم عالي النقاوة ، وأيضا مطياف التطابق الجامي المكون من كاشف الجرمانيوم عالي النقاوة ، وكاشف أيوديد الصوديوم المنشط بالثاليوم .

وقد توصلت الدراسة إلى التعرف على إنتقالين جاميين لم يسبق الاشارة إليها ذات طاقة ٨٤٠,١ و ٩٠٤,٢ ك. أ. ف. كما أمكن التأكد من تواجد بعض الإنتقالات الجامية ضعيفة الشدة والتي سبق الإشارة إليها في بعض البحوث .

كما توصلت الدراسة إلى التأكد من وجود مستوى عند ٩٤٦,٠ ك. أ. د. ف. ، بالاضافة إلى تواجد ثلاثة مستويات عند طاقات ٨٤٠,٠ ، ٩٠٤,٠ ، ٩٣٠,٠ ك. أ. ف. في نواة النبتونيوم ٢٣٧ .