INDC(IRQ)-1/G

491

CURRENT RESEARCH IN NUCLEAR PHYSICS, SOLID STATE PHYSICS AND THIER APPLICATION IN ACTIVATION ANALYSIS IN IRAQ. THESE ARE PRELIMINARY RESULTS AND ARE TO BE PUBLISHED SOON :

The (n,γ) group activities within the physics Department of Nuclear Research Institute - Iraqi Atomic Energy Commission for the years 1970 - 1971

This group utilizes one of the reactor channels as a source of neutron and its work is mainly in the (n,γ) field. However, a new setup is being completed to study neutron inelastic scattering on various isotopes. The group is equipped with a 4096 channel analyzer & two Ge(Li) detector of 30 and 15cc. Also an 8"x12" NaI(TI) detector for anticoincidence measurements and anticompton experiments.

The group had been completed and are going to complete the following researches and works during 1970 and 1971.

1. Measurement of the Reaction $^{35}Cl(n,\gamma)\ ^{36}Cl$ using a Three-Crystal Pair & Anti-Compton Spectrometer.

J.D.Jafar, A.A.Abdulla, N.H.Al-Quraishi, M.S.Alwash, J.Kaifosz, M.A.Khalil, M.H.Al-Kaissy & Z.Kosina.

The Cl(n,γ) reaction was investigated and the energies and intensities of 190 resolved γ-rays are reported.

A three-crystal NaI-Ge pair and anti-compton spectrometer was used. A computer programme useful in the automatic analysis of γ-ray spectra is briefly described.

A boot-strap technique generated a self-consistent energy calibration and the binding energy of ^{36}Cl was determined to be 8580.7 ± 1 KeV.

The appearance of single and double escape peaks in addition to photopeaks above pair production threshold will complicate the γ-ray spectrum even further and may cause ambiguities in its interpretation. It is essential to use pair spectrometers for accurate high energy measurements of γ-transitions.

In this present work a high efficiency three crystal NaI-GeNaI pair spectrometer has been used in an investigation of the (n,γ) spectrum from natural chlorine.

The intensity of the 25mm extracted neutron beam from the thermal column of the IRT-2000 was $1.5x10^8$n/sec at the target position. The three crystal pair spectrometer consits of a splitting annular Na(TI) crystal 12" long x 8" in diameter with 2" central through-hole. The two halves are optically isolated and each is viewed by six 2" EMI 9656 phtomultiplier tubes of high quantum efficiency 28%. The central detector is a 10CC coaxial Ge(Li) crystal mounted at the end of a long right-angle arm extending from a chicken-feed type LN_2 dewar vessel. The measured energy resolution (fwhm) of one crystal half was 10.6% for Cs^{137} and 8% and 7.5 for the Co^{60}. lines. The resolution of the Ge(Li) detector was 3 KeV for Co^{60} (1.33 MeV).

The coincidence efficiencies with energy restriction on the annihilation pair can be high, from 20-25% of the double escape peak area in the single spectrum may be collected in the coincidence mode. The high-energy data (above 2047.1 KeV) were taken with the pair spectrometer in a single run of 22 hours. The electronic arrangement permits simultaneous accumulation of data in the two operating modes when two multichannel analyzers are available.

The results were analyzed by an IBM 1130 computing system. A special programme was written for the automatic analysis of γ-ray spectra where the whole spectrum is plotted, smoothed and peaks located. Then the whole spectrum was divided into intervals for fitting and normalized discrete gaussian shape weighting function was used. After this the energies and intensities of γ-rays were determined.

The results were found to be in satisfactory agreement with those of Groshev et al. for the commonly observed lines. The results are listed in Table (1).

Table 1

Gives the energies and their intensities from $^{35}Cl\ (n,\gamma)\ ^{36}Cl$

No.	Energy	Intensity	No.	Energy	Intensity
1	8580.7	3.91	51	4752.2	0.13*
2	7792.1	10.38	52	4730.2	0.76
3	7415.4	11.52	53	4684.5	0.05
4	6979.2	2.46	54	4617.6	0.31
5	6953.3	0.16*	55	4588.1	0.29
6	6894.6	0.08*	56	4549.1	0.66
7	6870.2	0.08*	57	4526.1	0.48*
8	6646.0	0.01*	58	4519.1	0.18*
9	6628.9	4.55	59	4459.2	0.10
10	6620.9	8.97	60	4441.3	1.20
11	6544.9	0.16	61	4416.0	0.34
12	6487.4	0.19	62	4355.8	0.17
13	6423.3	0.33	63	4299.0	0.46
14	6380.4	0.27	64	4282.2	0.05
15	6341.9	0.16	65	4207.0	0.19
16	6268.6	0.44	66	4191.6	0.10
17	6112.0	23.82	67	4165.4	0.08
18	6087.8	1.25	68	4139.4	0.38
19	6051.0	0.05	69	4128.5	0.14
20	5957.5	0.29	70	4112.8	0.06
21	5904.0	1.38	71	4083.4	0.86
22	5778.9	0.15	72	4019.3	0.07*
23	5756.6	0.10*	73	4055.5	0.63
24	5734.8	0.48	74	4042.2	0.07
25	5716.2	6.15	75	4029.0	0.17
26	5704.4	0.50*	76	3999.9	0.14
27	5634.7	0.07	77	3981.7	(1.40)
28	5604.9	0.48	78	3963.6	0.40
29	5585.7	0.58	79	3917.0	0.11
30	5518.5	1.98	80	3862.4	0.06*
31	5474.7	0.10	81	3823.8	1.97
32	5372.4	0.06	82	3775.1	0.19
33	5262.8	0.13	83	3750.5	0.36
34	5247.8	0.64	84	3737.3	0.20
35	5205.8	0.26	85	3708.0	0.18*
36	5151.9	0.18*	86	3697.4	0.14*
37	5143.8	0.09*	87	3661.4	0.22
38	5125.0	0.04	88	3665.5	0.28
39	5110.7	0.09	89	3625.8	0.15*
40	5079.1	0.17	90	3613.6	0.08*
41	5018.8	0.51	91	3604.7	0.36*
42	4991.0	0.20*	92	3600.6	0.43*
43	4980.8	4.09	93	3588.8	(0.74)
44	4954.5	0.10*	94	3518.9	0.12*
45	4945.5	1.22	95	3567.2	0.30*
46	4886.4	0.08	96	3561.9	0.90*
47	4846.3	0.04	97	3549.3	0.09*
48	4830.4	0.23	98	3514.4	0.06*
49	4816.1	0.19	99	3502.2	0.49
50	4758.7	0.14*	100	3470.0	0.15

Table 1 (Cont.)

No.	Energy	Intensity
101	3460.7	0.07*
102	3429.3	0.84
103	3415.1	0.08*
104	3375.0	0.65
105	3367.1	0.08*
106	3350.6	0.17
107	3333.2	0.84
108	3316.5	0.25
109	3294.3	0.07
110	3273.5	0.04*
111	3267.7	0.09
112	3250.8	0.21
113	3245.0	0.11*
114	3212.5	0.07*
115	3201.5	0.11
116	3161.8	0.09*
117	3152.2	0.06*
118	3135.3	0.11
119	3116.5	0.92
120	3106.6	0.11*
121	3095.2	0.07*
122	3087.1	0.08*
123	3062.1	3.97
124	3027.7	0.07*
125	3016.3	1.02*
126	3002.1	0.76
127	2994.9	0.93
128	2975.3	1.44
129	2953.7	0.18*
130	2896.3	0.48
131	2877.5	0.29*
132	2864.4	0.73
133	2845.9	0.88
134	2811.4	0.45
135	2801.1	1.01
136	2754.4	(0.96)
137	2740.0	0.14*
138	2711.9	0.09
139	2677.0	1.56
140	2648.8	0.28
141	2623.7	0.58
142	2593.2	0.11
143	2538.7	0.33
144	2529.1	0.27
145	2492.7	0.79
164	2470.7	0.90
147	2432.2	0.21
148	2420.4	0.63
149	2397.2	0.17
150	2385.8	0.12
151	2330.8	0.22
152	2316.9	0.87
153	2296.0	0.28
154	2263.1	0.16*
155	2247.4	0.13*
156	2241.1	0.16*
157	2234.1	0.32'
158	2210.9	0.32
159	2191.7	0.24
160	2169.3	0.62
161	2124.6	0.32
162	2110.2	0.26
163	2094.8	0.81
164	2063.7	0.45*
165	2058.0	0.82*
166	2047.1	0.50
167	1959.9	10.03
168	1951.7	16.25
169	1625.9	0.19
170	1610.1	3.16
171	1513.7	0.27
172	1394.7	0.15
173	1327.6	0.92
174	1204.3	0.30
175	1165.0	24.40
176	1131.6	1.61
177	788.0	23.35
178	633.0	0.33
179	609.5	0.23
180	596.0	0.90
181	517.1	27.20
182	436.2	0.90
183	357.6	0.07
184	337.8	0.09
185	325.3	0.17
186	291.9	0.31
187	252.2	0.13
188	197.0	0.41
189	173.8	0.37
190	138.1	0.37

1) Asterisks indicate poor estimate for the intensity due to complex line shapes.
2) Intensities in parentheses have a slight contamination from known 24Na lines.

2. Cascade De-excitation of p-levels in Even-Odd Nuclei with 21≤ A ≤41 after Thermal Neutron Capture.

J.D.Jafar, M.A.Khalil, Fawzia A.H. & A.M.Demidov.

It is observed that the majority of p-levels with a large neutron width $\theta^2(2J + 1)$ also have the largest reduced transition probability (I/E^3) when decaying into the single-particle level 2s1/2 neutron state. However, for 2p1/2 levels and other p-levels higher than $2P_{3/2}$ the largest reduced transition probabilities are observed for de-excitation into the $2p_{3/2}$ state. This enhanced M1 strenght in comparison with E1 transitions, in the decay of p-levels, results from the predeminantly single-particle character of p-states and the relatively simple nature of the M1 transitions involved where only the spin-orbit coupling is affected while the nuclear core undergoes slight re-arrangement. For example, in ^{29}Si the matrix elements of M1 transitions from the 2p1/2 level nearly equals the single-particle estimate, whereas the E1 transition into the 2s1/2 state is only 5.5×10^{-3} of the single-particle value. Table (2) gives the radiation width of p-levels.

Table 2 Radiation Widths of p-levels

Nucleus	Level Energy MeV	Transition Energy MeV	Type of Transition	Experiment		Theory
				eV	W.U	eV
^{29}Si	4.93	4.93	E1	0.52	$6.9.10^{-3}$	75
^{29}Si	6.33	6.33	E1	0.91	$5.5.10^{-3}$	166
^{29}Si	6.33	1.41	M1	0.051	0.9	0.057
^{41}Ca	2.47	0.52	M1	9.10^{-4}	0.35	$2.7.10^{-3}$
^{41}Ca	2.47	2.47	E2	9.10^{-6}	$1.2.10^{-2}$	$7.5.10^{-4}$
^{41}Ca	2.47	0.46	E1	10^{-7}	10^{-3}	$7.5.10^{-2}$

Gamma Rays From Thermal Neutron Capture in Si^{30} & S^{34}

J.D.Jafar, A.A.Abdulla, N.H.Al-Quraishi, M.S.Alwash,
M.A.Khalil & A.M.Demidov.

Gamma radiation from the reactions $Si^{30}(n,\gamma)\ Si^{31}$ and $S^{34}(n,\gamma)\ S^{35}$ was measured with a Ge(Li) spectrometer. All the observed γ-transitions can be placed in the decay schemes of Si^{31} and S^{35} except the 4093 KeV in Si^{31}.

The neutron binding energy is 6588.4 ± and 6986.4 ± 0.3 KeV for Si^{31} and S^{35} respectively.

The γ-ray spectra from thermal-neutron capture in enriched S^{34} reported here, had not been previously measured. And only about two or three of the strongest γ-transitions in Si^{31} and S^{35} have been identified in previous studies of thermal neutron capture in natural targets.

In this work the energies and intensities of γ-transitions in Si^{31} and S^{35} are listed. The decay scheme for S^{35} was constructed, on the basis of energy levels identified in the (d,p) reaction. Primary transitions to the ground or first excited states were not observed.

In table (3), Report Ph-9, 1970, the absolute intensities I_γ and the reduced transition probabilities, I_γ/E^3 are listed for primary M1 transitions feeding 2S1/2 and 1d3/2 one-particle and one-hole states for eight nuclei with odd neutrons in the mass range A=21-41.

Given the ratio of the reduced primary transition Probabilities $\frac{B(M1)}{B(E1)}$. The WeissKof single-particle estimate for this ratio is≈ 0.028 for nuclei with A≈30. This reduction in the transition probability suggests that "Channel capture" is important in these reactions. The partial radiative width should then be proportional to E^2 and not to E^3 as this was predicted by Lane and Lynn, due to the dependance of the transition matrix elements on the level depth relative to the capture state in channel capture. For this reason the partial radiative width was calculated for two cases :

When width is assumed to be proportional to E^3 and to E^2 respectively. Table 4, Report Ph-9, 1970; gives the ratio of reduced transition probabilities feeding $2P_{3/2}$ and $2P_{1/2}$ levels.

It may be concluded that this data lends further support to the importance of the channel capture mechanism in the processes under consideration.

Tables (5,6) gives the energies and their intensities for both reactions.

Table 3

INTENSITY & RELATIVE PROBABILITY OF M1 TRANSITION FROM THE CAPTURE STATE TO 1d $\pm_{3/2}$ & 2S $\pm_{1/2}$ LEVELS

Primary transition to $1d_{3/2}$ or $1d^{-1}_{3/2}$ state				Primary transition to $2S_{1/2}$ or $2s^{-1}_{1/2}$ state			
Nucleus	E_x (MeV)	I_γ %	$\frac{B(M1;\ 1/2^+ \rightarrow 3/2^+)}{B(E1;\ 1/2^+ \rightarrow 3/2^+)}$ %	E_x (MeV)	I_γ %	$\frac{B(M1;\ 1/2^+ \rightarrow 1/2^+)}{B(E1;\ 1/2^+ \rightarrow 3/2^-)}$ %	B_n (MeV)
^{21}Ne				2.79	3.1	0.33	
^{25}Mg	0.976	0.4	0.6	0.584	1.8	0.12	7.33
^{29}Si	1.273	8	1.3	0	2.4	0.25	8.48
^{31}Si	0	1	0.14	0.752	<0.4	<0.08	6.59
^{33}S	0	2.3	1.1	0.842	3.8	2.25	8.64
^{35}S	0	<0.1	<0.05	1.572	<1.6	<1.8	6.99
^{37}Ar	0	10.1	1.4	1.410			8.79
^{41}Ca	2.01	1.0	2.7	2.571	2.2	10	8.36

Average = 1.0

Average = 2.1

Average without ^{41}Ca = 0.8

Table 4

RATIOS OF REDUCED TRANSITION

PROBABILITIES FEEDING $2P_{3/2}$ AND $2P_{1/2}$ LEVELS

Nucleus	$\dfrac{(I_\gamma / E_\gamma^3)\ 2P_{1/2}}{(I_\gamma / E_\gamma^3)\ 2P_{3/2}}$	$\dfrac{(I_\gamma / E_\gamma^2)\ 2P_{1/2}}{(I_\gamma / E_\gamma^2)\ 2P_{3/2}}$
^{29}Si	1.5	0.86
^{31}Si	3.0	1.26
^{33}S	1.7	0.9
^{35}S	3.1	1.3
^{37}Ar	1.8	1.05
^{41}Ca	2.0	1.2

TABLE 5

GAMMA RAYS FROM THE $^{30}Si\ (n,\gamma)\ ^{31}Si$ REACTION

This work			Beard et al.[1]	
$E_\gamma^{a)}$ (KeV)	$E_R^{b)}$ (KeV)	Intensity $^{c)}$	E (KeV)	Intensity
752.44 ± 0.15	0.01	100	753.0 ± 1.0	1.1
1306.1 ± 0.3	0.03	18	1307 ± 2	0.081
1695.6 ± 0.5	0.05	2.3	1694.8 ± 1.0	0.032
1837.3 ± 0.8	0.07	2.6		
2204.6 ± 0.8	0.08	12	2206.9 ± 0.6	0.11
2316.7 ± 1.0	0.09	2.8		
2781.1 ± 0.15	0.13	66	2781.0 ± 0.2	0.77
3054.76 ± 0.16	0.16	71	3055.0 ± 0.4	0.73
3534 ± 1.0	0.22	≃5	3534.0 ± 1.0	0.022
3630.7 ± 0.4	0.23	6.3	3630.2 ± 0.3	0.076
4382 ± 2	0.33	1.7	4381.5 ± 0.4	0.018
4529.3 ± 0.3	0.36	14	4528.3 ± 0.2	0.13
4903 ± 1	0.42	<1.0	(4902)	<0.007
6587.6 ± 0.8	0.8	1.1	6588.7 ± 0.4	0.018

a) Except for the 4903 KeV, all the γ-rays listed have been included in the level scheme for ^{31}Si.

b) E_R is the recoil-energy correction.

c) Number of γ-rays per 100 neutron captures in ^{30}Si.

TABLE 6

GAMMA RAYS FROM THE $^{34}S\,(n,\gamma)\,^{35}S$ REACTION

E_{γ} [a] (KeV)	E_R [b] (KeV)	Intensity [c]
646.9 ± 0.5	0.00	0.7
775.5 ± 0.15	0.00	19.5
908.1 ± 0.3	0.01	0.5
1572.15 ± 0.1	0.03	39
1839 ± 1	0.05	3.6
2022.8 ± 0.2	0.06	12
2082.65 ± 0.1	0.06	18
2347.5 ± 0.1	0.08	54
2555.9 ± 0.4	0.09	3.4
2614.3 ± 0.3	0.10	1.3
2796.6 ± 0.5	0.11	6.1
3184.3 ± 0.2	0.15	7
3331.08 ± 0.15	0.16	7.8
3390.86 ± 0.2	0.17	5.5
3802 ± 0.3	0.21	3.6
4189.6 ± 0.3	0.26	1.9
4268.4 ± 0.7	0.27	0.4
4638.4 ± 0.2	0.32	56
4903.4 ± 0.3	0.36	3.2
4963.2 ± 0.5	0.37	2.6
6078.2 ± 1.0	0.50	0.3

a) All the γ-rays listed have been included in the level scheme for ^{35}S .

b) E_R is the recoil-energy correction.

c) Number of γ-rays per 100 neutron capture in ^{34}S.

<u>Gamma Rays from Thermal Neutron Capture in Se^{75}, Se^{78}, Se^{81}, Mo^{97}, Mo^{99} and Mo^{101}.</u>

M.A.Khalil, M.R.Ahmed, S.A.Al-Najar,
A.M.Demidov, F.A.Hussian & Kh.I.Shakarchi.

The study of Se^{75}, Se^{78}, Se^{81}, Mo^{97}, Mo^{99} and Mo^{101} decay schemes by the thermal neutron capture method carried out by utilizing Ge(Li) detector and 4096 channel analyzer and the channel No: 1 on the (IRT-2000). The isotopes of Se^{78}, Se^{81}, Mo^{97}, Mo^{99} were studied before by other groups, but not accurately. Their intent was to study the low and high energy portions of the spectra, i.e. below 3MeV and above 6MeV. That portion of the spectrum lying between 3 and 6 MeV was not studied before because of the difficulties that usually arise in analysing the spectrum associated with the overlapping of photopeaks with single and double escape peaks. The great complexity of the spectrum in the medium energy range above the pair production threshold causes many ambiguities in identifying the "pure" photopeaks and furthermore misinterpretation of the experimental results. More than 50 new γ-lines were found from the results of our experiments & we introduction about 20 new levels in the decay scheme. Also we determined the binding energy values and the intensity of all γ-transitions observed. The decay scheme for each of Se^{75}, Se^{78}, Se^{81}, Mo^{97}, Mo^{99} & Mo^{101} isotopes were constructed. The spectrum calibration utilizing Cl, Si for calibration the standard sources ^{36}Cl, ^{29}Si, ^{203}Hg, ^{137}Cs, ^{60}Co, ^{57}Co & ^{22}Na were used, . Gain and Zero stabilization techniques were employed and the overall spectral resolution (FWHM) over 24 hours was approximately 3.5 KeV for E=1MeV and 8KeV at E=7 MeV. The IBM-1130 computer at the Engineering College was utilized for sorting out the decay schemes and calculating the energy levels for each isotope.

To simplify the techniques of sloving the problems of mixing between the peaks in the spectrum of Se and Mo isotopes pair spectrometer can be employed. This technique attenuate the contribution of γ-energies which are not created by pair production. This method was not employed because of the lack of material and the very small cross sections of Se and Mo isotopes.

Fast Neutron Inelastic Scattering Facility at the IRT-2000.

A.A.Abdulla, M.R.Ahmed, S.A.Al-Najar, M.A.Al-Amily
Kh.I.Shakarchi.

Inelastic Scattering of Fast Neutrons :-

The nuclear physics group planned to study the feasibility of the inelastic scattering of fast neutrons using neutron filters for the reduction of capture reactions. Using an extracted beam and Ge(Li) detector we expect that gamma-ray de-excitation, following neutron inelastic scattering, can be readily identified, and that such type of nuclear reactions provided by pile neutrons will involve a large amount of separated isotopes, available at this time.

Introduction :-

In this field of research only two experiments were done: The first by Donahue in 1961 who used an extracted beam and NaI(Tl) detector in angular correlation measurements. The second by Nichole and Kennet (1971), who used Ge(Li) detectors for studying in-core inelastic scattering experiments. They also used neutron filters.

It was decided here to provide such experiments using 30cc coaxial Ge(Li) detector and 4096 channel analyzer, and the channel number (8) was chosen for this purpose.

Filters :

0.5mm Cd, 40mm Pb and 10mm B_4C filters, Pb stainless steel collimators were installed into the channel gate and the extracted beam was of the same dimension of the last collimator (about 25mm). The beam was allowed to pass through series of filters outside the channel gate to achieve further exclusion of the thermal & resonance components. These filters were made of B_4C and Cd plates of different thicknesses, taking into consideration that other materials such as paraffine and lead may also be used as filters. The filter-box and collimator 20mm in diameter which was used to collimate the filtered beam, were enclosed together inside a "Shielding block" made in the form of an iron container filled with paraffine and heavily loaded with iron and adjacently placed to the reactor wall. The filter-box together with the steel box plugged in, which was filled with paraffin and iron as a continuation of the shielding block, was equipped with a pulley to make possible the process of changing the different filters under investigation.

Set-up of the facility :

The detector shielding assembly was made of three layers 5cm Fe, 8cm paraffin with B_4C and 10cm Pb. A cylinder of LiH 20mm in diameter and 10cm in lenght was plugged into the hole made in the detector shield to project additionally the detector crystal against the scattered fast neutrons.

Calculations :

Calculations were carried out to determine the expected distribution of the neutron spectrum after transmission through different filters of different thicknesses. Also the rise of the temperature in the first filter exposed to neutrons and gamma-rays was calculated.

Primary Results :

More than 30 γ-rays due to $Nb^{93}(n,n'\gamma)Nb^{93}$ reaction were detected and related to the excitation of the energy levels : (743.9), (808.5), (978.8), (1082.5), (1296.7), (1485), (1501), (1684.6), (1911.5), (1968.4) (KeV).

The Solid State Group activities within the Physics Department of Nuclear Research Institute - Iraqi Atomic Energy Commission for The years 1970 - 1971

The solid State Group is equipped with a 4-circle Neutron diffractometer and a 4-circle X-Ray diffractometer.

The main work which has been done and carried out so far could be summarised as :

1. After finishing the commissioning and bringing the Neutron diffractometer into working condition. The immediate work carried out was testing of all systems of the N.D. (Monochromator, detection system, and programming control system). The work include measuring of the :-

   a- Rocking curves of the monochromator at different Bragg angles.

   b- Stability and plateau of the two detection systems (monitor and main channels).

   c- Automatic operation and reproducibility.

2. The evaluation of the various diffractometer parameters for the powder diffractometry. A Nickle powder has been used as a standard sample. The whole pattern of Nickle is registered for different collimation conditions in order to determine the resolution and intensity by using different soller slits collimators. Effects of fuel elements arrangements on flux in horizental channel No. 6 were determined.

3. Three powder samples of MgO isotopes ($Mg^{24}O$, $Mg^{25}O$, $Mg^{26}O$) has been investigated in order to evaluate the scattering cross section of each isotopes seperately. In addition to these three isotopes, MgO natural has been investigated also. This study has been shown that the diffraction maximum intensities with odd Millers's indices are significantly less than these with even indices. This indicates that the sign of the coherent scattering amplitudes are positive. The values at the wavelength $\lambda=1.02$ Å are : $b^{24}Mg=0.547 \pm 0.018$, $b^{25}Mg=0.362 \pm 0.014$, $b^{26}Mg=0.489 \pm 0.015$. And thus the values for the natural mixture of magnesium isotopes will be equal to 0.523 ± 0.017, which is in good agreement with formerly measured values.

At present the Solid State group is engaged in determining the thermal neutron spectrum of the horizental channel (no.6) using the Lead Siggle Crystal which is mounted in the Neutron diffractometer as monochromator.

Expansion of this unit will be in the direction of the Magnetic structure studies which will be materialised by the installation of a cryostat and magnet and therefore extending the work to a temperature at or even below the temperature of liquid helium (4.2°K).

X-Ray Diffraction :

Since the commissioning of the Hilger and Watts single crystal diffractometer, the intention has been to carry our work complementary to the Neutron diffraction. This was materialised in determining the percentage of $Mg(OH)_2$ in the three isotopes of MgO, $Mg^{24}O$, $Mg^{25}O$, $Mg^{26}O$ by quantitative X-Ray diffraction phase analysis. The direct method suggested by Alexander and Klug with some modification which were later used to study their coherent amplitude scattering by neutron diffraction.

Amongst the work that was carried out by this group is the evalution of the various diffractometer parameters and also the application of quantitative phase analysis to metallic and Inorganic materials.

At present, preliminary studies are being made to make use of the diffractometer in the calculation of absorption coefficients from metallic spherical and cylenderical single crystals. Future plans include the extension of quantitive phase analysis to ternary and quaternary systems and also the application of X-rays in particle size determination of powders and colloidal solutions.

Expansion of this unit will be materialised by the installation of a second X-Ray generator with vertical tube stand, this generator will provide stable X-Ray to many cameras that are available both in the chemistry and physics department.

The Activation Analysis Group activities within the Physics Department of Nuclear Research Institue - Iraqi Atomic Energy Commission for the years 1970 - 1971

The activation analysis laboratory is well-equipped to handle bothároution analysis & research work. The equipment presently includes 30cc Ge(Li) detector, 2048-channel analyser, fast pneumatic transport system, and a number of NaI detectors and counting systems.

Research contines to occupy the major portion of the available operation time of the measuring facilities in this group. A variety of research projects were undertaken in the last year, and some of them have been brought to a sussessful conclusion while others are at the developmental stages. Abstracts of the published papers are included in Section B.

A. Services

The group also performs a number of service analyses for the other departments of the Institute and for outside agencies. During the last year the group analysed over 1,300 service samples for the following :

1- Dept. of Geology,
Dept. of Chemistry,
Dept. of Isotope Production
of the Nuclear Research Institute.

2- National Minerals Company,
Dora Oil Refineries,
Dept. of Geological Survey,
University of Baghdad,
and the Army Chemical Laboratories.

B. Research

Below is a list of the research projects completed during the last year or in progress :

Completed :

1- " The activation analysis of uranium and thorium and their mixtures by delayed neutron detection method. " by E.T.George, G.I.Barisov, G.Y.Al-Shahery and M.Al-Abbasi.

The analysis of fissile isotopes of ^{235}U, and ^{232}Th were carried out in the IRT-2000 reactor using delayed neutron detection technique. An automatic vaccum pneumatic transporter was used with two channels of irradiation: bare and cadmium covered. Pressurized ^{3}He detector was used for neutron counting.

The results of the quantitative determination of uranium in several reference samples (IAEA standards) and the limit of sensitivity of the method are presented.

Two methods of the quantitative determination of fissile elements in two component mixtures (with known and unknown total mass of fissile elements) are described. For a mixture of ^{235}U and ^{238}U the range of the determined weight ratios of ^{235}U and ^{238}U under both methods is found. For a mixture of U_{nat} and Th the range of the weight ratios of U_{nat} and Th under their unknown total mass is found, as well as the limit of sensitivity of the method for thorium under the zero content of uranium.

2- "Determination of trace elements in Iraqi crude oils via NAA". by Hussain Al-Shahristani and M.Al-Atyia.

The trace elemental composition of crude oil from the various Iraqi oil fields has been studied. The instrumental neutron activation analysis technique was used. The method neither requires chemical separation nor pre-or post-concentration of trace elements by ashing. High resolution Ge(Li) detector permitted the simultaneous multi-elemental determination of V, Al, Mn, and Na.

The vanadium concentrations remained quite constant within the same reservoir but varied remarkably among reservoirs of different geological ages. The vanadium concentration ranged from 1.6-109 ppm. Manganese generally followed the same trend as vanadium with its concentration varying from less than 0.15 to 1.6 ppm. Sodium and aluminum concentrations varied from one sample to another even within the same reservoir. Concentrations ranged from 5-55 ppm and from less than 25-1050 ppm for aluminum and sodium respectively.

3- "Determination of some elements in the sediments of Iraqi rivers by NAA" by E.T.George and M.J.Al-Atyia.

In this work many sediment samples from the Iraqi rivers were analyzed for geological purposes, using INAA. The γ-rays were detected and analyzed using a high-resolution 30 cm^3 Ge(Li) detector and ND-2048 channel analyzer. The elements determined are: Na, Mg, Al, Ca, Ti, V, Mn, Sc & Hf.

Using 3 sec. irradiation, 20 sec. delay and 10 sec. counting Sc and Hf were successfully determined by their isotopes ^{46m}Sc ($T_{1/2}$=20 sec.) & ^{179m}Hf ($T_{1/2}$=19 sec.)

The method used in this analysis was simple, non-destructive, fast and quite sensitive.

4- "Vertical Migration of oil in the Northern Iraqi oil fields; vanadium concentration evidence".

by Hussain Al-Shahristani and M. J. Al-Atyia.

A study was made to determine the vanadium concentration in oil samples representing the various pay horizons of all the Iraqi Oil fields. Variations of vanadium content of oils from different pays were measured to establish the history of migration and accumulation of these oils. The vanadium content of oil from different fields varies drastically from 1.6 to 109 ppm whereas the vanadium content of oils drawn from different wells in the same pay is remarkably constant. In the Kirkuk field, oil from Lower/Middle Cretaceous reservoirs contains 45 ppm V compared to

26 ppm V for oil from the overlying Oligocene/Lower Miocene reservoirs. In the Zubair field, oils from the second, third and fourth pays contain 57, 15 and 2 ppm V respectively.

The path of migration of oil in the northern Iraq oil fields is clearly reflected by the vanadium concentration variation. The results indicate that oil in Northern Iraq originated during the Lower/Middle Cretaceous, and has migrated vertically to the Tertiary reservoirs where it is found now.

5- "Determination of Uranium Content in Geological Samples by Neutron Activation". by M.R.Ahmed, A.A.Abdulla and G.Y.Al-Shahery.

Samples were irradiated in the IRT-2000 research reactor at the Nuclear Research Centre. The decay rate of $^{239}Np \rightarrow ^{239}Pu$ was measured and compared with a standard of known uranium content. Two techniques were applied; in the first method a Ge(Li) γ-ray spectrometer of high resolution was used to measure the γ-ray spectrum from this decay. In the second scintillation counters were placed in coincidence for detecting two-step cascade γ-rays from the same decay. The results from both techniques were in satisfactory agreement.

6- "Measurement of Neutron and Gamma field Parameters on Irradiation Position of Vacuum Pneumatic Transporter System".

by E.T.George, G.I.Borisov, G.Y.Al-Shahery, M.A.Al-Abbasi, O.K.Zhuravlev.

A system of vacuum pneumatic transporters was assembled and the tubes inserted into the IRT-2000 reactor through a horizontal channel. The system is described in short, listing basic technical characteristics. Given are the data of the measurements of neutron and gamma field parameters on the irradiation positions of the pneumatic transporters.

In Progress :

7- "Determination of Arsenic in Iraq tobacco via NAA",

by H.Al-Shahristani and A. Romaya.

Two methods are under development to measure exceedingly small quantities of arsenic in tobacco samples.

The first involves chemical separation and the second is instrumental using coincidence technique.

8- "Investigation of some problems of spectral interferences when analyzing geological samples",

by E.T.George and M.Al-Atyia

During the measurement of activated geological samples, a number of compound peaks are observed. This study has been undertaken to resolve these peaks and particularly the 511 KeV.

9- "Determination of cadmium in foods",

by H.Al-Shahristani and S.Is'hac

A technique is being developed to determine cadmium concentrations in local foods. Cadmium is initially absorbed on anion exchange resins and its radioactive indium daughter-product is washed away and counted.

10- "Determination of elements with very short half lives produced by (n,γ) and (n,n') reactions",

by H.Al-Shahristani, E.T.George, M.Al-Atyia and K.Abbas.

Radioactive elements with half-lives ranging from sub-second to few seconds are being investigated using a fast pneumatic transport system and synchronised counting facility.