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POSSIBILITY OF ELECTRON CAPTURED BY DEUTERON

Zhong–Liang Zhang and Wu–Shou Zhang

Institute of Chemistry, Chinese Academy of Sciences, P.O. Box 2709, Beijing 100080, China

ABSTRACT

In this work, the results about deuteron capturing electron are obtained from some calculation according to the experimental data presented in "NUCLEAR WALLET CARDS" [1]. The half–life of such electron capture decay is about 1.04×10^{11} y, which is almost as same as $t_{1/2} = 1.28 \times 10^9$ year of K^{40}, the $t_{1/2} = 1.3 \times 10^{13}$ year of Te^{123} and $t_{1/2} = 1.4 \times 10^{17}$ year of V^{50} shown in that "CARDS". The mass defect of this process is $6.694207691 \times 10^{-5}$ u. The mass of dineutron, or "neutro-deuteron" ${}_0X_2^2$ here is 2.01403513 u.

1. INTRODUCTION

Until now, it has not observed definitively a phenomenon of electron captured by a deuteron to be dineutron in experiments. However, The two–neutron ("n–n coincidence measurements") radioactivity was first observed from beta–delayed particle emission measuring by Azuma et al. in 1979 [2]. We guess there may be a possibility of electron captured by deuteron according to our results [3–4]. It was often found a voltage drop accompanying always "anomalous heat" to come out during our experimental of the electrolysis of D_2O before [4]. May these voltage drops show such phenomena of electron capture? We did some investigation in this field [4]. On the other hand, Yang also reported similar results before [5].

2. THE RELATIONSHIP BETWEEN HALF–LIFE (OR MASS DEFECT) AND ATOMIC NUMBER (Z)

For results about deuteron capturing electron, investigation and some related calculating with the experimental data presented in "NUCLEAR WALLET CARDS" [1] will be done in this work. It can be found easily that the electron capture process is always generated with the most of those nuclides, which are on proton rich side, shown in the "CARDS". Moreover, The half-lives of those nuclides increase with the number of neutron in an isotope.

We table values on the electron capture of nuclides using below relations

$$\ln t_{1/2} = a + b \cdot Z$$

$$\Delta E = {}^{A}_{Z}X_{N} - {}^{A}_{Z-1}X_{N} \quad (\text{MeV})$$

in Tables I to IX.

Table I. The mass defect and the relationship between half–life and atomic number of the nuclide with 3 neutrons

	N	*A*	*Z*	$t_{1/2}$/s	$\ln t_{1/2}$	*a*	*b*	*r*	ΔE/MeV
He	3	5	2	No (?)					?
Li	3	6	3	No (stable)					?
Be	3	7	4	4.604×10^6	15.342	47.854	–8.703	–0.909	15.769–14.908 = 0.861
B	3	8	5	0.77	–0.261				22.921– 4.942 = 17.979
C	3	9	6	0.127	–2.064				28.914–12.416 = 16.498
N	3	10	7						?

We try to use other functions as shown below; they are not as suitable as above formula.

formula	r	a	b
$\ln t_{1/2} = a + b/Z$	0.951	–40.270	217.02
$\ln t_{1/2} = a + b/Z^2$	0.966	–18.467	525.17
$t_{1/2} = a + b\cdot Z^2$	–0.836	7.227×10^6	-2.218×10^5
$t_{1/2} = a + b\cdot Z$	–0.866	1.304×10^7	-2.302×10^6
$t_{1/2} = a + b/Z$	0.918	-1.042×10^7	5.816×10^7
$t_{1/2} = a + b/Z^2$	0.938	-4.612×10^6	1.455×10^6

Form the above results, one can find that the $\ln t_{1/2} = a + bZ$ relation is very simple. Taking the relation should be convenient for us to treat them as below.

Table II. The mass defect and the relationship between half–life and atomic number of the nuclide with 4 neutrons

	N	A	Z	$t_{1/2}$/s	$\ln t_{1/2}$	a	b	r	ΔE/MeV
B	4	9	5	No (p, 2α)					12.416–11.348=1.068
C	4	10	6	19.255 s	0.655				20.39 –12.051=8.339
N	4	11	7	No (p)					25.3–10.651 =25.3
O	4	12	8	No (p)					32.05–17.338=14.712

Table III. The mass defect and the relationship between half–life and atomic number of the nuclide with 5 neutrons

	N	A	Z	$t_{1/2}$/s	$\ln t_{1/2}$	a	b	r	ΔE/MeV
C	5	11	6	1,223	7.109	40.666	–5.910	–0.873	10.651–8.668=1.983
N	5	12	7	0.011	–4.510				17.338–0.000=17.338
O	5	13	8	0.0089	–4.711				23.111–5.345=17.766
F	5	14	9	(?)					33.6–8.007=25.593

Table IV. The mass defect and the relationship between half–life and atomic number of the nuclide with 6 neutrons

	N	A	Z	$t_{1/2}$/s	$\ln t_{1/2}$	a	b	r	ΔE/MeV
N	6	13	7	59.79	6.393	21.345	–2.136	–1	5.345–3.125=2.220
O	6	14	8	70.606	4.257				8.007–2.863=5.144
F	6	15	9	No (p)					16.8 – 2.855=13.945
Ne	6	16	10	No (2p)					23.99 – 10.680=13.31

Table V. The mass defect and the relationship between half–life and atomic number of the nuclide with 7 neutrons

	N	A	Z	$t_{1/2}$/s	$\ln t_{1/2}$	a	b	r	ΔE/MeV
O	7	15	8	122.245s	4.806	32.894	–3.511	–1	2.855–0.101=2.754
F	7	16	9	No (p)					10.68–(–4.737)=15.417
Ne	7	17	10	0.109	–2.216				16.49–1.952=14.538
Na	7	18	11	No (p)					25.3–5.307=19.993

Table VI. The mass defect and the relationship between half–life and atomic number of the nuclide with 8 neutrons

	N	A	Z	$t_{1/2}$/s	$\ln t_{1/2}$	a	b	r	ΔE/MeV
F	8	17	9	64.49	4.167	19.005	–1.750	–0.978	1.952–(–0.809)=2.761
Ne	8	18	10	1.672	0.514				5.307–1.952 =3.355
Na	8	19	11	No (p)					12.93–1.751 =11.179
Mg	8	20	12	0.1	–2.303				17.57–6.845=10.725
Al	8	21	13						26.1 – 10.91=15.19
Si	8	22	14	0.006	–5.116				32.2 – 18.18=14.02

Table VII. The mass excess and the relationship between half–life and atomic number of the nuclide with 9 neutrons

	N	*A*	*Z*	$t_{1/2}$/s	ln$t_{1/2}$	*a*	*b*	*r*	Δ *E*/MeV
F	9	18	9	6,586	8.793	31.853	–2.785	–0.927	0.873–(–0.782)=1.655
Ne	9	19	10	17.22	2.846				1.751–(–1.487)=3.238
Na	9	20	11	0.446	–0.807				6.845–(–7.042)=13.887
Mg	9	21	12	0.122	–2.104				10.91–(–2.184)=13.094
Al	9	22	13	0.07	–2.659				18.18–(–0.397)=18.577
Si	9	23	14	0.0002(?)					23.80 – (6.77) =17.030

Table VIII. The mass excess and the relationship between half–life and atomic number of the nuclide with 10 neutrons

	N	*A*	*Z*	$t_{1/2}$/s	ln$t_{1/2}$	*a*	*b*	*r*	Δ *E*/MeV
Na	10	21	11	22.48	3.113	23.223	–1.829	–0.998	–2.184–(–5.732)=3.548
Mg	10	22	12	3.857	1.350				–0.397–(–5.182)=4.785
Al	10	23	13	0.47	–0.755				6.77–(–5.473)=12.243
Si	10	24	14	0.102	–2.283				10.75–(–0.055)=10.805
P	10	25	15	No (p)					18.9– 3.83 =15.070

We stop these treatments at isotopes with more than 10 neutrons. The parameters related the half-lives are summarized in Table IX.

Table IX. The relationship between ln$t_{1/2}$ and Z of the nuclides (*N* = 3 to 9)

N	*r*	*a*	*b*
3	–0.909	47.85	–8.07
5	–0.873	40.67	–5.91
7	∼– 1	32.89	–3.51
9	–0.927	31.85	–2.79

Table X. The relationship between N and the mass defect of nuclides (*N* = 3, 5, 7, 9, 11 and 13) generating electron capture

Name	N	A	Z	M/u	Name	N	A	Z	M / u	ΔM /u
Be	3	7	4	7.0169276	Li	4	7	3	7.0160033	0.000924
B	3	8	5	8.0246056	Be	4	8	4	8.0053044	0.019301
C	5	11	6	11.0114332	B	6	11	5	11.0093055	0.002128
N	5	12	7	12.0186131	C	6	12	6	12.0000000	0.018613
O	7	15	8	15.0030650	N	8	15	7	15.0001084	0.002966
F	9	18	9	18.0009372	O	10	18	8	17.99916049	0.0017767
Ne	9	19	10	19.0018798	F	10	19	9	18.99840364	0.0034762
Na	9	20	11	20.007342	Ne	10	20	10	19.9924347	0.0149073
Na	11	22	11	21.9944337	Ne	12	22	10	21.9913827	0.0030510
Mg	11	23	12	22.99412449	Na	12	23	11	22.9897670	0.0043575
Al	11	24	13	23.99994096	Mg	12	24	12	23.98504231	0.0148986
Al	13	26	13	25.9868920	Mg	14	26	12	25.9825936	0.0042984
Si	13	27	14	26.98670416	Al	14	27	23	26.98153827	0.0051659
P	13	28	15	27.9923124	Si	14	28	14	27.9769274	0.0153850

Table XI. The relationship between mass defect and Z of nuclides with odd number of neutron: $\Delta M = A_1+B_1\exp(C_1A)$

Name	N	A	Z	ΔM /u	A_1	B_1	C_1
Be	3	7	4	0.000924	0.00005	7.6728×10^{-13}	2.99308
B	3	8	5	0.019301			
C	5	11	6	0.002128	0.00044	7.3487×10^{-15}	2.37802
N	5	12	7	0.018613			
O	7	15	8	0.002966			
F	9	18	9	0.0017767	0.00093	3.4852×10^{-18}	1.80923
Ne	9	19	10	0.0034782			
Na	9	20	11	0.0149073			
Na	11	22	11	0.0030510	0.00189	1.7669×10^{-19}	1.62657
Mg	11	23	12	0.0043575			
Al	11	24	13	0.0178986			
Al	13	26	13	0.0042984	0.00332	5.0151×10^{-22}	1.59349
Si	13	27	14	0.0051659			
P	13	28	15	0.0153850			

The parameters related the mass defect are summarized in Table XII.

Table XII. The relationship between A_1 (B_1, or ln B_1 C_1) and N

	a	b	c	d
$A_1 = a + b\exp(cN)$	–0.00004	0.00008	0.28918	
$\ln B_1 = a + bN$	–21.97288	–2.02434		
$C_1 = a + b\exp((c–N)/d)$	1.45782	1.5349	3	3.92824

3. RESULTS AND DISCUSSION

As shown above, it is very clear that the electron capture processes generated with the most of those nuclides are on proton rich side, and the half-lives of those nuclides increase with the number of neutron for an isotope and the process generates more easily with odd number than even number of neutron. Furthermore, a proton in a nucleon can easily capture an electron, but for a free proton, it is very difficult to take such process. According to the parameters shown above, the final results were obtained as below:

1. The calculated half–life of electron capture of deuteron from Table IX can be expressed as:

$a = A + B \times N$ with $A = 55.049$, $B = –2.789$ and $R = –0.963$

$b = A' + B' \times N$ with $A' = –10.542$ $B' = 0.912$ and $R = 0.980$

When $N = 1$ and then $a_{N=1} = 52.260$, $b_{N=1} = –9.630$

Therefore:

$$\ln t_{1/2} = a_{\mathrm{N=1}} + b_{\mathrm{N=1}} \times 1 = 52.260 – 9.630 = 42.630$$

and

$$t_{1/2} = 3.27 \times 10^{18}\ \mathrm{s} = 1.04 \times 10^{11}\mathrm{y}$$

2. The calculated mass defect during the capturing electron by deuteron from Table XII:

When $N = 1$, $A = 2$ for deuteron and then $A_{1,\mathrm{N=1}} = 6.682656532 \times 10^{-5}$, $B_{1,\mathrm{N=1}} = 3.78564402 \times 10^{-11}$, $C_{1,\mathrm{N=1}} = 4.011662515$, so:

$$\Delta \mathrm{M} = \mathrm{A1}_{\mathrm{N=1}} + \mathrm{B1}_{\mathrm{N=1}} \times \exp(\mathrm{C1}_{\mathrm{N=1}} \times \mathrm{A}) = 6.694207691 \times 10^{-5}\ \mathrm{u}\ ,$$

Therefore, if $A = 2$, $Z = 1$, it implies that there is the electron captured by deuteron and the mass defect ΔM is $6.694207691 \times 10^{-5}$ u. It means that the ${}_{1}H_{1}^{2}$ mass is 2.014102072 u, and the ${}_{0}X_{2}^{2}$ mass is 2.01403513 u. It seems that the dineutron, or the "neutro-deuteron" ${}_{0}X_{2}^{2}$ mass is 2.01112411 u if its value is not quite right according to our treatments reported [3]. The results above should be verified further with more measurements on it.

The half–life of such electron capture decay is about 1.04×10^{11} y, which is almost as the same as $t_{1/2}$ =1.28

$\times 10^9$ year of K^{40}, the $t_{1/2}$ =1.3 × 10^{13} year of Te^{123} and $t_{1/2}$ =1.4 × 10^{17} year of V^{50} shown in that "CARDS". The mass defect of this process is 6.694207691 × 10^{-5} u. The mass of dineutron, or "neutro-deuteron" ${}_0X_2^2$ here is 2.01403513 u.

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