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CODEN (USA): JCBPAT **Research Article**

Calculation of the Reduced Transition Probabilities M (E2) for even-even Tungsten nuclide ($_{74}$W)(A=180-186)

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Abstract: In the present work, By using the half life time for (W – 74) isotopes for even-even from Ferston we calculated the electric quadruple transition and find the relation between number of neutron and M (E2) $|^{2}_{w.u}\downarrow$ for gamma ray from 2^+ to 0^+ .By using MATLAB program we find empirical formula for these relation and compare these data with global. The calculated reduced transition probabilities B (E2) e2b2 ↑ values are compared with that of experimental and theoretical predications for $_{74}$W nuclide listed and plotted and compares with SSANM and FRDM and with Experimental values of Global.

Keyword: The electric quadruple transition, reduced transition probabilities B (E2)e2b2↑

INTRODUCTION

The Gamma Ray Transition: Gamma-ray is the electromagnetic of radiation common of an isomeric transition from upper energy state of the nucleus to the lower energy by emission .For γ-transition from initial state of total angular momentum J_i and parity π_i [1]to a final state of total angular momentum J_f and parity π_f, the transition by emission of a single 2^L-pole quantum is possible if[1]

$$|J_i-J_f| \leq L \leq J_i + J_f \quad (1)$$

for L≠0

Where L is the angular momentum of the γ-transition which is defined as a multipolarity[3]. In such transition, the parity change of electric radiation (EL) is given by

$$\pi_i \pi_f=(-1)^L \quad (2)$$

The theoretical life time of γ-ray transition can be compared with the experimental value to obtain reduced transition probability, i.e.

$$Reduced\ transition\ probability = \frac{\mathrm{T_{th}}}{T_{exp}} \quad (3)$$

$$\mathrm{T} = \frac{1}{\tau} \quad (4)$$

Where T is defined as the transition probability, the half-life time $t_{1/2}$ and mean life time T are related by the following relation[5]

$$\mathrm{t_{1/2}} = \mathrm{T\ ln2} \quad (5)$$

To calculated the electric quadruple transition strengths $|M\ (E2)\ |^2_{w.u}\downarrow$ for gamma ray from 2^+ to 0^+ have been calculated by using Ferston[5] to get half-life for first exited state as follow:

$\tau = t_{1/2}\ \ln(2)$ where τ is mean life time

The total width for gamma decay is given by[6]:

$$\Gamma_\gamma = \sum \Gamma_{\Gamma 1} \quad (6)$$

Where $\Gamma_\gamma \tau \approx \hbar = 0.658212\mathrm{x}10^{-15}$ eV.S (7)

The gamma ray transition strength $|M\ (E2)\ |^2$ is defined as[7]

$$|M\ (E2)\ |^2 = \frac{\Gamma\gamma}{\Gamma\gamma w.u.} \quad (8)$$

Where $\Gamma\ (E2)_{w.u.}$ the Weisskopf single –particle widths

Theoretical predictions: The relation between the reduced transition probabilities,

B (EL) ↓ = B (EL, 2→1) and B (EL) ↑ = B (EL, 1→2), is given by[7]:

$$B\ (EL)\downarrow = \frac{2J_1+1}{2J_2+1} B\ (EL)\uparrow \quad (9)$$

The best theoretical models to calculate B (E2) ↑ are:

a- Single-Shell Asymptotic Nilsson Model SSANM one of the simplest theoretical model for understanding B(E2)↑ , which is based on assuming the nucleus as deformed as it can be in a single shell .This model has been discussed in detail in ref.[8] where the B(E2)↑ values in units of e^2b^2 are given by :

$$B\ (E2)\uparrow = \frac{5}{16\tau} [e^2Q_0]^2 \quad (10)$$

$(Q_0 \neq 0)$

Where Q_0 is the intrinsic quadrupole momentum[2].

b- Finite –Range Droplet Model (FRDM): in the (FRDM)[6] the nuclear ground state shapes are calculated by minimizing the nuclear potential energy function with respect to ε_2, ε_3, ε_4 and ε_6 shape degree of freedom. More details about this model are in ref.[9]. The B (E2) values are basic experimental quantities that do not depend on nuclear models[9]. This (Weisskopf) single-particle B (E2) ↑ value is given by[6]

$$B\ (E2)\uparrow = 2.6E^{-1}Z^2A^{-2/3} \quad (11)$$

RESULT AND DISCUSSIONS

By using half-life ($t_{1/2}$) ,energy of first excited state and γ_o-energy from Ferston[3].we calculated the electric quadrupole transition strengths $|M(E2)|^2_{w.u}\downarrow$ for γ_o-transition as a function of neutron number (N) for even nuclei of isotopic (106-112) for Tungsten ($_{74}W$) the results of calculations of mean life (τ) , the total width for gamma decay (Γ_γ) ,gamma Weisskopf ($\Gamma_{w.u.}$) and $|M(E2)|^2_{w.u}\downarrow$ are presented for all even nuclei listed in table (1). Transition strengths $|M\ (E2)\ |^2_{W.U.}\downarrow$ of γ_o –transition from $2^+\rightarrow0^+$ with partial gamma widths are increased with increased number of neutron as shown in **Table (1).**

Table (1): Transition strengths $|M\ (E2)\ |^2_{W.U.}\downarrow$ of γ_o –transition from $2^+\rightarrow0^+$ with partial gamma widths in W.u. $\Gamma\ (E2)_{wk.}$,total gamma width and mean life time τ for the first exited state of $_{74}W$ isotope (present work).

A	N	E_i(keV) [3]	E_γ(keV) [3]	$t_{1/2}$(ps) [3]	T(s) P.Work	Γ_{tot}x (eV) P.Work	$\Gamma(E2)_{w.u.}$ (eV) P.Work	$\|M(E2)\|^2_{W.U.}\downarrow$ P.Work
180	106	103.557	103.557	1280(5)	$1.847x10^{-9}$	$3.5636x10^{-7}$	$5.7986x10^{-10}$	614.5579
182	108	100.1060	100.10595	1381(10)	$1.9928x10^{-9}$	$3.3030x10^{-7}$	$4.9674x10^{-10}$	664.9338
184	110	111.208	111.208	1251(12)	$1.8052x10^{-9}$	3.6462x10-7	$8.5278x10^{-10}$	427.5683
186	112	122.33	122.30	1036(10)	$1.4949x10^{-9}$	$4.4029x10^{-7}$	$13.917x10^{-10}$	316.3667

In **Fig. (1)** We observed that the relation between mass number and the electric quadrupole transition strengths $|M\ (E2)\ |^2_{w.u}\downarrow$

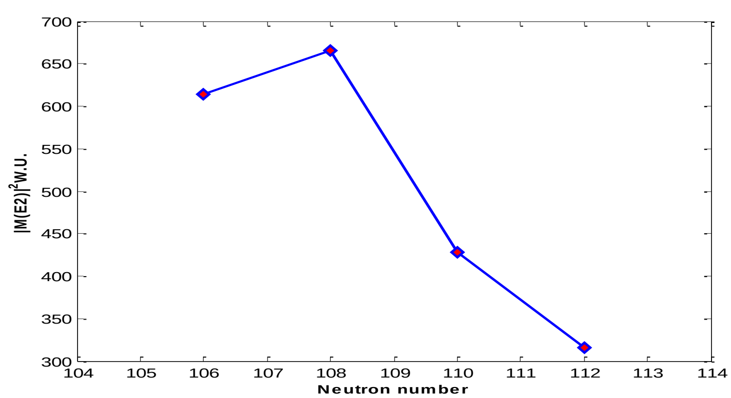

Fig. (1): Relation between neutron number and M (E2) $|^2_{W.U.}\downarrow$ for Tungsten

The calculated reduced transition probabilities B (E2) e2b2 ↑ values are compared with that of experimental and theoretical predications for $_{74}W$ nuclide listed and plotted and compares with SSANM and FRDM and with Experimental values of Global.

Table (2): The calculated reduced transition probabilities B (E2) e2 b^2 ↑ values are compared with that of experimental and theoretical predications for $_{74}W$ nuclide.

A	N	E_i(keV) [3]	E_γ(KeV) [3]	$B(E2;0_1^+\rightarrow 2_1^+)e^2b^2$			
				Experimental values of Global [6]	Theoretical values		
					Present work	SSANM [6]	FRDM [6]
180	106	103.557	103.557	4.3(7)	4.3126	3.914	4.68
182	108	100.1060	100.10595	4.4(8)	4.4286	3.72	4.668
184	110	111.208	111.208	3.9(7)	3.9575	3.532	3.956
186	112	122.33	122.30	3.5(6)	3.5727	3.344	3.604

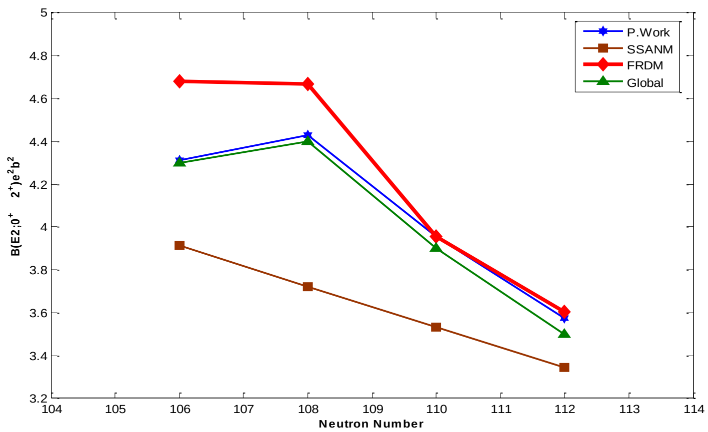

Fig. (2): Relation between neutron number and B (E2) for Tungsten

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