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THE INVESTIGATION OF THE log(ft) VALUES FOR THE ALLOWED GAMOW-TELLER TRANSITIONS OF SOME DEFORMED NUCLEI

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Abstract- The log(ft) values of allowed $\beta^{\pm}$ decay between odd-A nuclei for $125 \leq A \leq 180$ mass region are investigated. Single particle energies and wave functions are calculated by making use of a deformed Woods-Saxon potential. The calculations are performed in the framework of proton-neutron quasi particle random phase approximation (QRPA) including the schematic residual spin-isospin interaction among the nucleons in the particle hole channel. The calculations indicated that the results obtained through using the $\chi_{GT}=5.2/A^{0.7}$ are more in agreement with experimental observations.

Keywords- Beta decay, Gamow-Teller Transitions

1. INTRODUCTION

After the observations of the Fermi resonance in 1960 [1], Fujita et al. [2-6] studied this resonance theoretically and explained it through proton particle-neutron hole pair model. This model was also applied for the Gamow-Teller transition and showed that the existence of Gamow-Teller Resonance (GTR) observed first by Doering et al [7] is similar to the origin of the Fermi resonance. For the calculations of the β decay rates of the nuclei, "Gross Theory" developed by Takahashi et al. [8] was employed. But this theory describes, because its statistical character, only the average properties of the β strength function and not the effects associated with shell structure. The macroscopic model including the shell structures of nuclei in the β decay theory has been developed by Hamomoto et al. [9], and Halbleib and Sorensen [10]. The Random Phase Approximation (RPA) model developed by Halbleib and Sorensen has been improved by other authors [11-19]. In this model, one first constructs a particle or quasi-particle bases with a paring among like nucleons, and then solves the RPA or QRPA equation with a schematic spin-isospin (for Gamow-Teller β decay) or isospin (for Fermi β decay) residual interaction. The residual interaction mentioned above plays significant role to explain the properties of the Gamow-Teller and Isobar Analogue Resonance (IAS). As known the spin-isospin residual interaction includes free parameter χ_{GT}, while isospin residual interaction includes free parameter χ_F. The parameters are, in general, obtained from experimental positions of IAS and GTR.

As spin-isospin residual interactions between nucleons plays important role for explanation of the properties of GTR, this interaction has also effect on the β decay of odd nuclei [11,20,21], magnetic moment [22-24], the polarization of nuclear structure process [23,25], and the double β decay matrix elements.

The χ_{GT} constants are in general obtained from the experimental values of GTR via (n,p) and (^{3}He,t) reactions. In order to establish an agreement between experimental values of GTR positions in different mass region, different χ_{GT}'s are used. For example, for heavy nuclei (^{208}Pb) χ_{GT}=23/A MeV [26], in the region of Fe nuclei χ_{GT}=15/A MeV [16], in the region of neutron deficient Cs isotopes, χ_{GT}= 1.5÷2 (N-Z)/A MeV [14] are accepted. However Homma et al. [27] showed that $\chi_{GT}=5.2/A^{0.7}$ MeV approach is valid for all mass region.

In this study, theoretical and experimental values of log(ft) of beta decay between various odd mass nuclei are compared with each other, from which a value for the χ_{GT} constant is determined. The deformed Woods-Saxon potential base was selected for single particle base. The problem was solved in QRPA including the residual spin-isospin interaction among the nucleons in the particle-hole channel.

2. MODEL HAMILTONIAN

Let us consider a system of nucleons in an axially symmetric average field interacting via pairing and charge-exchange spin-spin forces. In this case, Hamiltonian of the system in single quasi-particle case is given as:

$$H_0 = H_{SQP} + V_{GT}. \tag{1}$$

H_{SQP} is the single quasi-particle Hamiltonian and described by

$$H_{SQP} = \sum_{s,\tau} E_s(\tau)\cdot\left[\alpha_s^\dagger(\tau)\cdot\alpha_s(\tau)+\alpha_{\bar{s}}^\dagger(\tau)\cdot\alpha_{\bar{s}}(\tau)\right], \tag{2}$$

where $E_s(\tau)$ is the single quasi-particle energy of the nucleons and the isospin index τ takes the values n(p) for neutrons(protons), and $\alpha_s^\dagger(\alpha_s)$ is the quasi-particle creation(annihilation) operators. V_{GT} is residual charge-exchange spin-spin(GT) interaction and given by the formula,

$$V_{GT} = 2\chi_{GT}\sum_{\mu}\beta_\mu^+\cdot\beta_\mu^-, \quad \mu=0,\pm1, \tag{3}$$

where

$$\beta_\mu^+ = \sum_{i=1}^{A}\sigma_\mu(i)\cdot t_+(i), \qquad \beta_\mu^- = (\beta_\mu^+)^\dagger. \tag{4}$$

The operator $t_+(t_-)$ changes a proton (neutron) into a neutron(proton) and σ_μ is the μ spherical component of the Pauli operator. In the quasi-particle representation, the $\beta_\mu^\pm$ operators are introduced

$$\beta_{\mu}^{-}=\sum_{np}\left[d_{np}D_{np}^{\dagger}+\bar{d}_{np}D_{np}+\bar{b}_{np}C_{np}-b_{np}C_{np}^{\dagger}\right], \tag{5}$$

by using the definitions from the Aygör et al.'s study [28] for the following quantities:

$$\begin{aligned}
&D_{np}\equiv\sum_{\rho=\pm1}\rho\alpha_{n-\rho}^{\dagger}\alpha_{p-\rho}, \quad D_{np}^{\dagger}\equiv\sum_{\rho=\pm1}\rho\alpha_{p-\rho}^{\dagger}\alpha_{n-\rho}\\
&C_{np}\equiv\frac{1}{\sqrt{2}}\sum_{\rho=\pm1}\alpha_{p\rho}\alpha_{n-\rho}, \quad C_{np}^{\dagger}\equiv\frac{1}{\sqrt{2}}\sum_{\rho=\pm1}\alpha_{n-\rho}^{\dagger}\alpha_{p\rho}^{\dagger}\\
&b_{np}\equiv\sqrt{2}\langle n\|\sigma_{\mu}\|p\rangle u_{p}v_{n}, \quad \bar{b}_{np}\equiv\sqrt{2}\langle n\|\sigma_{\mu}\|p\rangle u_{n}v_{p}\\
&d_{np}\equiv\langle n\|\sigma_{\mu}\|p\rangle u_{p}u_{n}, \quad \bar{d}_{np}\equiv\langle n\|\sigma_{\mu}\|p\rangle v_{n}v_{p}
\end{aligned}, \tag{6}$$

where v_τ (u_τ) are occupation (unoccupation) amplitudes, which are obtained in the BCS calculations, $|n\rangle$ and $|p\rangle$ are Nilsson single particle states, D_{np} corresponds to quasi-particle scattering operator, $C_{np}^{\dagger}(C_{np})$ is two quasi-particle creation(annihilation) operator for neutron- proton pair and satisfies the commutation rules:

$$\left[C_{np},C_{n'p'}^{\dagger}\right]\approx\delta_{nn'}\delta_{pp'} \quad , \quad \left[C_{np},C_{n'p'}\right]=0. \tag{7}$$

Hence, the effective GT interactions in the quasi-particle space can be written as follows:

$$V_{GT}=V_{CC}+V_{DD}+V_{CD}, \tag{8}$$

$$V_{CC}=2\chi_{GT}\sum_{\substack{n_1p_1\\n_2p_2}}\left(\bar{b}_{n_1p_1}C_{n_1p_1}^{\dagger}-b_{n_1p_1}C_{n_1p_1}\right)\cdot\left(\bar{b}_{n_2p_2}C_{n_2p_2}-b_{n_2p_2}C_{n_2p_2}^{\dagger}\right), \tag{9}$$

$$V_{DD}=2\chi_{GT}\sum_{\substack{n_1p_1\\n_2p_2}}\left(\bar{d}_{n_1p_1}D_{n_1p_1}^{\dagger}+d_{n_1p_1}D_{n_1p_1}\right)\cdot\left(\bar{d}_{n_2p_2}D_{n_2p_2}-d_{n_2p_2}D_{n_2p_2}^{\dagger}\right), \tag{10}$$

$$\begin{aligned}V_{CD}=2\chi_{\beta}\sum_{\substack{n_1p_1\\n_2p_2}}\Big[&\left(\bar{d}_{n_1p_1}D_{n_1p_1}^{\dagger}+d_{n_1p_1}D_{n_1p_1}\right)\cdot\left(\bar{b}_{n_2p_2}C_{n_2p_2}-b_{n_2p_2}C_{n_2p_2}^{\dagger}\right)+\\
&\left(\bar{b}_{n_1p_1}C_{n_1p_1}^{\dagger}-b_{n_1p_1}C_{n_1p_1}\right)\cdot\left(\bar{d}_{n_2p_2}D_{n_2p_2}+d_{n_2p_2}D_{n_2p_2}^{\dagger}\right)\Big]\end{aligned}, \tag{11}$$

where V_{CC} is spin-isospin collective interaction. In these calculations, V_{DD} is neglected because it only contributes to higher order terms. The V_{CD}, which contains linear terms in the quasi-particle scattering operator (D_{np}) is only needed for the odd-A transitions between one quasi-particle states when the particle-phonon interaction is treated in first order perturbation theory. Let us first consider the nuclei with even number. In this case, Hamiltonian of the system can be written in the form of

$$H_0=H_{SQP}+V_{CC}. \tag{12}$$

In QRPA, collective 1^+ states in odd-odd nuclei are considered as one-phonon excitations and described by

$$|\Psi_i\rangle = Q_i^\dagger|0\rangle = \sum_{np}(r_{np}^i C_{np}^\dagger - s_{np}^i C_{np}), \tag{13}$$

where $Q_i^\dagger$ is the neutron-proton QRPA phonon creation operator, $|0\rangle$ is the phonon vacuum which corresponds to the ground state of an even-even nuclei and fulfills $Q_i|0\rangle = 0$ for all i. The two-quasi-particle amplitudes r_{np}^i and s_{np}^i are normalized by:

$$\sum_{np}\left[(r_{np}^i)^2 - (s_{np}^i)^2\right] = 1. \tag{14}$$

Employing the conventional procedure of RPA and solving the equation of motion,

$$\left[H_{SQP} + V_{CC}, Q_i^\dagger\right]|0\rangle = \omega_i Q_i^\dagger|0\rangle, \tag{15}$$

we obtain the dispersion equation for the excitation energies ω_i of 1^+ states:

$$[1+\chi_{GT}A(\omega_i)]\cdot[1+\chi_{GT}\overline{A}(\omega_i)] - [\chi_{GT}B(\omega_i)]^2 = 0, \tag{16}$$

where $A(\omega_i), \overline{A}(\omega_i)$ and $B(\omega_i)$ are given by

$$A(\omega_i) = 2\sum_{np}\left[\frac{\overline{b}_{np}^2}{E_{np}-\omega_i} + \frac{b_{np}^2}{E_{np}+\omega_i}\right]; \quad \overline{A}(\omega_i) = 2\sum_{np}\left[\frac{b_{np}^2}{E_{np}-\omega_i} + \frac{\overline{b}_{np}^2}{E_{np}+\omega_i}\right]$$

$$B(\omega_i) = 2\sum_{np} b_{np}\overline{b}_{np}\left[\frac{1}{E_{np}-\omega_i} + \frac{1}{E_{np}+\omega_i}\right] \tag{17}$$

The two quasi-particle amplitudes then becomes

$$r_{np}^i = -\frac{b_{np} + L(\omega_i)\overline{b}_{np}}{E_{np}-\omega_i}\frac{1}{\sqrt{Z(\omega_i)}}, \quad s_{np}^i = \frac{\overline{b}_{np} + L(\omega_i)b_{np}}{E_{np}+\omega_i}\frac{1}{\sqrt{Z(\omega_i)}}, \tag{18}$$

where $E_{np} = E_n + E_p$ is two-quasi particle energy for neutron-proton pair, $L(\omega_i)$ is defined as,

$$L(\omega_i) = -\frac{B(\omega_i)}{\frac{1}{\chi_{GT}} + A(\omega_i)}, \tag{19}$$

and the normalization constant $Z(\omega_i)$ is determined from Eq.(14).

One of the quantities, which characterize the excited Gamow-Teller 1^+ states is the probability of $\beta^\pm$ transitions from these states to neighbor even-even nuclei. The $\beta^\pm$ transition amplitude from the even-even correlated ground state to 1^+ excited state in the odd-odd daughter nucleus is given by:

$$\begin{aligned}\left\langle 1_i^+ \middle| \beta^- \middle| 0^+ \right\rangle &= -\sum_{np} b_{np} r_{np}^i - \bar{b}_{np} s_{np}^i \equiv M_i^- \\ \left\langle 1_i^+ \middle| \beta^+ \middle| 0^+ \right\rangle &= \sum_{np} \bar{b}_{np} r_{np}^i - b_{np} s_{np}^i \equiv M_i^+\end{aligned} \quad (20)$$

Let us now examine the collective Gamow-Teller interaction for odd mass nuclei. In this case using Eqs. (13) and (20) Hamiltonian of the system in phonon representation can be written in the form;

$$\begin{aligned}H = H_{SQP} &+ 2\chi_{GT} \sum_{ij} \left(M_i^+ Q_i^\dagger + M_i^- Q_i\right) \cdot \left(M_j^+ Q_j + M_j^- Q_j^\dagger\right) \\ &+ 2\chi_{GT} \sum_{npj} \left[\left(d_{np} D_{np} + \bar{d}_{np} D_{np}^\dagger\right) \cdot \left(M_j^+ Q_j + M_j^- Q_j^\dagger\right)\right. \\ &+ \left.\sum_{npj} \left(M_j^+ Q_j^\dagger + M_j^- Q_j\right) \cdot \left(d_{np} D_{np}^\dagger + \bar{d}_{np} D_{np}\right)\right]\end{aligned} \quad (21)$$

In the QRPA method, the wave function of the odd mass (with odd neutron) nuclei is given by

$$\left|\Psi_{I_n K_n}^j\right\rangle = \Omega_{I_n K_n}^{j\dagger} |0\rangle = \left[N_{I_n}^j \alpha_{I_n K_n}^\dagger + \sum_{iI_p K_p} R_{ij}^{I_n I_p} (I_p K_p 1 K_n - K_p / I_n K_n) Q_i^\dagger \alpha_{I_p K_p}^\dagger\right] |0\rangle, \quad (22)$$

where I is the total angular momentum and K is the projection of I on the nuclear symmetry axis. It is assumed that wave function (22) is formed by superposition of one quasi-particle, and three quasi-particle (one quasi-particle+phonon) states. The mixing amplitudes $N_{I_n}^j$ and $R_{ij}^{I_n I_p}$ are fulfilled by the normalization condition:

$$\left(N_{I_n}^j\right)^2 + \sum_{iI_p} \left(R_{ij}^{I_n I_p}\right)^2 = 1. \quad (23)$$

Solving the equation of motion,

$$\left[H, \Omega_{I_n K_n}^{j\dagger}\right] |0\rangle = W_{I_n K_n}^j \Omega_{I_n K_n}^{j\dagger} |0\rangle, \quad (24)$$

the dispersion equation for excitation energies $W_{I_n K_n}^j$ corresponding to states given in Eq. (22) is obtained as

$$W^{j}_{I_nK_n} - E_{I_nK_n} = 4\chi_\beta^2 \sum_i \frac{\left(d_{I_nI_p} M_i^+ + \bar{d}_{I_nI_p} M_i^-\right)^2}{W^{j}_{I_nK_n} - \omega_i - E_{I_pK_p}}. \tag{25}$$

The mixing amplitudes $R_{ij}^{I_nI_p}$ are in the form of

$$R_{ij}^{I_nI_p} = \frac{2\chi_\beta\left(d_{I_nI_p} M_i^+ + \bar{d}_{I_nI_p} M_i^-\right)}{W^{j}_{I_nK_n} - \omega_i - E_{I_pK_p}} N^{j}_{I_n}, \tag{26}$$

and $N^{j}_{I_n}$ is calculated from Eq. (23). The corresponding expressions for the nuclei with odd- proton number are formulated by performing the transformation $I_nK_n \leftrightarrow I_pK_p$ in Eqs.(21-26).

3. GAMOW-TELLER $\beta^{\pm}$ TRANSITION MATRIX ELEMENTS IN ODD-A NUCLEUS

Gamow-Teller transition matrix elements of nuclei can be stated as following [14]:

$$M_{\beta^{\pm}} = \left\langle \Psi^{f}_{I_1K_1} \left| \beta^{\pm}_{\mu} \right| \Psi^{i}_{I_2K_2} \right\rangle. \tag{27}$$

The corresponding matrix elements of odd-A transitions are expressed for two different cases as follows

(a) The case in which the number of pair does not change:

$$\begin{aligned} M_{\beta^-} &= \left\langle \Psi^{f}_{I_pK_p} \left| \beta^{-}_{\mu} \right| \Psi^{i}_{I_nK_n} \right\rangle \\ &= -\left[d_{I_nI_p} N^{i}_{I_n} N^{f}_{I_p} + \bar{d}_{I_nI_p} \sum_j R_{ij}^{I_nI_p} R_{fj}^{I_nI_p} + N^{i}_{I_n} \sum_j R_{fj}^{I_nI_p} M_j^- + N^{f}_{I_p} \sum_j R_{ij}^{I_nI_p} M_j^+ \right] \\ M_{\beta^+} &= \left\langle \Psi^{f}_{I_nK_n} \left| \beta^{+}_{\mu} \right| \Psi^{i}_{I_pK_p} \right\rangle \\ &= -\left[d_{I_nI_p} N^{i}_{I_p} N^{f}_{I_n} + \bar{d}_{I_nI_p} \sum_j R_{ij}^{I_nI_p} R_{fj}^{I_nI_p} + N^{i}_{I_p} \sum_j R_{fj}^{I_nI_p} M_j^+ + N^{f}_{I_n} \sum_j R_{ij}^{I_nI_p} M_j^- \right] \end{aligned} \tag{28}$$

(b) The case in which the number of pair changes:

$$
\begin{aligned}
M_{\beta^-} &= \left\langle \Psi^f_{I_n K_n} \middle| \beta^-_\mu \middle| \Psi^i_{I_p K_p} \right\rangle \\
&= -\left[\bar{d}_{I_n I_p} N^i_{I_p} N^f_{I_n} + d_{I_n I_p} \sum_j R^{I_n I_p}_{ij} R^{I_n I_p}_{fj} + N^i_{I_p} \sum_j R^{I_n I_p}_{fj} M^-_j + N^f_{I_n} \sum_j R^{I_n I_p}_{ij} M^+_j \right] \\
M_{\beta^+} &= \left\langle \Psi^f_{I_p K_p} \middle| \beta^+_\mu \middle| \Psi^i_{I_n K_n} \right\rangle \\
&= -\left[\bar{d}_{I_n I_p} N^i_{I_n} N^f_{I_p} + d_{I_n I_p} \sum_j R^{I_n I_p}_{ij} R^{I_n I_p}_{fj} + N^i_{I_n} \sum_j R^{I_n I_p}_{fj} M^+_j + N^f_{I_p} \sum_j R^{I_n I_p}_{ij} M^-_j \right]
\end{aligned}
\tag{29}
$$

where $\mu = K_f - K_i$. The reduced transition probability for the $I_iK_i \rightarrow I_fK_f$ transitions on the laboratory frame expressed by

$$
B^{\pm}_{GT}(I_iK_i \rightarrow I_fK_f) = \frac{g_A^2}{4\pi}(I_iK_i1K_f - K_i / I_fK_f)^2 \left| M_{\beta^\pm} \right|^2, \tag{30}
$$

and the ft values for these transitions are given by the following formula [25]:

$$
(ft)_{\beta^\pm} = D\frac{g_V^2}{4\pi B^{\pm}_{GT}} = \frac{D}{\left(\frac{g_A}{g_V}\right)^2 (I_iK_i1K_f - K_i / I_fK_f)^2 \left| M_{\beta^\pm} \right|^2}. \tag{31}
$$

In our calculations we use the constants [29], $D \equiv \frac{2\pi^3\hbar^7 \ln 2}{g_V^2 m_e^5 c^4} = 6295\,\mathrm{s}$ and $\frac{g_A}{g_V} = -1.254$ and since transitions are among the ground states, $K_i=I_i$ and $K_f=I_f$ are accepted.

4. RESULTS AND DISCUSSIONS

Numerical calculations have been performed for the deformed nuclei in the atomic mass region of 125<A<131 and 150<A< 180. Nilsson single particle energies and wave functions were calculated with a deformed Woods-Saxon potential developed by Leander [30]. All energy levels from the bottom of the potential well to 8 MeV were considered for neutrons and protons. The deformation parameters and pairing interaction constants were chosen in accordance with Ref. [31]. The charge-exchange interaction strength χ_{GT} was chosen in order to describe the sentroid of the Gamow-Teller resonance in odd-odd nuclei. Resulting coupling strength is in good agreement with one derived in Ref. [27]. The log(ft) values for the GT transition in 16 nuclei are obtained from the formula given in Eq. (31). The calculations were carried out for the transitions [523]↑↔[523]↓, [514]↑↔[514]↓ and [402]↑↔[402]↓ having lower energies. Since there are some transitions (for ^{159}Ho→^{159}Dy and ^{167}Ho→^{167}Er) to the excited states of the daughter nucleus, the corresponding energies (with respect to the ground states) have been calculated.

The calculating log(ft) values and final energies for the investigated nucleus within the different models (SP, SQP and QRPA) are given in Table. The transitions up to 10th row of Table correspond to [523]↑↔[523]↓ transitions. The rows from 10 to 14 shows [514]↑↔[514]↓ transitions, and [402]↑↔[402]↓ transitions have been presented in rows from 14 to 16. In the third and fourth columns of Table, the comparison of the calculated energy values for the transitions to the excited states of the daughter nucleus together with the experimental ones has been given. In the last four columns of Table, the theoretical and experimental values of log(ft) values for the GT transitions in single particle, single quasi-particle and QRPA pictures have been presented, respectively.

In Fig. 1, the log(ft) values for the investigated nuclei in different models have been compared with the experimental values. The results show that the single-particle value of the GT beta transition rate is 15-20 times larger than the corresponding experimental values in the basis of Woods-Saxon potential as it is in the case of Nilsson potential. This number reduces to 8-10 when the pairing interaction among like nucleons is taken into account. However, if the effective Gamow-Teller interaction is considered and the appropriate value for the interaction constant, χ_{GT}, is chosen, it is possible to make the transition rate values close to the experimental ones.

Table : The log(ft) values and final energies for the investigated nucleus within the different models.

N	Transitions	E_f (KeV)		Log(ft)			
		Theory	Exp.[32]	SP	SQP	QRPA	Exp.[25,32]
1	^{159}Ho→^{159}Dy	34.03 1010	309.6 1016.2	3.61 4.41	4.07 4.69	4.44 5.07	4.81 5.24
2	^{161}Gd→^{161}Tb	310.66	417.2	3.49	4.14	4.73	4.86; 4.86±0.04
3	^{161}Ho→^{161}Dy	0	25.7	3.60	4.20	4.76	4.88; 4.80±0.2
4	^{163}Ho→^{163}Dy	97.3	0	3.60	4.40	4.91	4.50
5	^{163}Er→^{163}Ho	0	0	3.47	3.88	4.41	4.84; 4.83±0.01
6	^{165}Er→^{165}Ho	0	0	3.47	3.77	4.41	4.7; 4.64±0.02
7	^{165}Yb→^{165}Tm	238.7	160.5	3.46	3.72	4.35	4.80; 4.80±0.10
8	^{167}Ho→^{167}Er	97.8 621	346.5 667.8	4.44 3.59	5.31 3.92	5.90 4.62	5.90 4.60; 4.80±0.20
9	^{167}Yb→^{167}Tm	276.93	292.8	3.46	3.64	4.42	4.58; 4.55±0.05
10	^{169}Ho→^{169}Er	1054.2	853.0	3.59	3.88	4.53	4.86
11	^{175}Yb→^{175}Lu	302.11	396	3.38	3.73	4.44	4.70
12	^{179}W→^{179}Ta	0	30.7	3.38	3.85	4.44	4.59
13	^{181}Os→^{181}Re	55.5	262	3.38	3.62	4.29	4.40
14	^{125}I→^{125}Te	113.2	35.5	3.81	4.48	5.05	5.40
15	^{127}Te→^{127}I	0	0	3.66	4.46	5.10	5.48
16	^{131}Cs→^{131}Xe	0	0	4.24	4.67	5.82	5.54

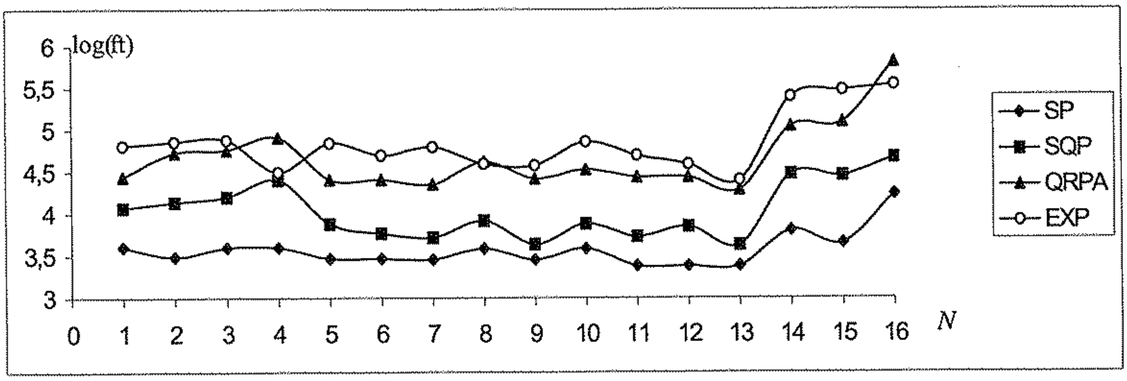

Fig.1: The log(ft) values for the investigated nucleus in different models

Calculations indicate that although the contributions of the three quasi-particle states to the one quasi-particle wave function is so small as a result of the GT interactions (the norm of wave function is less than 1%), the contribution of the core which comes from the polarization phenomena is significant. The sum of these contributions make the beta transition rate 7-8 times small, and thus the agreement between its theoretical and experimental values is provided.

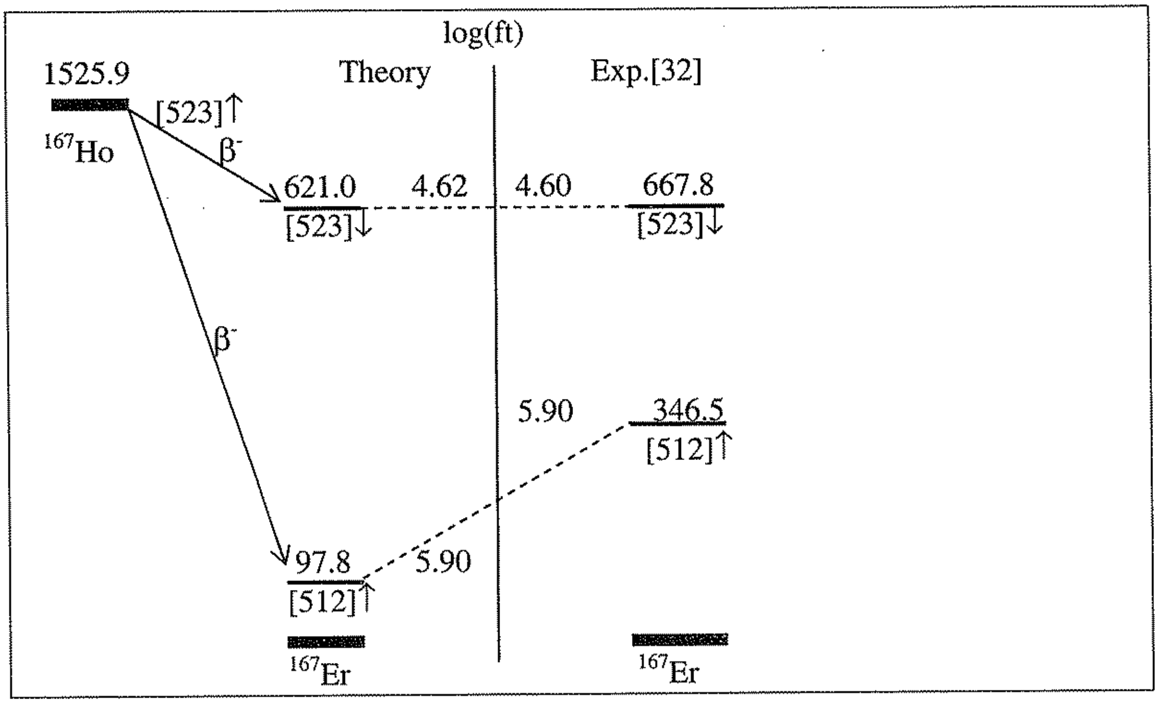

Fig. 2: Energy (in KeV) and log(ft) values for ^{167}Ho$\rightarrow$^{167}Er transitions

The schematic form of the β^- and β^+ Gamow-Teller transitions has been presented in Fig. 2 and Fig. 3 as an example. The ^{167}Ho$\rightarrow$^{167}Er and ^{159}Ho$\rightarrow$^{159}Dy transitions are shown in Fig. 2 and Fig.3, respectively. As can be seen from the figures, although the energies of low-lying states in both transitions are smaller than the corresponding experimental values, the log(ft) values are in good agreement with the experimental ones. In higher states, this agreement is valid for both the energy and log(ft) values.

We investigated in this study the $\beta^{\pm}$ decay between ground state of odd-A nuclei in the 125≤A≤180 mass region through proton-neutron QRPA by taking into account the residual spin-isospin interaction among the nucleons in the particle hole channel and log(ft) values of β decay has been calculated. The results obtained through QRPA are in agreement with experimental observations. The calculations showed that in the case of Gamow-Teller interactions a strength parameter $\chi_{GT} = 5.2/A^{0.7}$ MeV is suggested by Ref. [27] is in close agreement with our results.

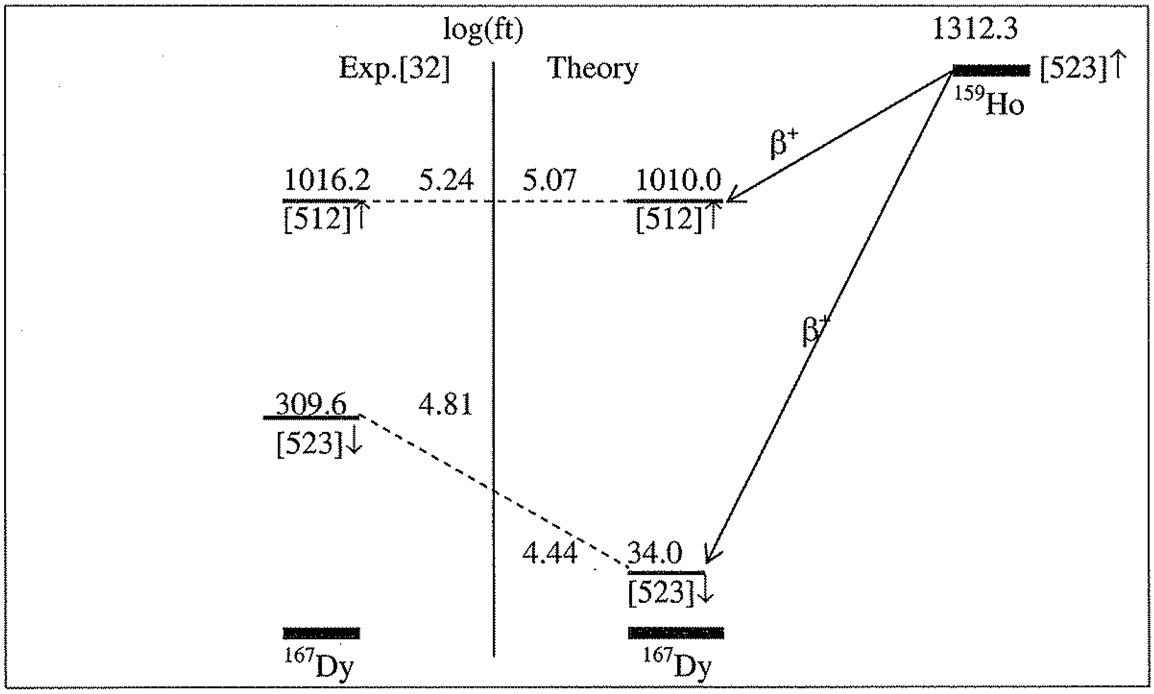

Fig. 3: Energy (in KeV) and log(ft) values for $^{159}Ho \rightarrow ^{159}Dy$ transitions

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