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THE PARTICLE-HOLE STRUCTURE FOR THE EXOTIC NUCLEUS ^{36}P BY USING PROTON-NEUTRON TAMM-DANCOFF APPROXIMATION (PNTDA)

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ABSTRACT

The structure of the exotic light nucleus ^{36}P is studied by using proton-neutron Tamm-Dancoff Approximation (pnTDA), where the neutron particle occupies the 2p-1f shells, and the proton hole occupies the 1s-1p, $1d_{5/2}$ and $2s_{1/2}$ shells. The configurations of one neutron particle- one proton hole are mixed in the presence of Modified Surface Delta Interaction (MSDI), and diagonalized to produce the best values of negative parity energy levels of ^{36}P. The electromagnetic properties and log ft values for the reaction $^{36}P(\beta^-)^{36}S$, are calculated and compared with the available data. It found necessary introduce the effective value for the axial-vector coupling constant of weak interaction g_A to enhance the calculated log ft values.

Keywords: Tamm-Dancoff Approximation, Nuclear structure, transition strength and Beta decay

1. INTRODUCTION

The structure of neutron-rich Phosphorus isotopes is of considerable experimental and theoretical interest in recent [1,2] and old [3,4] articles, since they have 15 protons and the excess neutrons occupying the upper sd shell, *i.e.* in the vicinity of the so called island of inversion. The large scale shell model was used to interpret the structure of these sd shell nuclei [1,2]. According to shell model, the nucleus is separated into inert core and active nucleons distributed over a valence space.

Some properties of the neutron rich nucleus ^{36}P are studied experimentally and theoretically. Fifield et al. [4] studied the properties of ^{36}P that obtained from charge-exchange reactions on ^{36}S. They interpreted their results performing shell model calculations with nucleons occupying both the 2s1d and 1f2p major shells and leaving ^{16}O as inert core. In their calculations they employed SDPF interaction [5]. Chapman et al. [2] discussed the level scheme of ^{36}P, and other neutron-rich Phosphorus isotopes populated in binary grazing reactions, within shell model calculations. Their model space is enlarged by including 1p shells, and leaving ^{4}He as inert core. The PSDPF interaction of Ref. [6] is used to interpret their experimental data.

The excited states of closed shells nuclei can be generated through the promotion of a particle from the filled shell to the empty shells, leaving a hole within the filled shell. The configuration mixing of these particle-hole states is called Tamm-Dancoff Approximation (TDA). For odd-odd nuclei having one neutron (proton) excess and one proton (neutron) defect, and adjacent to doubly closed shells nucleus, can be treated in the framework of TDA as configuration mixing of one neutron particle-one proton hole, or one proton particle-one neutron hole. This approach is called proton-neutron Tamm-Dancoff Approximation (pnTDA).

In this work, both TDA and pnTDA are employed to calculate energy levels, electromagnetic properties, and allowed beta decay of ^{36}P.

2. THEORY

2.1 TDA and pnTDA

In the Tamm–Dancoff Approximation (TDA), the excited states of doubly closed shells nucleus, A(Z,N), can be treated as linear combination of particle-hole configurations, and the ground state is taken as closed shell configuration with $J^{\pi} = 0^{+}$.

The configuration mixing wave functions of particle-hole states is given by:

$$\left| \varphi_J^{TDA} \right\rangle = \sum_{ab} \chi^{J}_{ab^{-1}} \left| a\, b^{-1}; JM \right\rangle \qquad (1)$$

where a and b^{-1} represent the particle and hole states, respectively. $\chi^{\omega}_{ab^{-1}}$ is the amplitude which satisfy the normalization condition:

$$\sum_{ab} \left| \chi^{J}_{ab^{-1}} \right|^2 = 1 \qquad (2)$$

One can write Schrödinger equation for the TDA model as follow [7]:

$$\sum_{cd} \langle a\, b^{-1}; J^{\pi} | H | c\, d^{-1}; J^{\pi} \rangle\, \chi^{J}_{cd^{-1}} = E\, \chi^{J}_{ab^{-1}} \qquad (3)$$

The Hamiltonian matrix elements are given by:

$$\langle a\, b^{-1}; J^{\pi} | H | c\, d^{-1}; J^{\pi} \rangle = \delta_{ac}\delta_{bd}(\varepsilon_a - \varepsilon_b) + \langle ab^{-1}; J^{\pi} | V | c\, d^{-1}; J^{\pi} \rangle \qquad (4)$$

where ε_α represents the single-particle energy , which are calculated by[8]:-

$$\varepsilon_{n\ell j} = \left(2n + \ell - \frac{1}{2}\right)\hbar\,\omega + \begin{bmatrix} -\frac{1}{2}(\ell+1)\langle f(r)\rangle_{n\ell} & for\ j = \ell - \frac{1}{2} \\ \frac{1}{2}\ell\langle f(r)\rangle_{n\ell} & for\ j = \ell + \frac{1}{2} \end{bmatrix}$$

$$\langle f(r)\rangle_{n\ell} \approx -20\,A^{-\frac{2}{3}}$$

$$\hbar\,\omega = 45\,A^{-\frac{1}{3}} - 25\,A^{-\frac{2}{3}}$$

The particle – hole interaction is transformed to particle – particle one through Pandya transformation [7,8]:

$$\langle ab^{-1};J|V|cd^{-1};J\rangle = -\sum_{J'}(2J'+1)\begin{Bmatrix} j_a & j_b & J \\ j_c & j_d & J' \end{Bmatrix}\langle ad;J'|V|cb;J'\rangle \qquad (5)$$

where $\begin{Bmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{Bmatrix}$ represents 6 - j symbol.

The nuclear structure of certain odd – odd nuclei with atomic mass A(Z-1, N+1) or A(Z+1, N-1), in the vicinity of doubly closed shells nucleus with atomic mass A(Z, N), can be studied in the framework of proton–neutron Tamm–Dancoff Approximation (pnTDA). According to pnTDA, any nuclear state is obtained by the linear combination of neutron particle – proton hole or vice versa.

The states of a nucleus with A(Z-1, N +1) can be treated through the creation of neutron particle and proton hole within the adjacent doubly closed shells nucleus A(Z,N), as follow [7] :

$$|\,n\,p^{-1};JM\,\rangle = \left[c_n^{\dagger}\times\tilde{c}_p\right]_{JM}|0\rangle \qquad (6)$$

where $|\,0\,\rangle$ is the ground state of the reference nucleus A(Z,N). The operators $c_n^{\dagger}\ and\ \tilde{c}_p$ creates a neutron particle and proton hole, respectively.

The configuration mixing wave functions of neutron particle-proton hole is given by:

$$|\,\varphi_J^{\mathrm{pnTDA}}\rangle = \sum_{\mathrm{np}}\chi_{\mathrm{np}^{-1}}^{J}\,|\,\mathrm{n\,p}^{-1};\mathrm{JM}\,\rangle \qquad (7)$$

So, for the pnTDA, the neutron occupies the particle states *c* and *a*, and the proton occupies the hole states *d* and *b*, in Schrödinger equation (eq. 3).

The adopted interaction in the present work is the Modified Surface Delta Interaction (MSDI) which is given by [8]:-

$$V^{MSDI} = -4\,\pi A_T\,\delta\,(\vec{r}_1 - \vec{r}_2)\delta(r_1 - R_0) + B(\vec{\tau}_1\,.\,\vec{\tau}_2) + C \qquad (8)$$

Diagonalization of the Hamiltonian matrix gives eigenvalues and eigenfunctions which are important for the calculation of transition properties.

2.2 Electromagnetic properties

The reduced transition probability $B(\sigma\lambda)$ is related to the nuclear matrix element by the formula [7] :

$$B(\sigma\lambda\,;\,J_i \rightarrow J_f) = \frac{1}{2J_i+1} \left| \left(J_f \| \widehat{M}_{\sigma\lambda} \| J_i\right) \right|^2 \qquad (9)$$

where(σ) selects electric (E) or magnetic (m) modes. The electric quadrupole transition operator is written as:

$$\widehat{M}_{E2} = e\, r^2 Y_2(\hat{r}) \qquad (10)$$

where e, is the electric charge of the nucleon, and $Y_2(\hat{r})$, are the well known spherical harmonics function. The magnetic dipole operator in units of nuclear magneton (μ_N) is[8]:

$$\widehat{M}_{m1} = \sqrt{\frac{3}{4\pi}}\,\mu_N\left(g_\ell \hat{\ell} + g_s \hat{s}\right) \qquad (11)$$

where, $\hat{\ell}$ and $\hat{s}$, are the orbital and spin angular momentum operators of the nucleon, and g_ℓ and g_s, are the gyromagnetic ratio for the orbital and spin motion of the nucleon.

The reduced matrix elements of the electromagnetic transition operator can be expressed in terms of neutron particle–proton hole reduced matrix elements as [7] :

$$\left(J_f \| \widehat{M}_{\sigma\lambda} \| J_i\right) = \sum_{n_i p_i n_f p_f} \chi^{\omega_f^*}_{n_f p_f}\, \chi^{\omega_i}_{n_i p_i} \langle n_f p_f^{-1}\,;\, J_f \| \widehat{M}_{\sigma\lambda} \| n_i p_i^{-1} ; J_i \rangle \qquad (12)$$

And the electric quadrupole moment Q given by [8]

$$Q = \sqrt{\frac{16\,\pi}{5}}\,\sqrt{\frac{J\,(2J+1)}{(J+1)(2J+1)(2J+3)}}\,\left(J_f \| \widehat{M}_{E\lambda} \| J_i\right) \qquad (13)$$

The magnetic dipole moment, μ, is defined by the equation:-

$$\mu = \sqrt{\frac{4\pi}{3}}\,\sqrt{\frac{J}{(J+1)(2J+1)}}\,\left(J_f \| \widehat{M}_{m\lambda} \| J_i\right) \qquad (14)$$

2.3 Allowed beta decay

The reduced half-life (ft)of the allowed beta decay is given by[7]:

$$ft = \frac{\kappa}{B_F + B_{GT}}$$

where $\kappa = 6147\,s$, and the Fermi and Gamow-Teller reduced transition probabilities are given respectively by[7]:

$$B_F = \frac{g_V^2}{2J_i+1} \left| \langle J_f \,|\,|\hat{\beta}_F\,|\,|J_i\rangle \right|^2,$$

and

$$B_{GT} = \frac{g_A^2}{2J_i+1} \left| \langle J_f || \hat{\beta}_{GT} || J_i \rangle \right|^2 .$$

with $\hat{\beta}_F$ is simply the unit operator, $\hat{1}$, and $\hat{\beta}_{GT}$ is the Pauli spin operator, $\hat{\sigma}$. Both g_V and g_A are respectively, the vector and axial-vector coupling constant of weak interaction.

The reduced matrix elements of Fermi and Gamow-Teller operators are given for β^-decay by [7]:

$$\langle J_f || \hat{\beta}_L || J_i \rangle = \sum_{n_i p_i p_f \acute{p}_f} \chi^{\omega_f^*}_{p_f \acute{p}_f} \chi^{\omega_i}_{n_i p_i} \langle p_f \acute{p}_f^{-1}; J_f || \beta_L^- || n_i p_i^{-1}; J_i \rangle + \sum_{n_i p_i n_f \acute{n}_f} \chi^{\omega_f^*}_{n_f \acute{n}_f} \chi^{\omega_i}_{n_i p_i} \langle n_f \acute{n}_f^{-1}; J_f || \beta_L^- || n_i p_i^{-1}; J_i \rangle$$

where L=0, 1 for Fermi and Gamow-Teller operators, respectively. The amplitudes, $\chi^{\omega_i}_{n_i p_i}$ of the initial (parent nucleus) particle-hole states, $|n_i p_i^{-1}; J_i\rangle$, are those of pnTDA, while the amplitudes $\chi^{\omega_f^*}_{p_f \acute{p}_f}$ and $\chi^{\omega_f^*}_{n_f \acute{n}_f}$, of the final (daughter nucleus) particle-hole states, $|p_f \acute{p}_f^{-1}; J_f\rangle$ and $|n_f \acute{n}_f^{-1}; J_f\rangle$, are those of TDA.

3. RESULTS AND DISCUSSION

The nucleus ^{36}P consists of 15 protons and 21 neutrons which can be treated by using pnTDA as proton hole within the ^{36}S and neutron particle outside it. The proton hole states are assumed to be $1s_{1/2}, 1p_{3/2}, 1p_{1/2}, 1d_{5/2}$, and $2s_{1/2}$, while the neutron particle states are $1f_{7/2}, 2p_{3/2}, 2p_{1/2}$ and $1f_{5/2}$. The states of neutron particle and proton hole are coupled to total angular momentum and parity; J^π. The nuclear states of ^{36}P are obtained by the configuration mixing of the neutron particle-proton hole states that reproduce the J^πvalue. The Modified Surface Delta Interaction (MSDI) is adopted as particle-hole residual interaction. The strength parameters of MSDI that reproduce the best energy eigenvalues for ^{36}P are: A_0=1.69, A_1=0.69, B=0.69 MeV and C = 0.0.

Fig. (1) shows the calculated low-lying negative parity states of ^{36}P as compared with the experimental spectrum[2,9]. The tentative assignments for J^πvalues are those of Chapman et al.[2]. In our pnTDA calculations, the $4^-$and 3^-states appear, respectively, as the ground state and the first excited state of ^{36}P, with energy difference equal to 0.315 MeV, which is comparable with the experimental value. An excellent reproduction of the first 1^-state is obtained, while the theoretical values of $5_1^-$and 4_2^-energy levels are 1.85 and 1.92, respectively, which are comparable with the corresponding experimental values at 2.03 and 2.446 MeV, respectively. A 2^-state appears in pnTDA calculation at 1.37 MeV, which is shifted about 1 MeV from its corresponding experimental value. However, shell model calculations within sdpf model space carried out by Woods [10] found this state at 1.042 MeV, while that carried out within psdpf model space [2] found it at 0.282 MeV. A prediction of some negative parity states is appearing in this figure. Table 1, displays the contribution of the neutron particle-proton hole configurations in the nuclear wave functions of ^{36}P, where only the important configurations are listed. The ground state (4_1^-) and the first excited state (3_1^-), are dominated by the configuration $\left(1f_{7/2}\right)\left(2s_{1/2}\right)^{-1}$, while the configuration $\left(2p_{3/2}\right)\left(2s_{1/2}\right)^{-1}$ has a dominant contribution in the wave functions of the excited states $1_1^-$and 2_1^-. A significant contribution of the configuration $\left(1f_{7/2}\right)\left(1d_{5/2}\right)^{-1}$is appear in the wave functions of these state.

In comparison with the shell model calculations of Chapman et al. [2], the $4_1^-$and 3_1^-states are dominated by the configuration$\left(2s_{1/2}\right)_\pi\left(1f_{7/2}\right)_\nu$, and the $2_1^-$and 1_1^-states are dominated by the configuration$\left(2s_{1/2}\right)_\pi\left(2p_{3/2}\right)_\nu$. Their calculations found the $5_1^-$and 4_2^-states at 1.817 and 2.687 MeV, respectively, with the dominant configuration $\left(1d_{3/2}\right)_\pi\left(1f_{7/2}\right)_\nu$for both states. In our pnTDA calculations the dominant configuration for producing those two states is $\left(1f_{7/2}\right)\left(1d_{5/2}\right)^{-1}$.

Tables 2. to 4. give the calculated values for the electromagnetic properties of ^{36}P, where no experimental values are available. The reduced transition probabilities $B(E2)$ and $B(M1)$, and electric quadrupole moment (Q) and magnetic dipole moment (μ), are listed in the second and third columns of these tables. The second column of each table includes calculations that carried out by using the values of free nucleon charge and gyromagnetic ratio, while that listed in the third column are calculated by using effective values. For B(E2) and Q, the effective charges are $e_p = 1.36\,e$ and $e_n = 0.45\,e$. And the effective g-factors used in the calculations of B(M1) and μ are $g_\ell^p = 1.114, g_s^p = 5.12, g_\ell^n = -0.054$ and $g_s^n = -3.52$. However, these effective values are extracted by Richter et al. [11]so that the electromagnetic properties of sd-shell nuclei are reproduced.

The nucleus ^{36}P is unstable toward beta (β^-) decay. On the contrary of the electromagnetic transitions, beta transitions change the electric charge of the decaying nucleus according to the reaction ^{36}P (β^-) ^{36}S. So, the initial state of this transition is described by the ground state of ^{36}P, and the final states are the excited states of ^{36}S. The isotope of sulfur ^{36}S is a semi-magic nucleus, where N=20 (major shell) and Z=16 (minor shell), and its structure can be studied by the Tamm-Dancoff Approximation (TDA). The proton particle is assumed to occupy $1d_{3/2}$ and 1f-2p orbits, and its hole occupies the orbits $1s_{1/2}$, $1p_{3/2}$, $1p_{1/2}$, $1d_{5/2}$, and $2s_{1/2}$. On the other hand, the neutron particle is assumed to occupy 1f-2p orbits, while its hole occupies the orbits 1s, 1p and 2s-1d.

Diagonalization of the Hamiltonian matrix of one particle-one hole (1p-1h) configurations for proton states and neutron states, in the presence of MSDI with strength parameters, A_0=0.49, A_1=0.21, B=0.45 and C = 0.3 MeV, yield the eigenvalues of the negative parity energy levels that given in table 5. The theoretical calculations of the energy levels are very well reproducing their corresponding experimental values. However, the energy level appears experimentally at 7.272 MeV has the uncertain assignment $(3^-, 4^-, 5^-)$. Our most probable assignment for this state is 4_2^-, since the TDA calculations found it at 6.999 MeV, while $3_5^-$and 5_2^-states are found at 9.18 and 8.49 MeV, respectively. Table 6. includes the configuration mixing wave functions for the negative parity states of ^{36}S. These wave functions are necessary in the calculation of log *ft* for the allowed β^- decay.

Table 7. includes theoretical and experimental values of log *ft* for the allowed β^- transition from the initial state $|4_1^-\rangle$ in ^{36}P to the final excited states, $|3_1^-\rangle, |4_1^-\rangle, |5_1^-\rangle, |3_2^-\rangle, |3_3^-\rangle$ *and* $|4_2^-\rangle$, respectively, in ^{36}S. The wave functions are generated within pnTDA and TDA calculations, for ^{36}P and ^{36}S, respectively. The calculated log *ft* values are listed in the 5th and 6th columns of table 7. The calculated values that listed in the 5th column, are carried out by using the free nucleon coupling constants of the weak interaction $g_V = 1.0$ *and* $g_A = 1.25$, which are comparable to the experimental values given in the 7th column. Due to the correlations, the value of g_A may replaced by an effective value less than that for free nucleon. For sd shell nuclei, the effective value $g_A^{eff} = 0.96^{+0.03}_{-0.02}$[12] is used. Our calculations are enhanced by using $g_A^{eff} = 0.95$ instead of g_A^{free}, as shown in the 6th column of table 7. A more sophisticated shell model calculations are carried out by Warburton and Becker[13], where the model space $(sd)^{19}(fp)^1$, and SDPF interaction, are used. Those calculations are listed in the last column.

4. CONCLUSIONS

The mixing of charge changing particle-hole configurations (pnTDA) appears suitable to study the structure of the exotic nucleus ^{36}P. The energy levels of ^{36}P are very well reproduced, and the resulting wave functions are used to calculate its electromagnetic properties. Since there are no available data for the electromagnetic transitions and moments of ^{36}P, the calculations are carried out by using the charge and g-factors of free nucleon and compared with their effective values.

To calculate the log *ft* values for the allowed beta decay ^{36}P (β^-) ^{36}S, the structure of ^{36}S is calculated by mixing the configurations of charge conserving particle-hole states (TDA). The energies of negative parity levels of ^{36}S are very well reproduced. The wave functions of the initial nucleus (^{36}P), and the final nucleus (^{36}S) are used to calculate the log *ft* values for the allowed beta transitions. In our calculations, the necessity for using effective value for the axial-vector coupling constant, g_A, appears very important.

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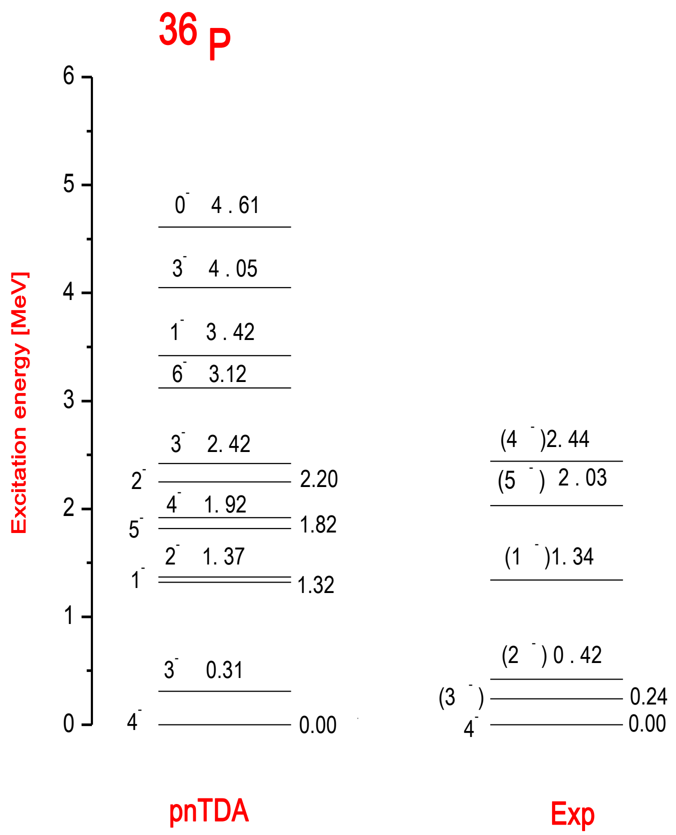

Fig. (1):- The Calculated Energy Levels of ^{36}P By Using pnTDA as Compared With The Experimental Data.

Table 1. The Configurations of Neutron Particle-Proton Hole States of ^{36}P. (Only Configurations with Absolute Value of Amplitude Greater than 0.1 are Listed)

configuration	0_1^-	1_1^-	2_1^-	3_1^-	4_1^-	5_1^-	6_1^-
$(2p_{1/2})(2s_{1/2})^{-1}$	0.957						
$(1f_{5/2})(1d_{5/2})^{-1}$	-0.287						
$(2p_{3/2})(2s_{1/2})^{-1}$		0.848	-0.721				
$(1f_{7/2})(1d_{5/2})^{-1}$		-0.529	0.69	-0.492	-0.328	0.995	1.0
$(1f_{7/2})(2s_{1/2})^{-1}$				0.865	0.928		
$(2p_{3/2})(1d_{5/2})^{-1}$					-0.17		

Table 2. The Calculated Reduced Transition Probability B(E2) in ^{36}P, By Using pnTDA.

$J_i^\pi \to J_f^\pi$	Calculated B(E2) W.u.	
	free nucleon charge	eff. nucleon charge
$1_1^- \to 3_1^-$	0.086	1.426
$1_1^- \to 2_1^-$	0.078	0.025
$2_1^- \to 4_1^-$	0.037	0.883
$5_1^- \to 3_1^-$	0.052	0.199
$5_1^- \to 4_1^-$	1.225	2.506
$4_2^- \to 4_1^-$	0.479	0.680
$4_2^- \to 3_1^-$	0.709	1.512
$3_1^- \to 4_1^-$	0.013	0.201

Table 3. The Calculated Reduced Transition Probability B(M1) in ^{36}P, By Using pnTDA.

$J_i^\pi \to J_f^\pi$	Calculated B(M1) W.u.	
	free g valus	eff. g values
$3_1^- \to 4_1^-$	2.80	2.725
$2_1^- \to 3_1^-$	0.548	0.732
$5_1^- \to 4_1^-$	0.211	0.292
$4_2^- \to 4_1^-$	0.0033	0.00036
$4_2^- \to 3_1^-$	0.136	0.247

Table 4. The Calculated Electric Quadrupole Moment and Magnetic Dipole Moment for The Ground State of ^{36}P, By Using pnTDA.

Quantity	Free nucleon values	Eff. nucleon values
Q (b)	-0.303	-0.897
μ (μ_N)	0.93	0.7

Table 5. Theoretical and Experimental Energy Eigenvalues for Negative Parity States of ^{36}S.

J^{π}	$E_{Theo.}(MeV)$	$E_{Exp.}(MeV)$[9]
4^-	5.15 6.99 8.82	5.022 (7.272)
3^-	4.81 5.64 7.06 8.27 9.18	4.193 5.251 5.831 6.187
5^-	5.04 8.49	5.206
1^-	3.72 7.13	5.573 6.472

Table 6. The Configurations of Neutron and Proton Particle-Hole States of ^{36}S. (Only Configurations with Absolute Value of Amplitude Greater than 0.1 are Listed)

configuration	3_1^-	3_2^-	3_3^-	4_1^-	4_2^-	5_1^-
$(1f_{7/2})_{\nu}\,(1d_{3/2})_{\nu}^{-1}$	0.807	-0.577		0.998		0.993
$(1f_{7/2})_{\pi}\,(2s_{1/2})_{\pi}^{-1}$	0.355	0.438	-0.28		0.707	
$(1f_{7/2})_{\nu}\,(2s_{1/2})_{\nu}^{-1}$	0.266	0.436	-0.473		0.705	
$(2p_{3/2})_{\nu}\,(1d_{3/2})_{\nu}^{-1}$	0.199	0.414	0.829			
$(1f_{7/2})_{\pi}\,(1d_{5/2})_{\pi}^{-1}$	0.19	0.183				
$(1f_{7/2})_{\nu}\,(1d_{5/2})_{\nu}^{-1}$	0.149	0.18				

Table 7. Theoretical and Experimental log ft Values for The Allowed $^{36}P(\beta^-)^{36}S$ Decay.

Parent nucleus, ^{36}P		Daughter nucleus, ^{36}S		Log ft			
E_i (MeV)	$J_i^{\pi_i}$	E_f (MeV)	$J_f^{\pi_f}$	Theo.		Exp.[9]	Other calculations [13]
				$g_A = 1.25$	$g_A = 0.95$		
0.0	4_1^-	4.193	3_1^-	6.03	6.27	6.1(2)	5.76
		5.022	4_1^-	4.60	4.84	5.72(4)	5.96
		5.206	5_1^-	5.68	5.91	6.39(8)	6.34
		5.251	3_2^-	4.24	4.48	5.57(4)	5.94
		5.831	3_3^-	3.88	4.11	4.66(3)	4.63
		7.272	4_2^-	3.25	3.49	4.62(5)	5.54

تركيب جسيم-فجوة للنواة الغريبة ^{36}P بإستخدام تقريب تام-دانكوف pnTDA

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الخلاصة:

درس تركيب النواة الغريبة الخفيفة ^{36}P بإستخدام تقريب تام-دانكوف (pnTDA)، حيث شغل الجسيم قشرات النيوترون 2p-1f، أما الفجوة فقد شغلت قشرات البروتون 1s-1p ، $1d_{5/2}$ و $2s_{1/2}$. مزجت تشكيلات جسيم-فجوة بوجود تفاعل دلتا السطحي المحور (MSDI) و حولت مصفوفتها الى مصفوفة قطرية لإنتاج أفضل قيم لمستويات طاقة سالبة التماثل ل ^{36}P. حسبت الخواص الكهرومغناطيسية و قيم $\log ft$ للتفاعل $^{36}P(\beta^-)^{36}S$ ، وقورنت مع البيانات المتوفرة. وجد من الضروري إدخال قيمة فعالة لثابت الإزدواج الإتجاهي-المحوري للتفاعل الضعيف g_A لتحسين قيم $\log ft$ المحسوبة.