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FRAGMENTATION OF TWO-QUASIPARTICLE STATES IN ^{92}Zr AND EVEN-EVEN Sn ISOTOPES

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1. INTRODUCTION

In recent years the fragmentation of one-quasiparticle states has successfully been studied experimentally /1-3/. A correct description of the fragmentation of one-quasiparticle states has been obtained within the quasiparticle-phonon nuclear model /4,5/, which is described in ref. /6/. The experimental information on the fragmentation of two-quasiparticle states is extracted from the spectroscopic factors of the one-nucleon transfer reactions in odd-A target nuclei. It has been shown /7,8/ that the two-nucleon transfer reactions of the type (p,t) may provide a more complete information on the fragmentation of two-quasiparticle states in spherical nuclei.

The spectroscopic factors of the $^{91}Zr(d,p)^{92}Zr$ reaction are determined experimentally in ref. /9,10/. The expressions for spectroscopic factors of one-nucleon transfer reactions within quasiparticle-phonon model are derived in ref. /11/.

The present paper is aimed at calculating the fragmentation of two-quasiparticle states in ^{92}Zr and some even-even Sn isotopes with the wave-functions including one-phonon and two-phonon components.

2. BASIC FORMULAE

The wave function of the excited state of a doubly even spherical nucleus is the following:

$$\Psi_\nu(JM) = \{ \sum_i R_i(J\nu) Q^+_{JMi} + \sum_{\lambda_1 \lambda_2 i_1 i_2} P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu) [Q^+_{\lambda_1 \mu_1 i_1} Q^+_{\lambda_2 \mu_2 i_2}]_{JM} \} \Psi_0 \cdot \quad (2.1)$$

where Ψ_0 is the ground state wave function. The two-quasiparticle component $j_1 j_2$ with spin J of state ν, described by the wave function (2.1), is

$$\Phi_{j_1 j_2}(J;\eta_\nu) = \frac{1}{2} | \sum_i R_i(J\nu) \psi^{Ji}_{j_1 j_2} |^2 . \quad (2.2)$$

Here j_1, j_2 are the quantum numbers of single-particle states, $\psi^{Ji}_{j_1 j_2}$ is a phonon amplitude.

The spectroscopic factors of nucleon transfer on the subshell j of an odd-A target have the following form /11/:
for the reaction of type (dp)

$$S_{jj_0}(J_f;\eta_\nu) = C^2_{j_0\nu_0} u^2_j \Phi_{j_1 j_2}(J_f;\eta_\nu), \qquad (2.3)$$

for the reaction of type (d,t)

$$S_{jj_0}(J_f;\eta_\nu) = C^2_{j_0\nu_0} v^2_j \Phi_{j_1 j_2}(J_f;\eta_\nu), \qquad (2.4)$$

where u_j, v_j are the Bogolubov transformation coefficients, $C^2_{j_0\nu_0}$ determines the contribution of the one-quasiparticle component to the norm of the ground state wave function of an odd-A nucleus.

The following expressions are often used:

$$S'_{jj_0}(J_f;\eta_\nu) = \frac{2J_f+1}{2j_0+1} S_{jj_0}(J_f;\eta_\nu);\ S'_{jj_0}(\eta_\nu) = \sum_{J_f} S'_{jj_0}(J_f;\eta_\nu). \qquad (2.5)$$

It is more practical and convenient to use the strength functions for (2.3)-(2.5) at high excitation energies. The expressions for these strength functions are given in ref. /11/ In our calculations we use the same Hamiltonian parameters as in ref. /11/.

3. RESULTS OF CALCULATION; COMPARISON WITH EXPERIMENT

Rich information on the fragmentation of two-quasiparticle states of the "particle-valence particle" and "valence particle-hole" type is gained in the reactions of type (d,p) and (p,d) on odd-A target-nuclei. In the one-nucleon transfer reactions on odd-A nuclei at fixed ℓ, the states with different spins J_f are excited. Therefore, in studying the fragmentation of two-quasiparticle states the summation was taken over J_f.

Let us consider the fragmentation of two-quasiparticle states of the "particle-valence particle" type in ^{92}Zr. The results of calculations will be compared with the spectroscopic factors, measured in refs. /9,10/ in the reaction ^{91}Zr(d,p)^{92}Zr. The spins of final states J_f have not been determined in refs. /9,10/ and the spectroscopic factors $S'_{jj_0}(J_f,\eta_\nu)$ are presented for all possible spins J_f of each quasiparticle state. The experimental data are represented as the spectroscopic factors $S'_{jj_0}(\eta_\nu)$ determined by formula (2.5). Therefore, the results of calculations are shown in fig.1 in the

Fig.1. Spectroscopic factors of the (d,p) reaction due to the fragmentation of two-quasiparticle states in ^{92}Zr: a) experimental data /9/; b) experimental data /10/; c) calculations by formula (2.5) with summation over spins of final states.

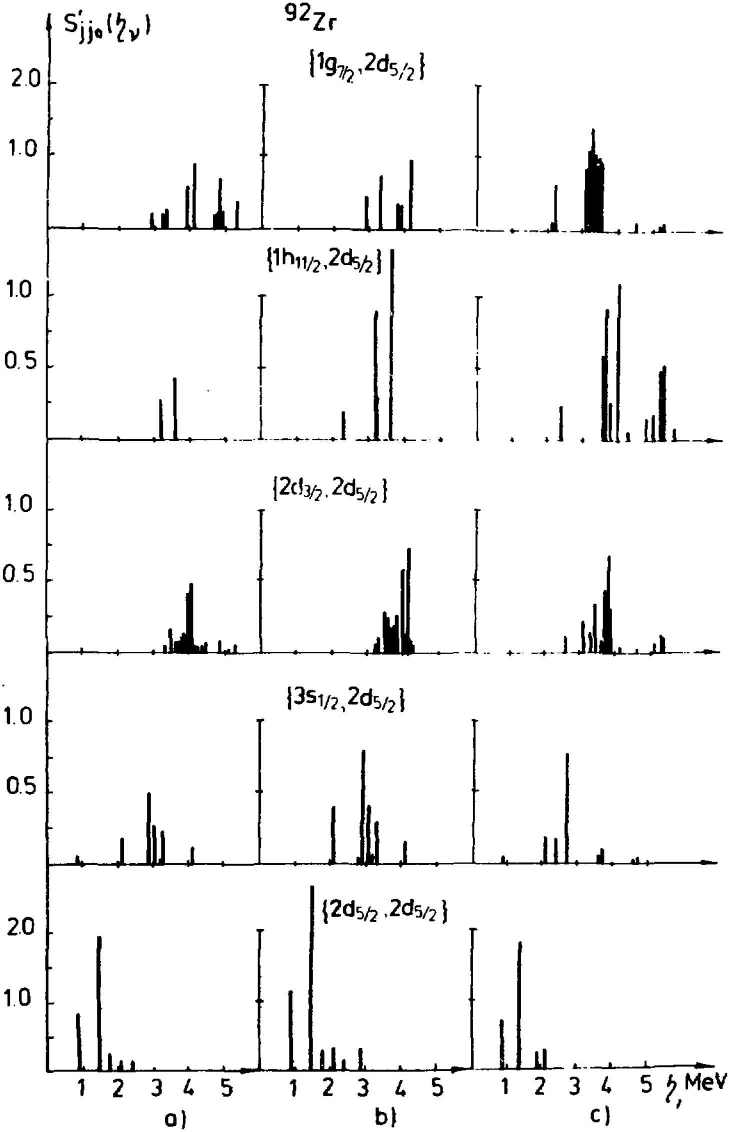
$S'_{jj_0}(\eta_\nu)$
^{92}Zr
$\{1g_{7/2}, 2d_{5/2}\}$
2.0
1.0
$\{1h_{11/2}, 2d_{5/2}\}$
1.0
0.5
$\{2d_{3/2}, 2d_{5/2}\}$
1.0
0.5
$\{3s_{1/2}, 2d_{5/2}\}$
1.0
0.5
$\{2d_{5/2}, 2d_{5/2}\}$
2.0
1.0
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5 η, MeV
a)
b)
c)

Table 1

Integral characteristics of two-quasiparticle states in ^{92}Zr

jj_0	Experiment				Calculation	
	Ref. 10		Ref. 9		$\Delta E=(0-5.4)$MeV	
	$\Delta E=(0-5.4)$MeV		$\Delta E=(0-4.9)$MeV			
	$\bar{E}_{jj_0}$	$\Sigma S'_{jj_0}$	$\bar{E}_{jj_0}$	$\Sigma S'_{jj_0}$	$\bar{E}_{jj_0}$	$\Sigma S'_{jj_0}$
$\{2d_{5/2}, 2d_{5/2}\}$	1.43	3.79	1.35	4.62	1.5	3.11
$\{3s_{1/2}, 2d_{5/2}\}$	2.94	1.30	2.93	2.28	2.9	1.70
$\{2d_{3/2}, 2d_{5/2}\}$	4.087	2.59	3.763	3.65	3.8	3.0
$\{1g_{7/2}, 2d_{5/2}\}$	4.207	4.55	3.674	2.99	3.3	6.6
$\{1h_{11/2}, 2d_{5/2}\}$	>3.44	0.66	>3.31	2.84	4.8	5.2
$\{2f_{7/2}, 2d_{5/2}\}$	>4.53	0.39	>3.18	0.23	5.11	1.7

same form. It is seen from fig.1 that the values of the spectroscopic factors obtained in these experimental papers differ considerably. The integral characteristics of the strength distribution of two-quasiparticle states are shown in table 1. These are the centroid energy

$$E_{jj_0} = \sum_{\nu\in\Delta E} \eta_\nu S'_{jj_0}(\eta_\nu) / \sum_{\nu\in\Delta E} S'_{jj_0}(\eta_\nu) \qquad (3.1)$$

and the sum of spectroscopic factors

$$\sum_{\nu\in\Delta E} S'_{jj_0}(\eta_\nu) \qquad (3.2)$$

in the energy interval ΔE.

Now we discuss the specific features of the fragmentation of two-quasiparticle states in ^{92}Zr. The state $\{2d_{5/2}, 2d_{5/2}\}$, whose both quasiparticles are located on the Fermi level, is fragmented in the energy interval 1-3 MeV. A large part of strength of this state with respect to the sum rule limit is observed experimentally. Our calculations give the sum strength larger than 50%. This is due to the value of the factor $u^2_{d_{5/2}}=0.75$.

In papers [9,10] the spins of final states have not been determined. It was assumed that in the one-nucleon transfer with $\ell=2$ up to an energy of 3 MeV just the component $\{2d_{5/2}, 2d_{5/2}\}$ was excited. These data for S'_{jj0} within 20% are in agreement with the data of ref.[12], obtained in the reaction $^{91}Zr(\vec{d},p)^{92}Zr$. The calculations show that almost the whole strength of the configuration $\{2d_{5/2}, 2d_{5/2}\}$ is concentrated up to an energy of 3 MeV. The theory describes correctly the fragmentation of two-quasiparticle states $\{3s_{1/2}, 2d_{5/2}\}$ and $\{2d_{3/2}, 2d_{5/2}\}$. A more strong than the experimental concentration of strength is obtained for the configuration $\{1g_{7/2}, 2d_{5/2}\}$ in the region of 3-4 MeV. With increasing excitation energy, the experimental observation of individual state becomes difficult. Just a small part of the $\{1h_{11/2}, 2d_{5/2}\}$ strength is observed experimentally. The calculations show that a considerable fraction of this strength is in the energy region higher than 4 MeV. On the whole the experimental data and our calculations provide a similar picture of the fragmentation of two-quasiparticle states in ^{92}Zr. It is seen from table 1 that the integral characteristics calculated of the two-quasiparticle states agree with the corresponding experimental data.

We can state that in general outline a proper distribution of strength of the two-quasiparticle states in ^{92}Zr is obtained within the quasiparticle-phonon nuclear model. This is achieved without fitting the model parameters which are fixed in ref.[13] in the calculations of the neutron strength functions. Note, that the calculations in refs.[9,10] describe well the spectroscopic factors too.

In recent years the experimental data on the fragmentation of two-quasiparticle states in the Cd and Sn isotopes have been obtained in the (p,d) and (p,t) reactions. At the excitation energies of 7-9 MeV a resonance-like structure is observed in the (p,t) reaction cross sections on doubly even isotopes of Cd and Sn. The peaks in the cross sections are caused by the excitation of components including a valence particle and a deep hole[15]. The two-hole states are assumed to have some admixture. The investigations [15,16] of the (p,d) reaction on $^{111,113}Cd$ and $^{117,119}Sn$ show the existence of pronounced resonance-like structures at the excitation energies of 6.7-9.0 MeV. Both the excitation energy and the width dependence with mass number A are similar in one- and two-nucleon transfer. The widths of these structures in the (p,d) data are significantly lower than the ones deduced from the (p,t) studies.

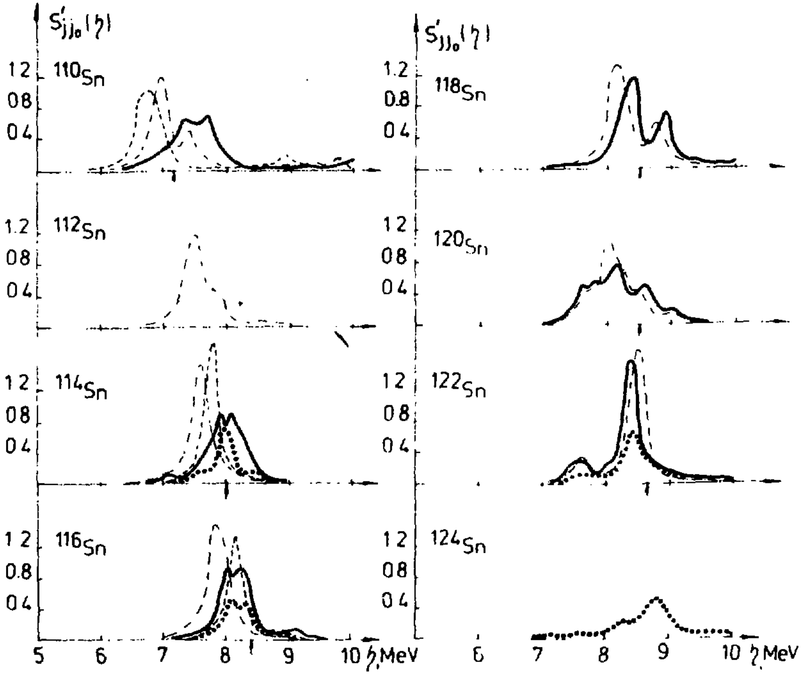

Fig.2. Fragmentation of two-quasiparticle states in doubly even Sn isotopes: the solid curve is $S'_{jj_0}(\eta)$ for the configuration $\{2d_{3/2}, 1g^{-1}_{9/2}\}$, the dashed curve is $S'_{jj_0}(\eta)$ for the configuration $\{1g_{7/2}, 1g^{-1}_{9/2}\}$, the dot-dashed curve is $S'_{jj_0}(\eta)$ for the configuration $\{3s_{1/2}, 1g^{-1}_{9/2}\}$, the dotted curve is $S'\ (\eta)$ for the configuration $\{1h_{11/2}, 1g^{-1}_{9/2}\}$.

At the excitation energies more than 5 MeV the state density is large. In the reactions (p,d) and (p,t) at fixes transfer momentum ℓ the states with different spins J_f of final doubly-even nuclei are excited. Therefore, to study the fragmentation of two-quasiparticle states, one should calculate the strength functions (2.4) and perform summation over the spins of final states.

Now we study the fragmentation of two-quasiparticle states in doubly even isotopes of Sn. The strength functions, deter-

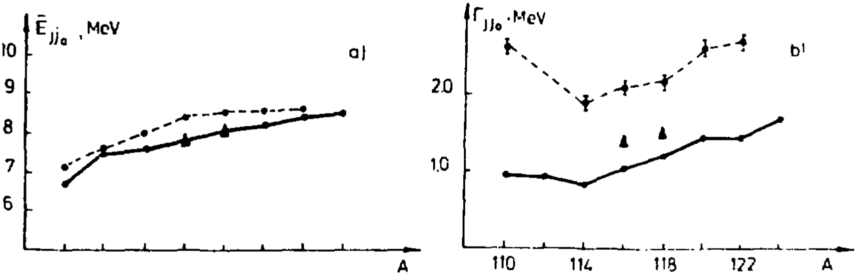

Fig.3. Centroid energy $\bar{E}_{jj_0}$ and width Γ_{jj_0} for doubly even Sn isotopes: a) dependence of $\bar{E}_{jj_0}$ on A; b) dependence of Γ_{jj_0} on A. A refers to the final nucleus; the points connected by the dashed line are the experimental data on the (p,t) reaction /15/; ▲ is the experimental data on the (p,d) reaction /15/; the points connected by the solid line are the calculations for the (p,d) reaction by formulae (3.3) and (3.4).

mined by formula (2.4), for the two-quasiparticle states $\{1g_{7/2}, 1g_{9/2}^{-1}\}$, $\{3s_{1/2}, 1g_{9/2}^{-1}\}$, $\{2d_{3/2}, 1g_{9/2}^{-1}\}$ and $\{1h_{11/2}, 1g_{9/2}^{-1}\}$ for the Sn isotopes are shown in fig.2. The energies of the peaks observed in the (p,t) reaction are denoted by arrows. In one-nucleon transfer reactions of the type (p,t) on odd-A target-nuclei, the two-quasiparticle states of the valence particle-hole type should be excited. Such configurations are: in ^{110}Sn – $\{1g_{7/2}, 1g_{9/2}^{-1}\}$, in ^{112,114,116,118}Sn – $\{3s_{1/2}, 1g_{9/2}^{-1}\}$, in ^{120}Sn – $\{2d_{3/2}, 1g_{9/2}\}$, in ^{122,124}Sn – $\{1h_{11/2}, 1g_{9/2}\}$. In the (p,t) reactions there are additionally excited the two-hole and the particle on the level adjacent to the Fermi level and the deep hole states.

The centroid energy $\bar{E}_{jj_0}$ and width Γ_{jj_0} obtained in the (p,t) and (p,d) reactions with the formation of the same final doubly even nuclei for different Sn isotopes, are shown in fig.3. For the calculation of centroid energy and width the following formulae have been used:

$$E_{jj_0} = \int_{\Delta E} \eta S'_{jj_0}(\eta)\, d\eta / N \qquad N = \int_{\Delta E} S'_{jj_0}(\eta)\, d\eta \qquad (3.3)$$

$$\Gamma_{jj_0} = 2.35\sigma \qquad \sigma^2 = \int_{\Delta E} (E_{jj_0} - \eta)^2 S'_{jj_0}(\eta) d\eta / N. \qquad (3.4)$$

The calculations of $\bar{E}_{jj_0}$ and Γ_{jj_0} are performed for the (p,d) reaction for the valence particle and hole $1g_{9/2}$ configuration with $\Delta E \approx 2$ MeV. It is seen from fig.3 that the calculations of the centroid energy $\bar{E}_{jj_0}$ agree fairly well with the experimental data on the (p,d) reaction. The calculated energies $\bar{E}_{jj_0}$ are somewhat lower than the peaks observed in the (p,t) reactions. The energy $\bar{E}_{jj_0}$ increase with A due to the decrease in the hole state $1g^{-1}_{9/2}$ energy with respect to the Fermi energy. The calculated values of $\bar{E}_{jj_0}$ for the two-quasiparticle states $\{3s_{1/2}, 1g^{-1}_{9/2}\}$ in ^{116}Sn and ^{118}Sn are equal to 7.8 and 8.1 MeV. According to ref./5/ the energies for the one-quasiparticle state $1g^{-1}_{9/2}$ in ^{115}Sn and ^{117}Sn are equal to 5.5 and 5.6 MeV. The difference between these centroid energies is 2.3 and 2.5 MeV, that is somewhat less than the difference between the experimental data /8,15/. Thus the calculations clear up the experimental difference observed between the centroid energy for the hole state in odd-A and doubly even tin isotopes.

The calculated widths are somewhat less than Γ_{jj_0} measured in the (p,d) reaction. The calculated dependences of Γ_{jj_0} on A for the (p,d) reaction are caused, first, by the $1g_{9/2}$ subshell position with respect to the Fermi energy, and second, by the spin j_0 of the subshell corresponding to the ground state of an odd-A target nucleus. If j_0 is large, the two-quasiparticle configuration has many spins, that leads to an increase in the width Γ_{jj_0} .Indeed, the configuration $\{1g_{7/2}, 1g_{9/2}\}$ with many different spins is excited in ^{110}Sn. The width Γ_{jj_0} in $^{112\text{-}116}$Sn somewhat decreases, as the configuration $\{3s_{1/2}, 1g^{-1}_{9/2}\}$ with two spins 4^+ and 5^+ is excited. In ^{120}Sn the configuration $\{2d_{3/2}, 1g^{-1}_{9/2}\}$ with $J^{\pi}=3^+\text{-}6^+$ is excited and the width slightly increases. In ^{124}Sn there is excited the configuration $\{1h_{11/2} 1g^{-1}_{9/2}\}$,which is strongly fragmented in the interval (7-10) MeV. The increase in the width Γ_{jj_0} with A is due to an enhancement of the fragmentation of the states $\{3s_{1/2}, 1g^{-1}_{9/2}\}$; this is demonstrated in fig.2. The results of our calculations for $\bar{E}_{jj_0}$ and Γ_{jj_0} and the available experimental data for the (p,d) reactions are collected in table 2. The calculated

Table 2

Centroids of energies $\bar{E}_{jj_0}$ and width Γ_{jj_0} for configurations excited in the (p,d) reaction

Nucleus	$\bar{E}_{jj_0}$			Γ_{jj_0}		
	Exper.	Ref.	Calc.	Exper.	Ref.	Calc.
^{110}Sn			6.7			0.94
^{112}Cd	6.95	16	7.5			1.2
^{112}Sn			7.5			0.9
^{114}Sn			7.6			0.8
^{116}Sn	7.79	15	7.8	1.38	15	1.0
	8.0	16				
^{118}Sn	8.14	15	8.1	1.6	15	1.2
	8.25	16				
^{120}Sn			8.2			1.4
^{122}Sn			8.4			1.5
^{122}Te			7.6			1.1
^{124}Sn			8.5			1.7

Γ_{jj_0} are slightly lower than the experimental values. The ratio of the widths for ^{118}Sn and ^{116}Sn is in agreement with experiment.

We can state that the two-quasiparticle valence particle-hole $1g_{9/2}$ configurations in doubly even Sn isotopes are located in the energy interval (1-2) MeV at 7-9 MeV. About 70-80% of strength of these two-quasiparticle states excited in the (p,d) reaction is concentrated in this interval.

The calculated energy $\bar{E}_{jj_0}$ and width Γ_{jj_0} dependence on A for the (p,d) reactions on odd-A Sn isotopes is similar to the experimental data on the (p,t) reactions. This similarity is due to the excitation of the valence particle-hole $1g_{9/2}$ configuration in the (p,t) reaction. This fact has been pointed out in ref./17/. The "hole-hole" and "hole-particle" configurations with a particle close to the Fermi level, can also be excited in the (p,t) reaction. The spectroscopic strength functions $S'_{jj0}(\eta)$ for these states are shown in fig.2.

The configurations $\{3s_{1/2}, 1g^{-1}_{9/2}\}$, $\{2d_{3/2}, 1g^{-1}_{9/2}\}$ and $\{2d_{5/2}, 1g^{-1}_{9/2}\}$ lie in ^{110}Sn at 6-8 MeV, i.e., at the same energies as the peak in the (p,t) interaction. Excitation in the (p,t) reaction of these configurations alongside with the $\{1g_{7/2}, 1g^{-1}_{9/2}\}$ configuration increases the width Γ_{jj0} as compared to the (p,d) reaction. It should be mentioned that the $\{1g_{7/2}, 2p^{-1}_{1/2}\}$ configuration in ^{110}Sn is in the region of 8.5 MeV. In the (p,t) reaction in ^{114,116}Sn apart from the main configuration $\{3s_{1/2}, 1g^{-1}_{9/2}\}$ there may be excited the configuration $\{1g^{-1}_{7/2}, 1g^{-1}_{9/2}\}$, $\{2d_{3/2}, 1g^{-1}_{9/2}\}$ and $\{1h_{11/2}, 1g^{-1}_{9/2}\}$. The increase in the width Γ_{jj0} in the (p,t) reactions on heavier Sn isotopes is due to the enhancement of the fragmentation of states $\{2d_{3/2}, 1g^{-1}_{9/2}\}$ and $\{1h_{11/2}, 1g^{-1}_{9/2}\}$.

We can state that the resonance-like structures observed in the (p,t) reactions on $^{112-124}$Sn at (7-9) MeV are mainly caused by excitation of the following states $\{1g_{7/2}, 1g^{-1}_{9/2}\}$, $\{3s_{1/2}, 1g^{-1}_{9/2}\}$, $\{2d_{3/2}, 1g^{-1}_{9/2}\}$ and $\{1h_{11/2}, 1g^{-1}_{9/2}\}$. According to the calculations the strength of these states is fragmented in the energy interval 6.5-9.0 MeV.

A similar picture is observed for the Cd and Te isotopes, whose single-particle spectra of the neutron states are analogous to those of the Sn isotopes. The strength functions $S'_{jj0}(J_f;\eta)$ and $S'_{jj0}(\eta)$ for the configurations $\{3s_{1/2}, 1g^{-1}_{9/2}\}$ in ^{112}Cd and ^{122}Te are shown in fig.4. These configurations are to be excited in the reactions ^{113}Cd(p, d)^{112}Cd and ^{123}Te(p,d)^{122}Te. It is seen from fig.4 that these two-quasiparticle states are fragmented in the interval of about 1.5 MeV at 7.5 MeV. Similarly to the Sn isotopes, about 70% of strength of the configuration $\{3s_{1/2}, 1g^{-1}_{9/2}\}$ is well localized. The calculated value of $\bar{E}_{jj0}$ for ^{112}Cd agrees with the data of ref./16/ within the experimental errors. The experimental data on the (p,t) reactions /7,8/ for these nuclei show the peaks at slightly higher excitation energies.

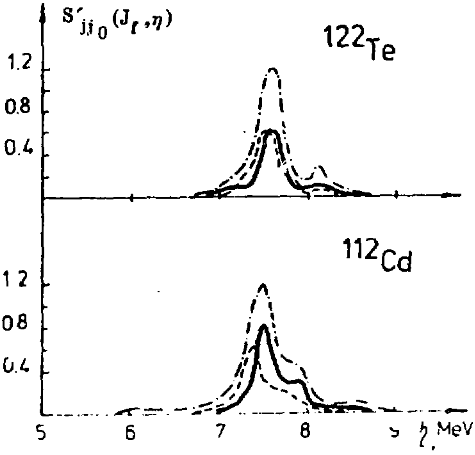

Fig.4. Fragmentation of the two-quasiparticle state $\{3s_{1/2},1g^{-1}_{9/2}\}$ in ^{112}Cd and ^{122}Te; ; the solid curve is $S'_{jj0}(J_f,\eta)$ for the state with $J^{\pi}=5^{+}$, the dashed curve is $S'_{jj0}(J_f,\eta)$ for the state with $J^{\pi}_{f}=4^{+}$, the dot-dashed curve is $S'_{jj0}(\eta) = \sum_{J_f} S'_{jj0}(J_f,\eta)$.

In the (p,t) reactions /7/ two peaks in the cross sections are observed on the Cd isotopes. The low-energy peak at about 7 MeV has the same nature as in the Sn isotopes. The high-energy peaks lie at about 12 MeV in the Cd isotopes. The dependence of $\bar{E}_{jj0}$ on A for these peaks is in agreement with the assumption that the two-hole levels are excited. Our RPA calculations show that at the excitation energies 11-12 MeV in the ^{110,112,114,116}Cd isotopes there are hole-hole $\{2d^{-1}_{5/2},1f^{-1}_{5/2}\}$ and $\{2d^{-1}_{5/2},2p^{-1}_{3/2}\}$ configurations. The configuration $\{1g^{-1}_{9/2},1g^{-1}_{9/2}\}$ is somewhat higher. The valence particle-deep hole $1f_{5/2}$, $\{3s_{1/2},1f^{-1}_{5/2}\}$ and $\{2d_{3/2},1f^{-1}_{5/2}\}$ configurations are also localized at these excitation energies. These configurations can also contribute to the (p,t) reaction cross sections. It is interesting to investigate consistently the (p,t) and (p,d) reactions on the Cd and Te isotopes.

4. CONCLUSION

The calculations and comparison with the experimental data show that within the quasiparticle-phonon nuclear model one can correctly describe the fragmentation of two-quasiparticle states in doubly even spherical nuclei. The quasiparticle-phonon interaction influences greatly the fragmentation of two-quasiparticle states.

The investigation of the fragmentation of two-quasiparticle states in the Sn isotopes has shown that the two-quasiparticle states of the valence particle-deep hole-type are localized at the excitation energies of (7-9) MeV. They should be observed in the one-nucleon transfer reactions. For some nuclei the energies and widths of peaks, which can be observed in the one-nucleon transfer reactions are calculated. It is significant that reactions of the type (p,t) provide an important information on the fragmentation of two-quasiparticle states.

REFERENCES

1. Sakai M., Kubo K.I. Nucl.Phys., 1972, A185, p.217; Siemsson R.H. In: Selected Topics in Nuclear Structure. JINR, D-9920, Dubna, 1976, vol.2, p.106.
2. Berrier-Ronsin G. et al. Nucl.Phys., 1977, A282, p.189.
3. Gerlic E. et al. Phys.Rev., 1980, C21, p.124.
4. Vdovin A.I. et al. Izv. AN SSSR, ser. fiz., 1979, 43, p.999.
5. Soloviev V.G. et al. Nucl.Phys., 1980, A342, p.261.
6. Soloviev V.G. Particle and Nucleus, 1978, 9, p.580; Nucleonica, 1978, 23, p.1149; In: Proc. Int. School on Nucl.Struct., JINR, D4-80-385, Dubna, 1980, p.57.
7. Crawly G.M. In: Proc. 1980 RCNP Int. Symp. on Highly Excited States in Nuclear Reactions. Osaka, 1980, p.590.
8. Gales S. Preprint of Institut de Physique Nucleaire. IPN-PhN-80-23, Orsay, 1980.
9. Ipson S.S. et al. Nucl.Phys., 1975, A253, p.190; Gloeckner D.H. Nucl.Phys., 1975, A253, p.301.
10. Borello-Lewin T. et al. Phys.Rev., 1979, C20, p.2101.
11. Soloviev V.G. et al. JINR, P4-81-227, Dubna, 1981.
12. Bieszik J.A. Nucl.Phys., 1980, A339, p.513.
13. Voronov V.V. et al. Yad.Fiz., 1980, 31, p.327.
14. Crawly G.M. et al. Phys.Rev., 1980, C22, p.316.
15. Crawly G.M. et al. Phys.Rev., 1981, C23, p.589.
16. Ishimatsu T. et al. J.Phys.Soc.Jap., 1973, 35, p.1579.
17. Nomura M. Prog.Theor.Phys., 1978, 59, p.1771.

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