ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ
ДУБНА

E4 - 8834

V.G.Soloviev, V.V.Voronov

THE ANALYSIS OF SIMPLE CONFIGURATIONS IN THE CAPTURE STATE OF ZIRCONIUM AND MOLYBDENUM

1975

E4 - 8834

V.G.Soloviev, V.V.Voronov

THE ANALYSIS OF SIMPLE CONFIGURATIONS IN THE CAPTURE STATE OF ZIRCONIUM AND MOLYBDENUM

Submitted to ЯФ

1. The wave functions of neutron resonances in complex nuclei contain thousands of different components. In the process of neutron capture and γ-decay of resonance there is a small number of fewquasiparticle components. Thus, experimental data make it possible to find the values of individual few-quasiparticle components of the neutron resonance wave function. It is, undoubtedly, of interest. It is shown in refs. /1,2/ that the mean values of one-quasiparticle components can be obtained from the neutron widths. A wide use of the valence neutron model /3/ gives evidence of an important role of one-quasiparticle components. It is shown in refs. /4,5/ for several nuclei. The values of some simple configurations were estimated in refs. /6,7/ from experimental data. There, the quasiparticle plus phonon components in the wave functions of capture states are found to be very important in the E1-transitions to the low-lying states.

On the basis of a general semimicroscopic approach to the study of highly excited states /1,8/ and the model for the description of fragmentation of one-particle states /9,10/, one has an opportunity to find individual simple configurations in the capture states /9,10/. It is possible to point out in which nuclei the valence neutron model would work well. The examples of such an analysis are given in /2,11/.

In this paper the part of semimicroscopic description which is used for analysis of the structure of neutron resonances is presented. The simple configurations in the capture state of odd-A isotopes are obtained, and the effectiveness of the valence neutron model is determined.

2. Now we write down the formulae necessary for analyzing γ-transitions from neutron resonances to low-lying states in odd-A spherical nuclei.

The wave function of a highly excited state can be represented both as an expansion in a number of quasiparticle and as that in quasiparticle plus zero, one, two and so on phonons. The wave function of a highly excited state of odd-N-spherical nuclei represented in the form of expansion in a number of quasiparticles is as follows

$$\Psi_\nu (J^\pi M) = b_J^\nu (j^n)\, \delta_{J j^n} \delta_{M m^n}\, \alpha^+_{j^n m^n} \Psi_0 + \tag{1}$$

$$+ \sum_{j_1^n j_2 j_3} \sum_{m_1^n m_2 m_3} b^\nu_{JM}(j_1^n m_1^n\, j_2\, m_2\, j_3\, m_3)\, \alpha^+_{j_1^n m_1^n} \alpha^+_{j_2 m_2} \alpha^+_{j_3 m_3} \Psi_0 + \ldots$$

where b_J^ν are the unknown coefficients, α^+_{jm} is the quasiparticle creation operator, Ψ_0 is the quasiparticle vacuum, $(j^n m^n)$, (jm) define the one-particle states, corresponding to the neutron and the neutron and proton systems respectively. The peculiarities of this wave functions are described in /1/. In the model for describing the fragmentation of one-particle and many-particle states over the nuclear levels, the wave function is of the form:

$$\Psi_\nu (J^\pi M) = C_J^\nu \{ \alpha^+_{JM} + \sum_{\lambda i j} D_j^{\lambda i} (J\nu) \sum_{\mu m} \langle \lambda\mu j m | JM \rangle \alpha^+_{jm} Q^+_{\lambda\mu i} + \ldots \} \Psi_0 , \tag{2}$$

where $Q^+_{\lambda\mu i}$ is the phonon creation operator, the energy states and the function C_J^ν, $D_j^{\lambda i}(J\nu)$ are determined from the solutions of corresponding equations.

Consider γ-transitions with highly excited states, described by the wave functions (1) and (2), to the one-quasiparticle components of the low-lying states with the wave function

$$\Psi_f (j_f\, m_f) = C_f\, \alpha^+_{j_f m_f} \Psi_0 + \cdots , \tag{3}$$

where $|C_f|^2$ defines the contribution of the quasiparticle component to the wave function normalization (3), and the spectroscopic factor $S_f = |C_f u_f|^2$, u_f is the Bogolubov transformation coefficient.

The radiation width is connected with the matrix element of γ -transition in the following way:

$$\Gamma_{\gamma\nu f}(\lambda) = \frac{8\pi\lambda(\lambda+1)}{\lambda[(2\lambda+1)!!]^2} E_\gamma^{2\lambda+1} \Gamma^\circ_{\gamma\nu f}(\lambda) , \tag{4}$$

$$\Gamma^\circ_{\gamma\nu f}(\lambda) = \Big| \sum_{\mu m_f} (j_f m_f \lambda \mu / JM) M(\lambda; J^\pi M\nu \to j_f m_f) \Big|^2 , \tag{5}$$

$M(\lambda; J^\pi M\nu \to j_f m_f)$ is the matrix element for γ - transition from the state $J^\pi M\nu$ to the state $j_f m_f$. The radiation width for the E1 and M1 transitions can be written as :

$$\Gamma(E1) = 1{,}05.10^3 E_\gamma^3 \Gamma^\circ(E1) \text{ meV} , \tag{6}$$

$$\Gamma(M1) = 11{,}6.\, E_\gamma^3 \Gamma^\circ(M1) \text{ meV} , \tag{6'}$$

where the energy E_γ is in MeV, $\Gamma^\circ(E1)$ is in $e^2 fm^2$, $\Gamma^\circ(M1)$ is in $(\frac{e\hbar}{2mc})^2$, then we use $\hbar = C = 1$. The reduced radiation width calculated with the wave functions (1) and (2) has the following form:

$$\Gamma^\circ_{\gamma\nu f} = |C_f|^2 \Big| b_J^\nu \frac{\langle j_f \| \Gamma \| J \rangle}{\sqrt{2J+1}} v_{j_f J}^{(\mp)} \pm \frac{1}{2} \sum_{j_1 j_2} \frac{\langle j_1 \| \Gamma \| j_2 \rangle}{\sqrt{2\lambda+1}} u_{j_1 j_2}^{(\pm)} b_J^\nu (j_f j_1 j_2) \Big|^2 , \tag{7}$$

$$\Gamma^\circ_{\gamma\nu f} = \Big| C_f C_J^\nu \Big|^2 \Big| \frac{\langle j_f \| \Gamma \| J \rangle}{\sqrt{2J+1}} v_{j_f J}^{(\mp)} \pm \frac{1}{2} \sum_{j_1 j_2} \frac{\langle j_1 \| \Gamma \| j_2 \rangle}{\sqrt{2\lambda+1}} u_{j_1 j_2}^{(\pm)} D_{j_f}^{\lambda i}(J\nu)(\psi_{j_1 j_2}^{\lambda i} \pm \varphi_{j_1 j_2}^{\lambda i}) \Big|^2 \tag{8}$$

Here $\langle j_1 | \Gamma | j_2 \rangle$ are the one-particle matrix elements of the $E\lambda$ and $M\lambda$ transitions, $\psi^{\lambda i}_{j_1 j_2}$, $\phi^{\lambda i}_{j_1 j_2}$ define the contributions of the two-quasiparticle states to corresponding phonons (see /12/),

$$u^{(\pm)}_{j_1 j_2} = u_{j_1} v_{j_2} \pm u_{j_2} v_{j_1} \qquad v^{(\pm)}_{j_1 j_2} = u_{j_1} u_{j_2} \mp v_{j_1} v_{j_2} ,$$

the upper sign in (7), (8) corresponds to the $E\lambda$ -transitions, and the lower sign to the $M\lambda$ -transitions. The first terms in formulae (6), (8) give the known expressions for the radiation width of the valence neutron model /3/, in which the coefficients b^{ν}_{J} are determined from experimental data of the reduced neutron widths.

The reduced neutron width is connected with one-quasiparticle components of the wave functions (1), (2) in the following way:

$$\Gamma^{o}_{\lambda n} = \Gamma^{o}_{s.p.} \; | b^{\nu}_{J} (j) u_{j} |^{2} \quad \Gamma^{o}_{\lambda n} = \Gamma^{o}_{s.p.} \; | C^{\nu}_{J} u_{J} |^{2} , \qquad (9)$$

where $\Gamma^{o}_{s.p.}$ is the one-particle reduced neutron width.

3. When analyzing the γ -transitions from neutron resonances to the low-lying states we shall make use of the fact that the one-and three-quasiparticle states are distributed over the levels in a wide energy interval. Suppose that at energies close to the neutron binding energy B_n maximum strength of the one-quasiparticle state is concentrated in the 2-3 MeV interval and, of the three-quasiparticle state in the 1-2 MeV interval. We calculate the energies of the one-quasiparticle, three-quasiparticle and quasiparticle plus phonon states for each nucleus. We choose the states, lying near B_n from which the E1 and M1-transitions proceed. Note, that under the γ -transitions to one-quasiparticle components the components of the wave-functions with five and more quasiparticles do not take part, it is seen from (7), (8). Calculations are performed with the one-particle energies and the wave functions of a Saxon-Woods potential. The parameters of the Saxon-Woods potential and interaction constants are the same as in /13/.

The results of our calculation for the odd-A isotopes of Zr and Mo are given in figs. 1-4 which present the energies of the subshells $3p_{1/2}$, $3p_{3/2}$ and of those three-quasiparticle states from which the E1 and M1-transitions proceed to one-quasiparticle components of the low-lying states. The neutron binding energy B_n and the calculated energies and spectroscopic factors for the ground and a series of low-lying states are given in the figures.

On the basis of general regularities of fragmentation of one-quasiparticle and three-quasiparticle states and formulae (7), (8) for the γ-transitions from the neutron resonances one may confirm that the neutron valence model works under the following conditions: i) the one-quasiparticle components of the neutron resonance wave function should be maximal which holds in nuclei in the ranges of maxima of the s or p-wave neutron strength

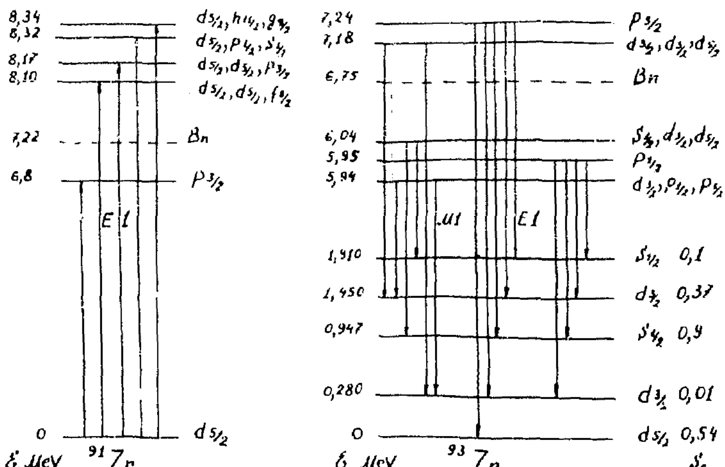

Fig. 1. The E1-transitions from p *-wave resonances and the M1-transitions from* s *-wave resonances in* ^{91,93}Zr.

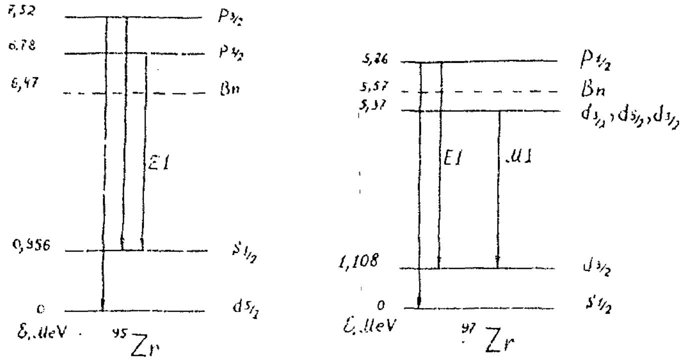

Fig. 2. The E1-transitions from p -wave resonances and the M1-transitions from s -wave resonances in ^{95,97}Zr.

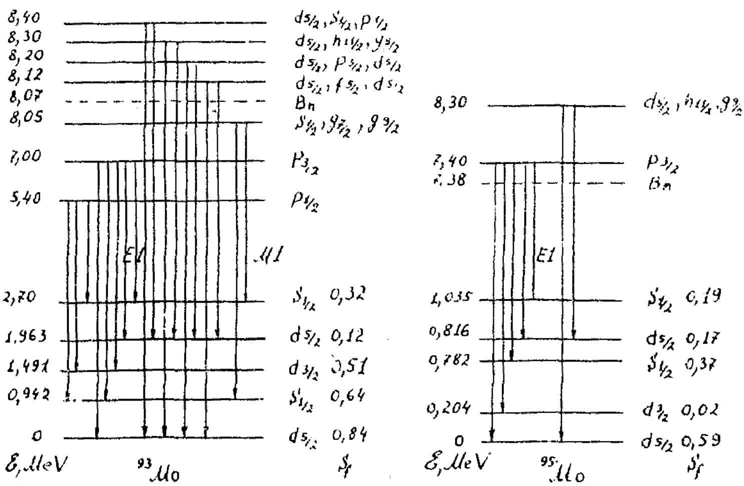

Fig. 3. The E1-transitions from p -wave resonances and the M1-transitions from s -wave resonances in ^{93,95}Mo.

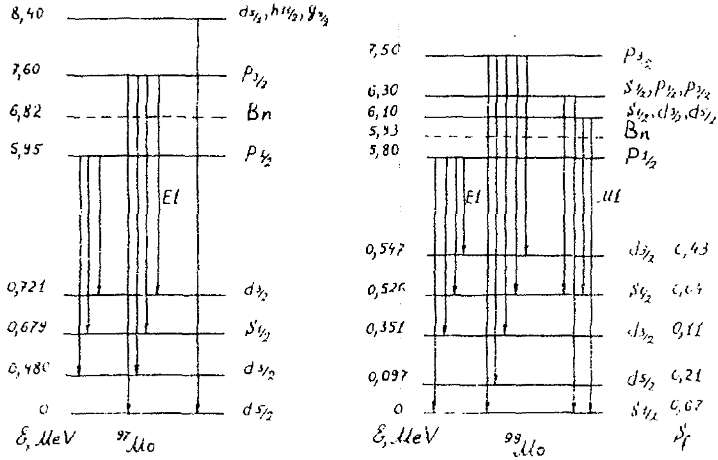

Fig. 4. The E1-transitions from p *-wave resonances and the M1-transitions from* s *-wave resonances in* ^{97,95}Mo.

functions. ii) Near Bn there are no such three-quasiparticle states, from which the El-transitions proceed to one-quasiparticle components of the wave functions of *low-lying states. iii)* Low-lying states to which the El-transitions from neutron resonances proceed must have large one-quasiparticle components.

The analysis of the partial radiation widths makes it possible to obtain information on individual one-quasiparticle, three-quasiparticle and quasiparticle plus phonon components of the neutron resonance wave functions. In practice this can be performed if the main contribution into the γ -transition is given by one or two components of the wave function. We find an order of magnitude of one-quasiparticle component from the neutron width. The one-quasiparticle component is very important in the correlation between neutron and radiation widths. In the valence neutron model this correlation is equal to unity.

4. Let us analyse the partial radiation width in the odd isotopes of zirconium to obtain the information on simple configurations in the capture states and verify the valence neutron model. Consider the nucleus ^{91}Zr, which ground state is the one-particle neutron state $d_{5/2}$ of a above closed neutron shell and closed proton subshell. Due to the valence neutron model the El-transitions would occur between the subshells $p_{3/2}$ and $d_{5/2}$, the coefficients of the correlation ρ between the reduced radiational and neutrons widths is equal to unity. In /15/ the radiational and neutron widths in the reactions $^{91}Zr(\gamma,n)$ ^{90}Zr, $^{90}Zr(n,\gamma)$ ^{91}Zr for $36 p_{3/2}$ resonances with energy from 5 keV to 225 keV are estimated and the correlation $\rho = +0.59$ is found. The value $<\Gamma_{0\gamma}> = 0.15$ eV was obtained for the mean radiation width. The calculations by the valence neutron model give $<\Gamma_{0\gamma}>_{v.m.} = 0.089$ eV. It follows that the valence transitions are very important but they do not exhaust the strength of El-transitions. As is seen from fig. 1, for ^{91}Zr in the energy interval from 8.0 to 8.5 MeV there lie for three-quasiparticle configurations to which the El-transitions from the ground state can proceed, thus, with increasing excitation energy the valence neutron model in (γ,n) reaction in ^{91}Zr is expected to work worse. From the mean reduced neutron width, by (9), we obtain the following estimations of the one-quasiparticle component: for s-wave resonances $|\delta|^2 \sim 2.10^{-4}$, for p- wave resonances $|\delta|^2 \sim 10^{-3}$. The large values of one-quasiparticle components are due to a slower development of fragmentation in near magic nuclei, compared to non-magic ones. It is shown in ref. /5/ that the valence neutron model describes well the partial γ-widths for the El-transitions to the low-lying levels with large spectroscopic factors in $^{93,95,97}Zr$. As is seen from figs. 1,2 at the excitation energies of B_n order there are no three-quasiparticle configurations through which the El-transitions proceed. Thus, the regularities of the valence neutron model should be clearly displayed in these nuclei.

We also note that ^{93}Zr contains an anomalously large width $\Gamma_\gamma = 600$ meV for the Ml-transitions from s-wave resonance. The Ml-transitions to one-quasiparticle state proceed through three-quasiparticle configurations. In the range of neutron binding energy there are three-quasiparticle configurations.

$$\{ d^{n}_{3/2}, p^{p}_{1/2}, p^{p}_{3/2} \}, \{ s_{1/2}, d_{3/2}, d_{5/2} \}^{3n}, \{ d_{3/2}, d_{5/2} d_{3/2} \}^{3n}.$$

If one uses the values of spectroscopic factors given in Fig. 1 then for the partial Ml widths for the transitions

$$\{ d^{n}_{3/2}, p^{p}_{1/2}, p^{p}_{3/2} \} \to d_{3/2} s_f = 0{,}37, \{ s_{1/2}, d_{3/2}, d_{5/2} \}^{3n} \to s_{1/2} s_f = 0{,}9,$$

$$\{ d_{3/2}, d_{5/2}, d_{3/2} \}^{3n} \to d_{3/2} s_f = 0{,}37, \{ s_{1/2}, d_{3/2}, d_{5/2} \}^{3n} \to s_{1/2} s_f = 0.1$$

the calculations give the values $\Gamma(Ml) =$ 125 meV, 380 meV, 130 meV, 15 meV correspondingly. To describe the enhancement of the Ml-transitions it is necessary to introduce the collective phonon 1^+ in ^{92}Zr. According to calculations there is a phonon 1^+ at the energy 5.5 MeV. It is a collective one due to a gap in the spectrum energies of two-quasiparticle poles. By introducing the collective phonon 1^+ into ^{92}Zr one may explain a large width for the Ml-transitions. Further experimental study of the Ml-transitions from s -wave resonances in ^{93}Zr is necessary.

On the basis of the performed analysis we can make the following conclusion:

i) In the wave function of neutron resonances in the isotopes Zr with A = 91, 93, 95, 97 there clearly appear the one-quasiparticle components $3p_{1/2}$, $3p_{3/2}$. The neutron valence model should work well.

The large radiation El-width in ^{91}Zr gives evidence for a noticeable contribution of three-quasiparticle components into the wave functions of p -wave resonances (given in Fig. 1),

iii) The large radiation Ml-width in ^{93}Zr points out a considerable contribution of the components $d_{3/2}$ plus the collective phonon 1^+ and $s_{1/2}$ plus the collective phonon 1^+ to the wave functions of s -wave resonances.

5. Let us analyse the partial E1 and M1 transitions from neutron resonances to the low-lying states of odd isotopes of molybdenum. The valence transitions in the reaction ^{92}Mo (n, γ) ^{93}Mo are investigated in refs. /4,7,16/. The analysis showed /16/ that the valence transitions are very important, however, do not dominate. For the γ -transitions with energy 8.067, 7.126, 6.576 MeV, the valence transitions give the contribution to the average partial widths equal to 40%, 25%, 15% correspondingly. The part of the valence E1-transitions increases with increasing energy of the final states. It is connected with the growth of the quasiparticle plus phonon components in the wave function of the low-lying states to which the γ -transitions with one-, three-, and five-quasiparticle components of the wave functions of highly excited states proceed. The calculations show that in the energy interval of 8.0-8.5 MeV there are three-quasiparticle configurations, given in fig. 3, from which the E1-transitions proceed to one-quasiparticle components of the low-lying states. The presence of such configurations results in the violation of the valence neutron model, thus in ^{93}Mo there is no detailed resemblance between the experimental partial widths and those calculated by the valence neutron model. From the mean neutron width by (9) we obtain the average value of the one-quasiparticle component $3p_{3/2}$, equal to $\overline{|b|^2} = 1.6 \cdot 10^{-4}$ which is in agreement with the estimation in /7/, obtained from the radiation width. If the one-quasiparticle component has the above-mentioned width, we find from the mean radiation width for the transition to the state that the mean value of three-quasiparticle components, given in fig. 3 for ^{93}Mo, is equal to $\overline{|b'|^2} \sim 5 \cdot 10^{-5}$. Note that estimations of one-quasiparticle components, in /1/, appeared to be lower due to the incorrect interpretation of the experimental data.

The partial M1-widths for seven s -wave resonances in ^{93}Mo are measured in /16/. There has been found the enhancement of the M1-transitions which is explicitly seen for the resonance $1/2^+$ with energy 3.2 keV. For the transition from this resonance to the states $1/2^+$ with

$\mathcal{E}$ = 0.942 MeV, s_f = 0.64 and $\mathcal{E}$ = 2.7 MeV, s_f = 0.32 the partial radiative widths are equal to Γ_γ = 64.1 meV and Γ_γ=2.7 meV correspondingly. According to our calculations there is three-quasiparticle neutron configuration near B_n fragmented over several neutron resonances. We obtain from the average partial radiation width that the contribution of a given three-quasiparticle configuration to the wave functions of s -wave resonances is equal to $|\bar{b}|^2 \sim 6.10^{-3}$. Note that the wave function of the state $1/2^+$ with $\mathcal{E}$ = 2.7 MeV has large quasiparticle plus phonon components and this influences the radiation widths of s -wave resonances. The estimations of the contribution of the component quasiparticle plus one and two phonons for the Ml-transitions without changing the number of quasiparticle are given in [7]. The valence transitions from p -resonances into ^{93,95,97}Mo and the correlations between the reactions (n,γ) and (d,p) are investigated in [17]. The coefficient of the correlation ρ_{93} is found to be equal to 0.69, 0.67, 0.42 and 0.97 for ^{93}Mo , ^{95}Mo , ^{97}Mo and ^{99}Mo correspondingly. The valence transitions $p_{3/2} \rightarrow d_{5/2}$ in these nuclei are very important. According to the calculations at an energy by (1.0-1.5) MeV higher than B_n in ^{95}Mo and ^{97}Mo there is a neutron state $\{d_{5/2}, h_{11/2}, g_{9/2}\}$, from which the El transition proceeds to the state $d_{5/2}$. The presence of this state leads to the violation of the valence neutron model, but it fails to explain the decrease of ρ in ^{97}Mo compared to ^{95}Mo. In the process of filling up the subshell $d_{5/2}$ its fragmentation over the low-lying states increases, the contribution into the radoation widths from transitions of the type

$$\{p_{3/2}Q_{2^+}\} \rightarrow \{d_{3/2}Q_{2^+}\}, \quad \{p_{1/2}Q_{2^+}\} \rightarrow \{d_{3/2}Q_{2^+}\},$$

which proceed without changing the number of quasiparticles, increases too. As has been pointed earlier [13], the valence neutron model describes well the partial widths of the El-transitions in ^{99}Mo. In ^{99}Mo, the valence transitions give the contribution of 65% into a full strength of the El-transitions to the low-lying states [18]. Alongside with the correlations between the reactions (n,γ) and (d,p), there is a large correlation between the reduced neutron and radiation widths, equal to $\rho = 0.6$. As is seen from fig. 4 in the region of B_n there are no three-quasiparticle configurations through which the El transitions proceed to the one-particle components of the low-lying states. The violation of the valence neutron model is due to the three-quasiparticle components of the low-lying states. We obtain from the mean neutron and radiation width the following estimations for the one-quasiparticle components of p -wave resonances: for $p_{3/2}$ $|\bar{b}|^2 \sim 6 \cdot 10^{-4}$, for $p_{1/2}$ $|\bar{b}|^2 \sim 10^{-3}$ Consider the M1-transition in ^{99}Mo. For the transition from the resonance $1/2^+$ 467 meV to the ground state $s_{1/2}$ the partial radiation width is equal to $\Gamma(M1) \approx 4$ meV. Our calculations show that in the region S_n - B_n there are three-quasiparticle configurations $\{s_{1/2}, d_{3/2}, d_{5/2}\}^{3n}$, $\{s^n_{1/2}, p^p_{3/2}, p^p_{1/2}\}$ for which the M1-transition widths to the ground state is correspondingly equal to $\Gamma(M1) \approx 425$ meV, $\Gamma(M1) = 41$ meV. It makes it possible to interpret the observed M1-transition as a transition from three-quasiparticle configurations, fragmented over several neutron resonances.

According to the calculation and analysis of the radiation widths in odd-A isotopes of Mo one can make the following conclusions: i) The valence neutron model for the El-transitions from p -wave resonances should work well in ^{99}Mo, somewhat worse - in ^{95}Mo and ^{97}Mo . In ^{93}Mo the El-transitions from three-quasiparticle components of the wave function of p -wave resonances, are very important. ii) In the wave functions of p -wave resonances, one-quasiparticle components $3p_{1/2}$ and $3p_{3/2}$ are equal to 10^{-3} - 10^{-4}. iii) The observed enhancement of the M1-transitions in ^{93}Mo and ^{99}Mo is due to the presence in the wave functions of s -resonances of the corresponding three-quasiparticle configurations.

In conclusion we are grateful to A.I.Vdovin for useful discussions.

References

1. V.G.Soloviev. Particles and Nucleus, 3, 770 (1972). V.G.Soloviev. Nucl.Structure Study with Neutrons, ed. by Ero and Szucs, p. 85, Akademiai Kiado Budapest, 1974.
2. V.G.Soloviev. JINR, E4-8116, Dubna, 1974.
3. J.E.Lynn. The Theory of Neutron Resonance Reactions, Clarendon Press, Oxford, 1968.
4. S.F.Mughabghab, R.E.Chrien, O.A.Wasoon et al. Phys.Rev.Lett., 26, 1118 (1971); R.E.Chrien. Nucl. Str., p. 123, JINR, D-6465, Dubna, 1972.
5. S.F.Mughabghab. Nucl.Struct. Study with Neutrons, ed. by Ero and Szucs, p. 167, Akademiai Kiado Budapest, 1974; Statistical Properties of Nuclei, ed. by J.B.Garg, Plenum Press, New York, p. 191, 1972, BNL-19196 (1974).
6. V.A.Knatko, E.A.Rudak. Yad.Fiz., 13, 521 (1971); 15, 1132 (1972).
7. L.V.Rudak, E.A.Rudak. Yad. Phys., 20, 483 (1974).
8. V.G.Soloviev. Yad.Phys., 13, 48 (1971); 15, 733 (1972).
9. V.G.Soloviev. Izv. Akad. Nauk SSSR (ser. fiz.), 35, 666 (1975), V.G.Soloviev. Theor. Mat. Fiz., 17, 90 (1973). A.I.Vdovin, V.G.Soloviev. Theor. Mat. Fiz., 19, 275 (1974).
10. V.G.Soloviev, L.A.Malov. Nucl.Phys., A196, 433 (1972); L.A.Malov, V.G.Soloviev. Yad.Phys., 21, 502 (1975); 22 (1975); Preprint JINR E4-8558, Dubna , 1975.
11. V.G.Soloviev. Second. Intern. School on Nucl. Phys., p. 233, JINR, D3-7991, Dubna, 1974.
12. V.G.Soloviev. Theory of Complex Nuclei. Nauka, 1971.
13. V.G.Soloviev, Ch. Stoyanov, A.I.Vdovin. Nucl.Phys., A224, 411 (1974).
14. V.G.Soloviev. Phys.Lett., 35B, 109 (1971); V.G.Soloviev. Pisma JETF, 14, 194 (1971).
15. R.E. Toohey, H.E.Jackson. Phys.Rev., 9C, 346 (1974).
16. O.A.Wasson, G.G.Slaughter. Phys.Rev., 8C, 297 (1973).
17. K.Rimavi, R.E.Chrien. Preprints of Second International Symposium on Neutron Capture Gamma Ray Spectroscopy and Related Topics, Petten, the Netherlands, p. 107, 1974.
18. G.Rohr, H.Weighmann, J.Winter. Nucl.Phys., A150, 97 (1970).

Received by Publishing Department
on April 25, 1975.