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GAMMA-DECAY OF THE COMPOUND STATE AND CHANGE OF STRUCTURE OF THE ^{124}Te EXCITED LEVELS

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Гамма-распад компаунд-состояния и динамика изменения структуры возбужденных уровней ^{124}Te

Независимый анализ полученного в Ржеже большого объема данных по спектру гамма-лучей радиационного захвата тепловых нейтронов в ^{123}Te ($\sum(i_\gamma E_\gamma)/B_n = 0{,}49$) позволил получить новую и надежную информацию о зависимости сумм радиационных силовых функций дипольных гамма-переходов от энергии возбуждаемых ими уровней. Эти данные, как и плотность уровней в ^{124}Te, демонстрируют сильное изменение структуры ядра практически для всего интервала возбуждаемых захваченным нейтроном уровней. Как и в ранее изученных (с использованием данных по интенсивностям двухквантовых каскадов) ядрах, указанные параметры процесса гамма-распада можно воспроизвести с точностью эксперимента только с помощью моделей, прямо учитывающих сосуществование и взаимодействие сверхтекучей и обычной компонент ядерной материи.

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Gamma-Decay of the Compound State and Change of Structure of the ^{124}Te Excited Levels

Independent analysis of a large amount of data on the spectrum of gamma-rays of the radiative capture of thermal neutrons in ^{123}Te ($\sum(i_\gamma E_\gamma)/B_n = 0.49$) obtained in Řež made it possible to obtain new and reliable information on the dependence of sums of radiative strength functions of dipole gamma-transitions on the energy of levels excited by them. These data, as does the level density in ^{124}Te, demonstrate a strong change of structure of the nucleus practically for the whole region of the levels excited by a captured neutron. As in the earlier studied nuclei (using data on the intensities of two-step cascades), it is possible to reproduce the stated parameters of the gamma-decay process to the accuracy of experiment only by the models directly taking into account the coexistence and interaction of the usual and superfluid component of the nuclear matter.

The investigation has been performed at the Frank Laboratory of Neutron Physics, JINR.

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INTRODUCTION

Properties of the nucleus at its low energies are determined by the coexistence and interaction of quasi-particles and phonons. Here, only the excitation region E_{ex}, lying lower than the neutron binding energy B_n, is implied.

This most general physical result has been obtained both by the authors of the quasi-particle–phonon model [1], and those of the model of interacting bosons and fermions [2]. The main details of this process may be generalized and interpreted by theorists without serious errors only on the basis of reliable data from experiments, which are maximally sensitive to the structure of excited levels of the studied nuclei. In the first place, this statement refers to the region of level energies of any nuclei, which cannot be resolved by the spectrometers used in experiment.

This is the most complicated object of investigation of the low-energy nuclear physics. Any experiment in this excitation region produces spectra S (including the interaction cross sections), the value of which is always determined by an unknown level density ρ and strength functions, for example, of gamma-quanta $k = \Gamma_{\lambda f}/(E_\gamma^3 \times A^{2/3} \times D_\lambda)$ of the cascades connecting the compound state λ and the low-lying level f. An inevitable error of determining the measured intensity usually varies from several percent to several tens of percent. Since the S amplitude in ordinary spectra is determined by the product of ρ and k, the accuracy of solving the inverse problem diminishes very much.

Experimental spectra for any nucleus may be used in two ways, either:

a) for testing of some model representations on ρ and k, or as the initial data;

b) at solving the inverse problem of mathematical analysis — the determination of values of the function parameters by its quantity.

Reliability of the obtained conclusions may be partially or utterly lost both in the first and in the second cases.

1. MAIN PROBLEMS OF ANALYSIS OF EXPERIMENTAL DATA

1. Any model of ρ and/or k under test is obtained in the framework of some hypotheses and a priory may describe the predictable value only with certain usually unknown error. Moreover, potentially, models of the same values

having a different theoretical basis are possible, but they can provide even more precise reproduction of experimental spectra. At the same time, the degree of discrepancy between various models may reach utter incompatibility of their basic theoretical representations. In addition, the error transfer coefficients $\delta\rho$ and δk to the errors δS are usually very small. As a consequence, the same spectra (cross sections) within the limits of total errors δS may be described by fundamentally differing models. One may see this from compilations [3] of practically used models of ρ and k. This circumstance is not taken into account, for example, in the analysis [4]. Therefore, the use of the criterion χ^2 in the first method of comparison of models and experiment provides for the correct and error-free conclusion on the model under test only at its unconditional falseness. Due to this, it cannot be used in conclusion on the correctness of certain model representations and particularly — for the unstudied region of nuclei and their excitation energies.

The reason for this circumstance is obvious: information on the studied phenomenon may only be obtained from the experiment adequate to the studied object. Mathematics and mathematical statistics may not generate new physical information in principle. Actually, the result of analysis obtained on the basis of χ^2 smallness may utterly distort the picture of the studied process.

2. Solution of the inverse problem of mathematical analysis may not be unique practically in any experiment to determine ρ and/or k. And transfer coefficients of inevitable errors of the δS spectrum to the errors of parameters $\delta\rho$ and δk may reach module 10–100 and more.

The situation with function $S = f(\rho, k)$ relating unknown parameters to the measured spectrum may also be ambiguous. For example, up to now the extraction of data on ρ and k from gamma-spectra has been carried out for the most part in the framework of assumption on the k independence of the excitation energy of nucleus. The corresponding hypothesis on the independence of cross section of nuclear interaction of the excitation energy of target nucleus has been formulated in general form in [5] and is used without verification to present day in analysis of any experiments to determine the level density. In addition, in nuclear reactions with charged particles, for example, spin window of the determined level density usually may not be recorded precisely. As a consequence, transition to the total level density inevitably introduces an additional error. It is impossible to obtain its estimation from experiment.

Therefore, a direct determination of the level density and partial widths Γ of the emission of products of the studied reaction is preferable. And solution of this problem from the spectra measured in the experiment should be performed using experimental techniques providing the minimum total error of the measured spectrum, minimum error transport factors and the maximum use of all available information for the given nucleus.

2. POSSIBILITIES OF THE PRESENT-DAY EXPERIMENT TO DETERMINE ρ AND k

An experiment to measure intensities of two-step cascades with the total energy $E_1 + E_2 = B_n - E_f$ satisfies the above-mentioned conditions as much as possible. A possibility of its realization with Ge-detectors has been demonstrated for the first time in Dubna [6, 7]. The technique to determine ρ and k and results obtained for many nuclei in the variants, which use and do not use the hypothesis [5] is described in [8,9], respectively.

Approximation [10, 11] of the level density obtained in such a way by the V. M. Strutinsky model [12] adequate to the experiment for various assumptions on the shape of correlation function of a nucleon pair in a heated nucleus and the energy dependence of density of single-particle states g near the Fermi surface was performed for all nuclei, in which two-step cascades were measured. Except for those, in which small statistics of useful events did not allow one to determine [13] the shape of energy dependence

$$I_{\gamma\gamma}(E_1) = \sum_{\lambda,f} \sum_{i} \frac{\Gamma_{\lambda i}}{\Gamma_\lambda} \frac{\Gamma_{if}}{\Gamma_i} \tag{1}$$

with an acceptable systematic error for all possible cascades connecting 3 levels: $\lambda \rightarrow i \rightarrow f$.

The estimation [14] of influence of the error $\delta I_{\gamma\gamma}$ on the desired parameters shows that its variation from -25 to $+25\%$ changes the obtained values of ρ and k no more than by a factor of 2–3. Simultaneously, both the deviation value and its sign change depending on the excitation energy of nucleus. However, the specific shape of the energy dependence of ρ and k remains entirely. In order to reach the same level of $\delta\rho$ and δk, an alternative technique of simultaneous determination of these parameters because of very large error transport factors [15] requires measurement of total gamma-spectra for arbitrary excitation energy with an error considerably less than 1%. Therefore, maximum reliable representations on the properties of a nucleus manifesting themselves in the process of gamma-decay may at present be obtained only from intensities of two-step cascades and from methodically similar two-step reactions.

3. EXPERIMENTAL LEVEL DENSITY AND STRENGTH FUNCTIONS OF CASCADE GAMMA-TRANSITIONS IN ^{124}Te

The intensities of two-step cascades necessary for analysis for the ground and first excited states of ^{124}Te were measured for the first time [16] in Dubna at the coincidence spectrometer with Ge-detectors of low effeciency and poor resolution. Nevertheless, small-level density of this nucleus below $\sim 0.5B_n$ made it possible to obtain the dependence required for the analysis [8,9] with a satisfactory systematic error. Contemporary data on the i spectrum of gamma-rays of the thermal neutron capture [17] allowed one to obtain values of the total population $P = i_1 i_2 / i_{\gamma\gamma}$ for 29 levels of this nucleus up to their maximum energy 4.37 MeV. The use of these data to normalize $I_{\gamma\gamma}$ somewhat increased the value of two-step cascade intensities. The obtained values of ρ and k have been published in [18]. Comparison of the shape of energy dependence of ρ and k for all the nuclei studied in Dubna, Riga and Řež for both variants of their determination allows one to suppose that the level density of this nucleus obtained both in [8] and in [18] has been overestimated at the energy of $E_i > 3$ MeV, and the radiative strength functions have been underestimated, respectively. In the first place, this is due to a small width of the energy region of levels, for which their total population has been determined by primary gamma-transitions and cascades of arbitrary multiplicity of gamma-quanta in them.

A very large amount of spectroscopic information presented in [4] makes it possible to obtain significantly more accurate data for ρ and k comparing to the ones published in [18].

3.1. Main Problems of Analysis of Experiment. 1. It should be pointed out that any new technique to acquire information on the properties of a nucleus may realize its potential only at developing of adequate methods of its analysis. This analysis should take into account the peculiarities of the whole complex of the information involved and it should be implemented in algorithms and programs based on the use of the earlier obtained results of other experiments checked by practice, mathematical rules and mathematical statistics.

2. Naturally, the algorithms must provide the maximum effective extraction of physical information on the nucleus and its maximum possible reliability. First of all, this condition necessarily requires a maximum possible experimental verification of any even generally accepted statements and hypotheses on the studied object.

The technique of using the intensities of two-step cascades to study the properties of nucleus in the region of high density of its level unresolveable by a spectrometer with the FWHM ($\rho_i^{-1} <$ FWHM) line width clearly confirms these two clauses. System (1) of equations relating to the cascade intensity in an arbitrary energy region of cascade gamma-transitions with the determined parameters ρ and k is strongly correlated. Therefore, the cascade intensity in any point of the measured spectrum depends on the values of ρ and k in the whole region under investigation. It should be added that the experimental spectra of two-step cascades from the point of view of mathematics are a linear sum of unknown intensities of two-step cascades with primary and secondary gamma-transitions of practically one and the same energy. As a result, any experimental spectra of such cascades may be accurately reproduced by an infinite number of various functional dependences of $\rho = f(E_i)$ and $k = \phi(E_1, E_i)$. The relation of maximal values of these parameters to the minimal ones is limited [15] by a value on the order of $10^1 - 10^2$ due to the non-linearity of the equations. However, it increases greatly and inevitably at the restriction of the energy region of gamma-quanta used, for example in [19], to compare calculation and experiment.

3. The statement on inevitable and fast complication of the structure of excited levels, for example, at the excitation energy increase is generally accepted. But it has not been tested by experiment and does not comply with the theoretical calculations of dynamics of the states strength fragmentation process on its level for nucleus of various complexity with various excitation energy. It follows quite unambiguously from [20] that, for example, the state 2 quasi-particles $\otimes$ 2 phonons is fragmented considerably weaker than the two-quasi-particle and/or two-phonon states. Since the energy of any state of nucleus grows at the increase of the degree of its complexity, one should expect [20] a considerable change of structure of the nucleus under investigation at the increase of excitation energy. The degree, at which the fragmentation rules in a concrete region of the excitation energy of a concrete nucleus exert influence on the desired ρ and k lower than B_n, may be obtained only from an experiment.

Thus, maximum reliable conclusions on the nucleus under investigation, analysis of intensities of two-step (and of larger multiplicity) cascades may only be obtained:

a) after determination of the sequence order of quanta in them and, of course,

b) without attraction of not tested, although generally accepted, representations on the nucleus properties.

3.2. Algorithm and Necessary Data to Determine ρ and k in ^{124}Te. Further analysis has been carried out meeting these two important conditions.

The intensity of two-step cascades to a first approximation is inversely proportional to the level density of the nucleus under investigation. Therefore, it is necessary to determine the $I_{\gamma\gamma}$ absolute values with the maximum accuracy. Actually, this may be done only at the normalization of the measured relative intensities of the strongest cascades with low-lying intermediate levels of a nucleus on their own absolute values. Renormalization of the experiment carried out earlier in Dubna [16] has been performed using intensities i_1 and branching factors $B_r = i_2 / \sum i_2$ from the data [4]. The values of sums of intensities of all possible two-step cascades for the ground and first excited states of ^{124}Te obtained in this way equal to 7.8(23) and 16.6(25)% decays.

Their values summarized by 0.5 MeV intervals of intermediate and all final levels are shown in Fig. 1, with an example of typical calculated reproduction. Non-linearity of the $I_{\gamma\gamma} = f(E_1)$ function provides for the finalness of the interval of ρ and k values reproducing the experimental data even on condition that the number of unknown parameters exceeds by a factor of 2 the number of intensities measured in the experiment. However, this interval includes their real values

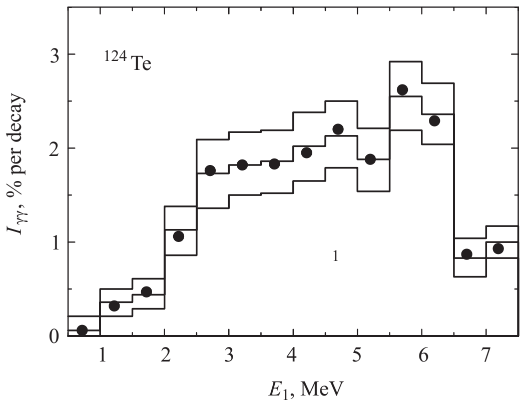

Fig. 1. Histogram — the summarized experimental intensity of two-step cascades in the intervals of 0.5 MeV in the function of the primary gamma-transition energy E_1 with statistical errors only [16]. The intensity is renormalized using the data [4]. Points — a typical approximation [9] for the ρ and k data, which are given in Figs. 4 and 5

only on condition that the relation of strength functions for gamma-transitions of one and the same multipolarity and energy $k^{\text{sec}}/k^{\text{prim}} = f(E_{\text{ex}}) \neq \text{const}$ is determined for arbitrary excitation energy E_{ex} on the basis of independent information. This problem has not been posed so far by experimenters and has not been solved to the necessary degree even in methods [9]. In order to solve it completely, it is necessary to determine from experiment certain functionals of the process of cascade gamma-decay, which are unambiguously connected to the excitation energy of a nucleus right up to $E_{\text{ex}} \approx B_n$, as well as to the type of multipolarity of gamma-transition and, which are maximum sensitive to variation of the strength function.

Potentially, a problem of such a scale may only be solved in an experiment to investigate the intensities of cascades of the given multiplicity for the final levels up to their maximum possible energy. But qualitative representation on the expected effect and the possibility of its account to the calculations in a first approximation may be obtained from comparison of values of the experimental population P of excited levels of the nucleus under investigation and the calculated total (or, only cascade) one up to the maximum possible energy of their excitation for various tested functional dependencies of $\rho = f(E_i)$ and $k = \phi(E_1, E_i)$.

The P value may be determined from the evident relation

$$P_{\gamma\gamma} = i_1 i_2 / i_{\gamma\gamma} \tag{2}$$

purely experimentally with minimal error on the conditions that:

a) the sequence order of quanta in two-step cascades through various intermediate levels is determined independently of the Ritz combination principle with the obligatory use of the maximum likelihood method (effective algorithm is realized in [21]),

b) their absolute intensities $i_{\gamma\gamma}$ and also the corresponding intensities of primary i_1 and secondary i_2 cascade transitions have been determined.

Systematic error $P_{\gamma\gamma}$ in such a way of determination is almost completely correlated, and the random one is determined only by the degree, in which approximation of spectrum peaks of the single HPGe-detector resolves multiple structures in the region of E_1 and E_2. The peak density in spectra $I_{\gamma\gamma}$ for various final levels is usually smaller, the background depends weakly on the energy, and the resolution improves additionally when the technique [6] is used, so a set of data for $i_{\gamma\gamma}$ at the equal detector effectiveness usually exceeds a set of data for i. The amount of data on $i_{\gamma\gamma}$ is proportionate to ϵ^n $(n > 2)$. Unfortunately, a small value of the detector efficiency ϵ in [16] prevents from using the technique [9] to obtain the $P_{\gamma\gamma}$ values in this nucleus. Therefore, analysis of the level population has been performed below only on the basis of the data from Table 2 from [4]. Naturally, the $P_{\gamma\gamma}$ data from the decay scheme [4] (defined as a sum of all the gamma-transitions depopulating the given level and placed into the decay scheme), contain extra (comparing to [9]), maybe considerable, systematic error. This error grows module at an increase of the excitation energy of a level. Besides, it is impossible to estimate really its value on the basis of data from the decay scheme. Most likely, at the analysis of an experiment the obtained data should be regarded as a $P_{\gamma\gamma}$ lower estimate. First of all, the above-mentioned facts refer to maximum energies of the ^{124}Te excited levels.

Data on the cascade-level population summarized on a small region of the excitation energy are the most effective [9] for estimation of the $k^{\mathrm{sec}}/k^{\mathrm{prim}} = f(E_{\mathrm{ex}})$ function. But only at the determination of $P_{\gamma\gamma}{-}i_1$ from (2). However, for the data from [4] the error increases strongly with an increase of the excitation energy (only the cascade population $P_{\gamma\gamma}$ decreases faster than the i_1 intensity of the corresponding primary gamma-transition decreases). Therefore, it is inevitable that extraction of the information on the $k^{\mathrm{sec}}/k^{\mathrm{prim}} = f(E_{\mathrm{ex}})$ function in this case considerably differs from the procedure used in [9].

So, only the average value of population of a single level in a small (200 keV) region of the excitation energy has been determined from the data on the summarized intensity of the secondary gamma-transitions placed into the decay scheme [4]. The average value of only the intermediate cascade-level population $\langle P_{\gamma\gamma}{-}i_1\rangle$ from this region is shown in Fig. 2, and of its sum — in Fig. 3. The data from Fig. 2 have been used to determine discrepancy parameters of the energy dependence of radiative strength functions of the primary and secondary gamma-transitions in a similar manner [9]. The data from Fig. 3 allow one to make certain conclusions about the degree of discrepancy between the obtained estimate of strength functions and the experimental values and the factors causing it. Naturally, accuracy of the used estimate is determined directly by the degree

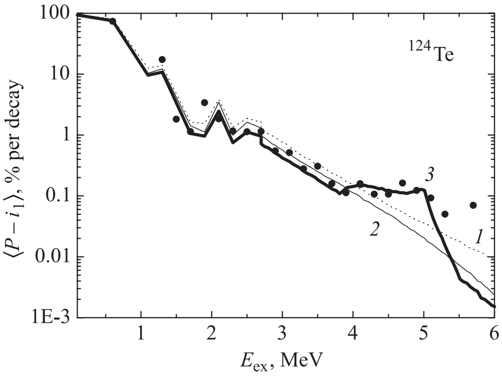

Fig. 2. Points mean value of the cascade population of ^{124}Te individual levels from the scheme [4]. Line 1 — calculation according to the models [22, 23]. Line 3 — calculation of the population with the level density and strength functions from Figs. 4 and 5 taking into account differences of the energy dependence of strength functions of the primary and secondary cascade transitions. Line 2 — the same, but without taking into account this dependence

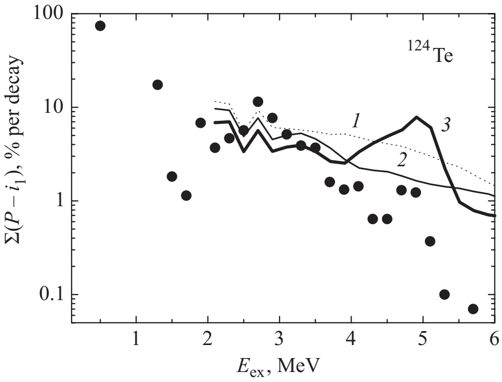

Fig. 3. The same as in Fig. 2 for the cascade population summarized on the excitation energy intervals of 200 keV

of fluctuations of $P_{\gamma\gamma}$ values for neighboring levels of one and the same spin and parity. If they are large, than the error of estimation of the $k^{\rm sec}/k^{\rm prim} = f(E_{\rm ex})$ function may not be small. However, in this case realistic hypotheses are necessary, which can explain strong selectivity of the gamma-decay process higher than $\sim 0.5B_n$. Such a selectivity seems to be quite improbable: the parameter $\sum(i_\gamma E_\gamma)/B_n = 0.49$ for the data from Table 1 [4] at the value $\sum i_\gamma = 237\%$ of decays. This means that on average only a half-energy of each cascade is observed in peaks of the capture spectrum of thermal neutrons resolved experimentally in ^{123}Te (and in Table 1 [4]). Simple extrapolation of the dependence of i_γ sum on the $\sum i_\gamma E_\gamma/B_n$ parameter value to its asymptotic value obtained for various i_γ registration thresholds gives a possible value $\sum i_\gamma \approx 400-450\%$. It follows that no less than 160–210% of decays fall to the part of gamma-quanta with the intensity less than the threshold in [4]. Out of them, about 75% of decays fall to the share of the primary ones. There is no reason to exclude a possibility that the rest ($\sim 80-130\%$) of decays of the intensity of weak gamma-quanta fall to the region of high-lying ($E_{\rm ex} > 0.5B_n$) levels. Therefore, one must not exclude a possibility that the level population obtained using the data [4] is a lower estimate for levels with the energy higher than $E_{\rm ex} \sim 4-5$ MeV.

3.3. Results of Determination of ρ and k in ^{124}Te. Level density and strength functions reproducing all the mentioned experimental data in the best way are given in Figs. 4 and 5. Approximation of ρ by the model functional dependence [12] (Fig. 5) has been performed similarly to [10]. Naturally, it contains errors related to the necessity to use more or less realistic hypotheses on the values of coefficient of vibration increase of the level density, the correlation function of nucleons in a heated nucleus, the density of single-particle states near the Fermi surface, etc. Therefore, in principle, there is a possibility to increase the accuracy of approximation comparing to the one observed in Fig. 5. As in other nuclei studied by now, in ^{124}Te an unconditional stepped structures are observed in the region of ≈ 3.5 and $\sim 7-8$ MeV. Taking into account values of the pairing energy Δ are of two neutrons and two protons close to 2.5 and 2 MeV, respectively, on the basis of model representations [12], the first step corresponds to breaking of the neutron pair. Perhaps, the second one is caused by the breaking of the second neutron pair or the first proton one. In other words, in the nucleus under consideration no fundamental discrepancies with the shape and parameters

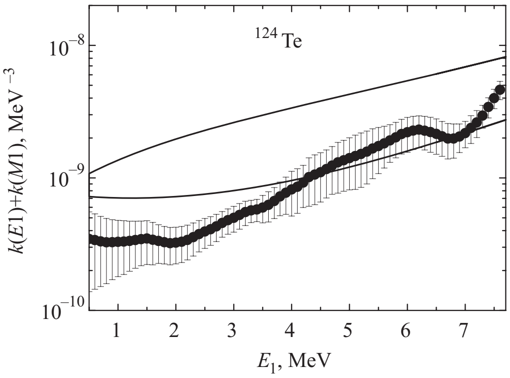

Fig. 4. Solid lines — $k(E1) + k(M1)$ from models [23,24] (for $k(M1) = \text{const}$). Points with errors — an interval of values of k reproducing $I_{\gamma\gamma}$ (Fig. 1) with practically the same values $\chi^2/f << 1$

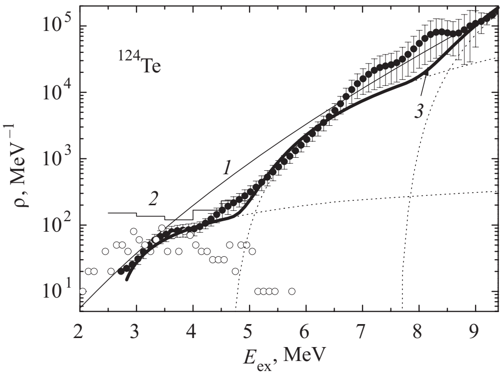

Fig. 5. The same as in Fig. 4 for the level density. Points with errors — the density of intermediate cascade levels [9]. Line 1 — model values [22], line 2 — extrapolation according to the technique [26], line 3 — approximation according to [10]. Dotted lines — the level density with two-, four- and six-quasi-particle structure. Open points — the level density with spins $J = 0 - 2$ from the decay scheme [4]

of functional dependence $\rho = f(E_i)$ of other nuclei is observed. The width of the observed region and level density in the region of its almost constant value depends strongly on the accuracy of estimation of the $k = \phi(E_1, E_i)$ function parameters, and also on the values of the analysis parameters — the density of neutron resonances and low-lying levels. The dynamics of the $\rho = f(E_i)$ change in the analysis [8], [18] gives grounds to consider the obtained values of ρ to be overestimated at 4–5 MeV, first of all, because of the lack of reliable data for the level population with the excitation energy higher than ~ 5 and underestimated values of the density of discrete levels lower than ~ 3 MeV. Due to a strong anticorrelation of the values of level density and strength functions, most likely, the values $k(E1) + k(M1)$ are underestimated in the region of $\sim 4{-}6$ MeV of the primary transitions. The same is true for smaller energies of the secondary transitions exciting levels in the same energy region. A considerable excess of the $\sum(P_{\gamma\gamma}{-}i_1)$ calculated sum observed in Fig. 3 as compared to the experimental values of the same parameter of the cascade gamma-decay at the $\sum(P_{\gamma\gamma}{-}i_1)$ good reproduction may be explained by hypotheses on:

- a strong selectivity of the process of cascade gamma-decay;
- a considerable systematic underestimate of the summarized intensity of gamma-transitions in Table 2 [4] depopulating levels, or
- a very strong underestimate of strength functions for the secondary and subsequent cascade gamma-transitions and, as a result, by overestimate of values of the obtained level density.

Approximation of the intensity distribution of the primary gamma-transitions for levels in the given region of their energies or sums of the cascade intensities through one and the same level [26] with the subsequent extrapolation to the zero value of intensities gives an independent estimation of the level density.

It cannot give precise estimates of the level number excited by the primary transitions lower than the threshold of their registration in [4] for the following reasons:

- nobody has verified the Porter–Thomas [25] distribution hypothesis for width deviation from the mean value in the region of the smallest widths necessary for such an analysis;
- the ratio of the level number of various parity at the given excitation energy is unknown and, most likely, will not be obtained as a parameter of the analysis [26];
- considerable deviations of strength functions from the uniform dependence observed for the majority of studied nuclei [9] restrict the width of energy region of levels optimal for such an analysis, for which the width distribution is approximated.

Nevertheless, such an analysis of the experimental data [4] (Fig. 5) shows that the nude matter on a considerable missing of levels does not comply with the available experimental data.

CONCLUSION

Model description of intranuclear processes cannot have the accuracy exceeding that of the experiment at the moment of its development. This may be accepted as an undoubted fact. This and the results of the performed analysis imply that the «statistical» approach to the calculation of the process of cascade gamma-decay gives currently unacceptable error for the ^{124}Te compound nucleus.

Model of the level density [12] reproduces its energy variation with higher accuracy than any models, which do not take into account the presence and interaction of usual and superfluid component of the nuclear matter, at least lower than B_n.

Data on the dependence of correlation function of two nucleons in a heated nucleus and the coefficients of vibration increase ρ necessary for this model, as shown in [10], may only be obtained from the analysis of additional information. It seems that the only chance to obtain this result at present is to develop fundamentally new models of radiative strength functions. They must in an explicit form take into account two-component nature of the nuclear matter and their parameters may be fitted from the data for $k(E1) + k(M1)$ obtained from the technique [9].

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