One-nucleon decay of isoscalar giant multipole resonances in ^{208}Pb

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A detailed description of any giant resonance (GR) includes the following characteristics: (i) Strength distribution for a large excitation-energy interval; (ii) Energy-dependent double transition density (which depends only on nuclear structure) and projected one-body transition density (associated with a given one-body probing operator), and; (iii) Partial and total probabilities of direct one-nucleon decay**.** The recently developed particle-hole dispersive optical model (PHDOM) is a microscopically-based extension of the standard continuum-random-phase approximation (cRPA) by taking the spreading effect into account. Within the PHDOM, which is a semi microscopic model, Landau damping and coupling to the continuum are considered microscopically (in terms of a mean field and p-h interaction), while the spreading effect is treated phenomenologically (in terms of a properly parameterized energy-averaged p-h self-energy term). The imaginary part of this term determines the real part via a dispersive relationship, which are added to the real mean field. We have recently implemented [1] the PHDOM to describe the main properties of the isoscalar giant multipole resonances (ISGMPRs) (up to $L = 3$) together with the overtones of isoscalar giant monopole and quadrupole resonances. The model parameters related to a mean field and p-h interaction were taken from independent data accounting for the isospin symmetry and translation invariance of the model Hamiltonian. Parameters of the imaginary part of the strength of self-energy term were adjusted to reproduce in PHDOM-based calculations of ISGMPR total widths for the considered closed-shell nucleus. The calculation results obtained for the ^{208}Pb nucleus, taken as an example, were compared with available experimental data.

To demonstrate the unique ability of the model in describing the branching ratios for direct one-nucleon decay of ISGMPRs, we show the partial and total branching ratios, $b^{\uparrow}_{L,\mu}$ and $b^{\uparrow}_{L}$, evaluated within the PHDOM for ^{208}Pb. The calculated values of the branching ratios were obtained under the assumption of a purely single-hole nature of the product-nucleus states that are populated in the decay process and can be considered as an upper limit of possible values. In Table I we present the branching ratios for direct one-neutron decay of four ISGMPRs in the ^{208}Pb nucleus, which are given together with available experimental data. An approximately two-

Table I. The partial and total branching ratios for direct one-neutron decay of the isoscalar giant multipole resonances (ISGMPRs) into the channel μ. The branching ratios (in %) for ^{208}Pb, evaluated within PHDOM, are given with indication of the respective excitation-energy intervals ($\boldsymbol{\omega_{12}}$ in MeV) and compared with experimental data

	$b^{\uparrow}_{L=0,\mu}$	$b^{\uparrow}_{L=1,\mu}$	$b^{\uparrow}_{L=2,\mu}$	$b^{\uparrow}_{L=3,\mu}$
$\mu^{-1} \setminus \omega_{12}$	12.5 – 15.5 [3]	20 – 25 [2]	9 – 12	16 – 23
$3p_{1/2}$	3.6	1.1	2.8	1.6
$2f_{5/2}$	18.0	5.4	1.5	5.9
$3p_{3/2}$	7.5	2.6	5.8	3.8
$1i_{13/2}$	0.8	11.4	0.2	5.9
$2f_{7/2}$	26.6	9.3	0.2	13.3
$\sum_{\mu} b^{\uparrow}_{L,\mu}$	56.5	29.8	10.5	30.5
$\left(\sum_{\mu} b^{\uparrow}_{L,\mu}\right)_{expt}$	22 ± 6 [3] 14.3 ± 3 [4]	23 ± 5 [2] 10.5 [5]	-	-
$b^{\uparrow,n}_{L}$	56.7	66.8	10.6	37.5

fold excess of the calculated values above the respective experimental values for ISGMR and ISGDR is worth noting. This note is also valid for the calculated values of the branching ratios for direct one-proton decay of ISGDR shown in Table II. However, the description of experimental data is markedly improved upon multiplying the calculated branching ratios $b^{\uparrow}_{L=1,\mu}$ by the experimental values of spectroscopic factors S_{μ} for proton-hole states of the product nucleus ^{207}Tl. The experimental spectroscopic factors S_{μ} are close to unity for the majority of neutron-hole states of the ^{207}Pb nucleus, which are indicated in Table I.

Table II. The branching ratios (in %) for direct one-proton decay of the isoscalar giant dipole resonance (ISGDR) in ^{208}Pb evaluated within PHDOM for the excitation-energy intervals $\boldsymbol{\omega_{12} = 20 - 25}$ MeV, are compared with experimental data.

μ^{-1}	$b^{\uparrow}_{L=1,\mu}$	S_μ [6]	$S_\mu \cdot b^{\uparrow}_{L=1,\mu}$	$\left(b^{\uparrow}_{L=1,\mu}\right)_{expt}$ [2]
$3s_{1/2}$	3.4	0.55	1.9	2.3 ± 1.1
$2d_{3/2}$	3.0	0.57	1.7	
$1h_{11/2}$	0.2	0.58	0.1	1.2 ± 0.7
$2d_{5/2}$	4.1	0.54	2.2	
$\sum_\mu b^{\uparrow}_{L,\mu}$	10.7	-	5.9	3.5 ± 1.8

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