Direct Nucleon Decay Of The Isoscalar Giant Monopole Within A Continuum-RPA Approach.

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Study of the direct nucleon decay of various giant resonances is of special interest, because such study allows one to obtain information on the microscopic structure of giant resonances. This work is stimulated by the accumulation of experimental data on partial widths (branching ratios) for direct neutron decay of the isoscalar giant monopole resonance ($ISGMR$) in ^{90}Zr [1], ^{124}Sn [2] and ^{208}Pb [3], deduced from the $(\alpha, \alpha' n)$-reaction. We have analyzed the data within a continuum-RPA (CRPA) approach taken in the form used in refs. [4,5] and applied previously mainly to isovector GRs. A phenomenological mean field and density-dependent Landau-Migdal particle-hole interaction are used in the calculations together with some partial self-consistency conditions. The isoscalar part of the interaction is modified somewhat in order to reproduce, in the calculations, the above mentioned spurious state at zero energy.

In the calculations presented in the following, the isoscalar part of the phenomenological nuclear mean field (including the spin-orbit term) was chosen in accordance with Ref. [6]. Only the mean-field amplitude U_0 was slightly increased (54 MeV instead of 53.3 MeV) to better describe the nucleon separation energies B_α for the magic subsystems in a wide range of nuclei. The intensities of the phenomenological density-dependent Landau-Migdal particle-hole interaction $F(r) = Cf(r), F'(r) = Cf'$ ($C = 300 MeV fm^3$, $f(r)$ and f' are the dimensionless intensities) are parametrized in the standard form (see e.g. Ref. [6]) with the following values for the parameters: $f' = 1.0; f^{in} = 0.0875$, while $f^{ex} \simeq -(2.25 \div 2.50)$ was slightly varied to make the spurious-state energy close to zero for each considered nucleus. The isovector part of the mean field $U_1 = \frac{1}{2}v(r)\tau^{(3)}$ is determined in a self-consistent way: $v(r) = 2F'\rho^{(-)}(r)$, where $\rho^{(-)} = \rho^n - \rho^p$. The Coulomb part of the nuclear mean field is calculated in Hartree approximation via the proton density ρ^p. Thus, all the model parameters used in the calculations for several medium-heavy mass nuclei are fixed from independent data.

In the resonance region the calculated energy dependence of the monopole strength function of these nuclei do not exhibit any gross-structure. The $ISGMR$ energies and relative strengths obtained are in good agreement with data. In table 1, we present the calculated partial neutron escape widths of the $ISGMR$ in ^{208}Pb. The experimental spectroscopic factors s_μ and the experimental decay-channel energies ε_μ^{exp} were used in the calculations. Similar agreement with data was also obtained for the $ISGMR$ in ^{90}Zr and ^{124}Sn.

In conclusion, we have carried out CRPA calculations of the strength function and partial widths for direct neutron decay of the $ISGMR$ for several medium and heavy mass nuclei. In spite of the absence of full self-consistency between the mean field and the particle-hole interaction, the calculated results are found to be in qualitative agreement with the corresponding values deduced from experimental data.

Table 1: Calculated partial neutron escape widths of the $ISGMR$ in ^{208}Pb in comparison with experimental data

μ, ^{207}Pb	E_x, MeV	s_μ a)	$\bar{\Gamma}^{\uparrow}_{\mu}$, keV	$\Gamma^{\uparrow}_{\mu}$, keV b)	$\Gamma^{\uparrow}_{\mu}$, keV c)
$(1/2)^-$	0.00	1.1	34	in $(13/2)^+$	140±35
$(13/2)^+$	1.63	0.91	4	75±35	incl.$(1/2)^-$
$(5/2)^-$	0.57	0.98	180	<35	70±15
$(3/2)^-$	0.89	1.0	57	75±40	50±10
$(7/2)^-$	2.34	0.7	135	<140±30 incl.$(5/2)^+$ $(7/2)^+$	165±40
$(9/2)^-$	0.61	10.78	3		
Γ^{tot}, keV			413	325±105	425±100

a) Values from the ref.[8] b) Values from the ref.[3] c) Values from the ref.[7]

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