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DESCRIPTION OF $T_>$ GIANT DIPOLE RESONANCES IN DEFORMED NUCLEI

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An intensive study of giant, including charge-exchange, resonances and analog states made it interesting to describe the $T_>$ giant resonances in deformed nuclei, i.e., those parts of isovector resonances, isospins of which are by unity larger than isospin of T_0 nucleus in the ground state. In the present paper the energies and reduced excitation probabilities of the $T_>$ giant isovector are calculated for deformed nuclei in the rare-earth and actinide region.

We shall perform calculations within the quasiparticle-phonon nuclear model [1]. The model parameters are used the same as in ref. [2]. As well as in the case of spherical nuclei [3], the wave function of the $T_>$ state is written in the form of

$$(2T_0 + 2)^{-1/2}\, T^{(-)}\, \Omega^+_{\lambda\rho\mu i}\, \Psi_0\,, \qquad (1)$$

where the np phonon creation operator $\Omega^+_{\lambda\rho\mu i}$ is determined in ref. [4], $\rho = \pm 1$ is the μ projection sign; the operator $T^{(-)}$ diminishes the isospin projection by unity, Ψ_0 is the ground state wave function of doubly even nucleus with isospin T_0. The $T_>$ state energy (1) is

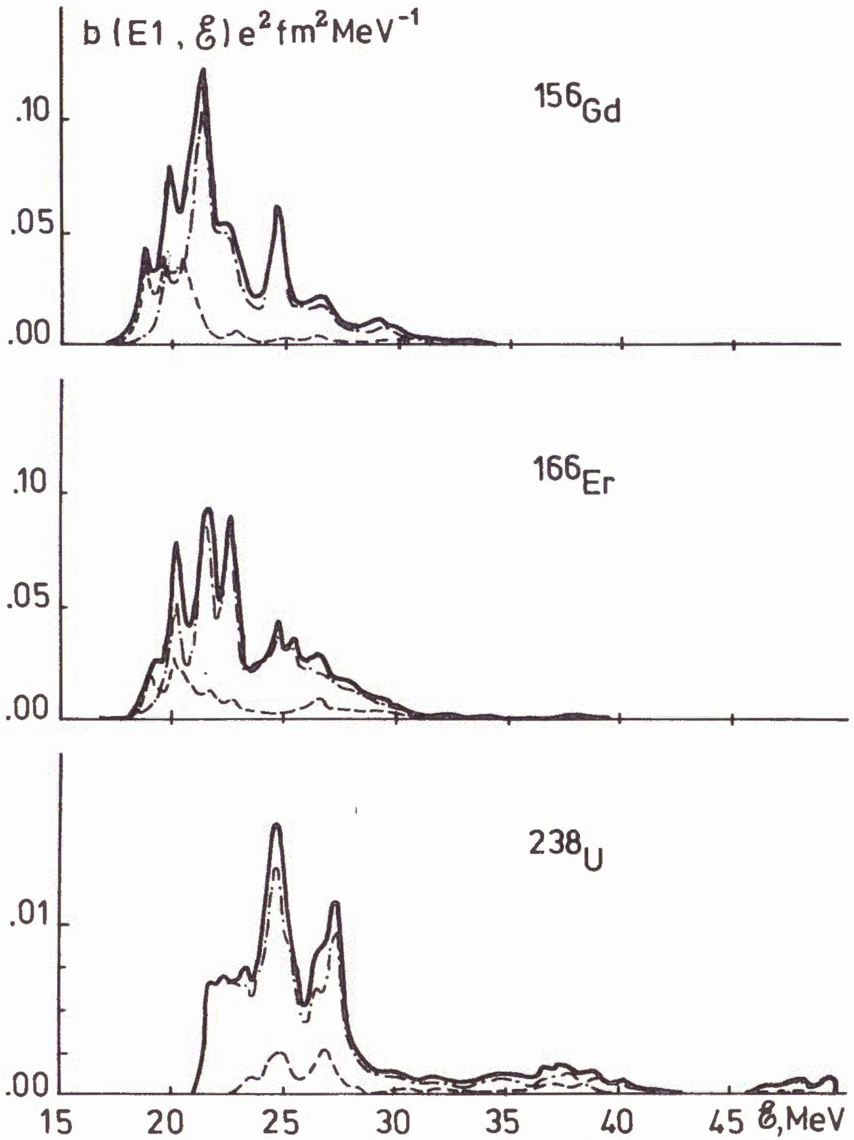
$$\epsilon^{\lambda\mu i}_{>} = \Omega_{\lambda\mu i} + \Delta E_c\,. \qquad (2)$$

The phonon energies $\Omega_{\lambda\mu i}$ are found from the solutions of secular equations given in ref. [4], ΔE_c is the Coulomb energy. For the rare-earth nuclei the Coulomb energy is taken from ref. [5] and for the rest nuclei it is calculated by formula $\Delta E_c = 1.444(Z - 1/2)A^{-1/3} - 1.131$.

The reduced $E\lambda$-transition probability from the ground state of a double even nucleus to a state described by the wave function (1) is

$$B(E\lambda;\, 0^+, T_0, T_0 \to \lambda\mu i, T_0+1, T_0) = e^2 (2T_0+2)^{-1} \cdot$$
$$\cdot (2-\delta_{\mu 0}) \cdot \sum_{rs} \{ f^{\lambda\mu}_{rs} (v_r u_s \psi^{\lambda\mu i}_{rs} + u_r v_s \phi^{\lambda\mu i}_{rs}) \}. \qquad /3/$$

This formula holds when the effective proton and neutron charges are related by $e^{(\lambda)}_p - e^{(\lambda)}_n = 1$. Here $f^{\lambda\mu}_{rs}$ are the matrix elements of the multipole operator between proton r and neutron s single-particle states, $\psi^{\lambda\mu i}_{rs}$ and $\phi^{\lambda\mu i}_{rs}$ are the direct and inverse ampli-



Strength function of E1 transitions with excitation of $T_>$ states of the dipole giant resonance in ^{156}Gd, ^{166}Er and ^{238}U. The dashed and dashed and dash-dotted line denote the transitions with $I^\pi K = 1^-0$ and 1^-1, the solid line denotes their sum.

tudes of np phonon; their explicit form is given in ref. /4/.

We calculate the strength functions $b(E1,\epsilon)$ determined in refs. /1,2/ with the averaging parameter $\Delta = 0.5$ MeV

The strength functions $b(E1,\epsilon)$ of excitation of the isovector $T_>$ giant dipole resonance in ^{156}Gd, ^{166}Er and ^{238}U are shown in the figure. It is seen from this figure that the resonance strength is distributed in the interval of 18-36 MeV for nuclei in the rare-earth region and of 24-50 MeV for actinides. The difference between centroid energies for components of the $T_>$ resonance with $I^\pi K = 1^-0$ and 1^-1 for the rare-earth nuclei varies from -1.5 to -1.5 MeV. For nuclei from the actinide region the energies of the states with $I^\pi K = 1^-0$ are 3.5-4 MeV higer than of the states with $I^\pi K = 1^-1$.

The centroid energies $\bar{E}_> = (\sum_i B(E1,T_>,i)\epsilon^i_>)/(\sum_i B(E1,T_>,i)$ and ratios $\sigma_{-1}(T_>)/\sigma_{-1}(T_<)$, where $\sigma_{-1} = \sum_i(\sigma_i/\epsilon_i)$, $\sigma_i(E1) = 0.282\,\epsilon_i B(E1)\,e^2\cdot fm$ for all calculated nuclei are presented in the table. It is seen from the table that the centroid energies

Table

Characteristic properties of the $T_>$ giant dipole resonance

Nucleus	$\bar{E}_>$, MeV	$\bar{E}_> - \bar{E}_<$, MeV	$\frac{\sigma_{-1}(T_>)}{\sigma_{-1}(T_<)}\cdot 10^3$
^{156}Gd	23.7	8.1	17
^{158}Gd	23.3	7.7	9
^{160}Gd	22.9	6.4	7
^{160}Dy	23.8	7.2	11
^{162}Dy	23.7	8.9	10
^{164}Dy	23.5	8.7	7
^{164}Er	24.6	9.8	12
^{166}Er	24.2	9.4	10
^{168}Er	24.0	9.4	8
^{168}Yb	25.0	10.0	13
^{236}U	27.7	14.9	1
^{238}U	27.9	15.1	1
^{238}Pu	27.5	14.7	1.8
^{240}Pu	27.6	14.7	1

for the rare-earth nuclei are at 23-25 MeV; and for actinides, at 27-28 MeV. These values are larger than the centroid energy of the $T_<$ resonance [2] by 6.5-10.0 and 14.7-15.1 MeV, respectively. The value of $\sigma_{-1}(T_>)/\sigma_{-1}(T_<)$ for the rare-earth nuclei is 0.008-0.017, that is close to the value obtained for spherical nuclei [3]. The value of this quantity for actinides is ten times less. The values of $\sigma_{-1}(T_>)$ decrease for isotopes with increasing A.

According to our calculations the centroid energies of the $T_>$ giant dipole resonances in deformed nuclei lie at (24-28) MeV and the excitation cross sections in photonuclear reactions are essentially smaller than the excitation cross sections of the $T_<$ giant dipole resonance.

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Соловьев В.Г., Сушков А.В. Е4-84-187
Описание $T_>$ гигантских дипольных резонансов в деформированных ядрах

В квазичастично-фононной модели ядра рассчитаны характеристики $T_>$ компоненты дипольного гигантского резонанса для деформированных ядер редкоземельной области и области актинидов. Центроид энергии $T_>$ резонанса для ядра редкоземельной области равен /23-25/ МэВ, а для ядер области актинидов - /27-28/ МэВ. Расщепление между $T_>$ и $T_<$ компонентами гигантского дипольного резонанса равно /6-15/ МэВ. Отношение сечений фотопоглощения для $T_>$ и $T_<$ компонент равно 0,001-0,017.

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Soloviev V.G., Sushkov A.V. E4-84-187
Description of $T_>$ Giant Dipole Resonances in Deformed Nuclei

The characteristic properties of $T_>$ component of the dipole giant resonance for deformed nuclei of rare-earth and actinide regions are calculated within the quasiparticle-phonon nuclear model. The centroid energy of $T_>$ resonance for rare-earth nuclei is /23-25/ MeV; and for nuclei in the actinide region, /27-28/ MeV. The splitting between $T_>$ and $T_<$ components of the giant dipole resonance is /6-15/ MeV. The ratio of photoabsorption cross sections for $\sigma_{-1}(T_>)/\sigma_{-1}(T_<)$ is 0.001 and 0.017.

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

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