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Dao Tien Khoa, V.V.Voronov

# DIPOLE PHOTON SCATTERING FROM NUCLEI IN THE LEAD REGION

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## INTRODUCTION

The experimental study of the resonant photon scattering from nuclei in the lead region [1-4] has shown that the energy dependence of the cross-sections at excitation energies below the giant dipole resonance (GDR) differs from the Lorentz extrapolation of the GDR. The cross-section substructures also have been observed in some other spherical nuclei [1]. The investigation of such substructures and the influence of the GDR on radiative strength functions within the quasiparticle-phonon nuclear model (QPM) has been made in [6,7]. It was shown that the substructures in the photoabsorption cross sections are caused by the low lying slightly-collective dipole states. The calculations of the photoabsorption cross-section in $^{208}Pb$ [7] give a correct description for the substructure at the energy near 7.3 MeV rather than for the local maximum of the cross-section at the energy 5.5 MeV. In ref. [8] the dipole strength distribution in $^{208}Pb$ has been investigated within the random phase approximation (RPA). Using the experimental single-particle spectrum, the authors [8] showed the existence of the dipole pigmy-resonances at energies 4.49 and 7 MeV, but the energy of the GDR is 2 MeV lower than the experimental value.

In this paper the average elastic photon scattering cross-sections are calculated in the frame of the QPM for nuclei in the lead region. The calculations have been made with a modified single-particle spectrum in comparison with the spectrum used in the previous reports [7,9,10]. Our results are compared with the experimental data.

## 1. CALCULATION DETAILS

The QPM Hamiltonian is explicitly given in ref. [5]. It includes the average field as the Saxon-Woods potential, the pairing interaction and the separable multipole and spin-multipole effective forces. The Hamiltonian parameters are fixed in the way proposed in [5] to describe correctly in the RPA the experimental data for the reduced probabilities of the electromagnetic transitions to the lowest collective states. One can describe simultaneously the level energies and transition probabilities by taking into account the two-phonon components in the wave function for excited states in the even-even nuclei. With this set of fixed parameters, the interaction between different states in the neighbouring odd nuclei does not contain any free parameter /5/. In contrast with the even-even nuclei, the excitation energies of the neighbouring odd nuclei are very sensitive to the choice of the single-particle spectrum. In this paper the single-particle spectrum is chosen to describe simultaneously the characteristics of the low-lying levels in $^{208}Pb$ and in the nuclei differing from $^{208}Pb$ by one nucleon.

The wave function of an odd spherical nucleus is the following

$$\Psi_\nu (JM) = C_{J\nu} \{ a^+_{JM} + \sum_{\lambda i j} D_j^{\lambda i} (J\nu) [ a^+_{jm} Q^+_{\lambda \mu i} ]_{JM} \} \Psi_0 , \qquad (1)$$

where $a^+_{JM}$ and $Q^+_{\lambda\mu i}$ correspond to the quasiparticle and phonon creation operators, $\Psi_0$ is the ground state of the even-even nucleus.

The energies $\eta_{J\nu}$ of states described by the wave functions (1) are found by solving the secular equation

$$\epsilon_J - \eta_{J\nu} - \frac{1}{2} \sum_{\lambda i j} \frac{[1 + \mathcal{L}(Jj\lambda i)] \Gamma^2 (Jj\lambda i)}{\epsilon_j + \omega_{\lambda i} - \eta_{J\nu} - \mathcal{R}(Jj\lambda i)} = 0 , \qquad (2)$$

where $\epsilon_j$ are the single-particle energies, $\omega_{\lambda i}$ are the phonon frequencies calculated in the RPA, $\Gamma(Jj\lambda i)$ are the matrix elements of the interaction between one-quasiparticle states and states of the quasiparticle plus phonon type. The coefficients $\mathcal{L}$ and $\mathcal{R}$ appear with taking into account Pauli principle correctly. The detailed description of this equation and of those for the $C_{J\nu}$ and $D_j^{\lambda i}(J\nu)$ coefficients is given in /11/. The numerical calculations are performed with the computer code PHOQUS /12/. In the cross-section calculation for $^{208}Pb$ the wave function of an excited state is taken as follows /5/

$$\Psi_\nu (JM) = \{ \sum_i R_i (J\nu) Q^+_{JMi} + \sum_{\lambda_1 i_1 \lambda_2 i_2} P^{\lambda_1 i_1}_{\lambda_2 i_2} (J\nu) [ Q^+_{\lambda_1 \mu_1 i_1} Q^+_{\lambda_2 \mu_2 i_2} ]_{JM} \} \Psi_0 . \qquad (3)$$

The differential dipole photon scattering cross-section can be written in the form /13/

$$\frac{d\sigma}{d\Omega}\Big|_\theta = \frac{E'}{E(2I_i + 1)} \sum_{J=0,1,2} | \langle I_f || P^{11}_J || I_i \rangle |^2 g_J(\theta), \qquad (4)$$

where $I_i$ and $I_f$ are the initial and final spins of the nucleus, $E$ and $E'$ are the energies of the incident and scattered photons, respectively. The angular distributions are

$$g_0(\theta) = \frac{1 + \cos^2\theta}{6}, \quad g_1(\theta) = \frac{2 + \sin^2\theta}{12}, \quad g_2(\theta) = \frac{13 + \cos^2\theta}{60},$$



$\langle I_f || P^{11}_J || I_i \rangle$ are the reduced generalized polarizabilities for dipole scattering /13/.

After some transformations one can obtain the following expression for the average elastic photon scattering on an $1^-$ excited state of the nucleus

$$\frac{d\sigma}{d\Omega}\Big|_\theta = \{ [ \frac{4\pi B(E1; 0^+ \to 1^-)}{9} ]^2 \frac{2\pi E_x^2}{\Gamma \Delta E} + \frac{(Ze)^4}{(AM)^2} \} \frac{1 + \cos^2\theta}{2} , \qquad (5)$$

where $\Gamma$ is the decay width of the $1^-$ level with energy $E_x$, $\Delta E$ is the energy interval of averaging taken to be equal to 0.2 MeV in our calculations, which is in good agreement with the experimental energy resolution for photons /1-4/, and $B(E1, 0^+ \to 1^-)$ is the reduced electric dipole transition probability. In the approximation $\Gamma = \Gamma_0$, expressing $\Gamma_0$ in terms of the B(E1)-value, one can obtain

$$\frac{d\sigma}{d\Omega}\Big|_\theta = \{ \frac{2\pi^2 E_x B(E1; 0^+ \to 1^-)}{3\Delta E} + \frac{(Ze)^4}{(AM)^2} \} \frac{1 + \cos^2\theta}{2} . \qquad (6)$$

The term $(Ze)^4/(AM)^2$ corresponds to the Thompson scattering and is nearly $10^2$ times smaller than the resonant term. The approximation $\Gamma \simeq \Gamma_0$ is good for all levels below the neutron emission threshold. From the analysis of the experimental data for nuclei in the lead region, one can get $\Gamma_0/\Gamma \simeq 0.9$-$1.0$ /4/. We have used the strength function method developed in /5/ to calculate the transition probabilities

$$b(E1; \eta) = \frac{1}{2\pi} \sum_\nu \frac{\Delta}{(\eta - \eta_\nu)^2 + \Delta^2/4} B(E1; 0^+_{g.s.} \to 1^-_\nu), \qquad (7)$$

the B(E1)-values are calculated with the wave functions (1), (3). In this case from (6) one can get

$$\frac{d\sigma}{d\Omega}\Big|_\theta = \{ \frac{2\pi^2 E_x}{3\Delta E} \int_{E_x - \Delta E/2}^{E_x + \Delta E/2} b(E1; \eta) d\eta + \frac{(Ze)^4}{(AM)^2} \} \frac{1 + \cos^2\theta}{2} . \qquad (8)$$

For the total photon scattering cross-section, which is nearly equal to the photon absorption cross-section /6/, one has

$$\sigma_{\gamma\gamma}(E_x) = \frac{16\pi^3 E_x}{9\Delta E} \int_{E_x - \Delta E/2}^{E_x + \Delta E/2} b(E1; \eta) d\eta = \frac{4.025 E_x}{\Delta E} \int_{E_x - \Delta E/2}^{E_x + \Delta E/2} b(E1; \eta) d\eta \ \text{mb}. \qquad (9)$$

Here $E_x$ and $b(E1; \eta)$ are in MeV and $e^2 fm^2/MeV$, respectively. The radiative strength functions $b(E1; \eta)$ for $^{208}Pb$ are calculated with the computer code GIRES /14/.

## 2. DISCUSSION OF RESULTS

We consider first the results of our calculation for the low-lying levels in the odd neighbouring $^{208}Pb$ nuclei. The wave functions have the form (1) in our calculation. The single-particle energies are the entering parameters for solving the secular equation (2). The single-particle spectrum, which gives a good description of the characteristics of the low-lying states, is shown in fig.1.

As one can see from fig.1, the chosen spectrum is close to the experimental data and is more compressed in comparison with the spectrum calculated with the Saxon-Woods potential with parametrization described in[15]; the proton particle levels are strongly changed. It should be noted that the chosen spectrum is near to the spectrum used in[16]. In contrast with[15], in the calculation of the single-particle spectrum in[16] the spin-orbital parameters of the potential had been varying independently of the central part. Since the high-lying single-particle levels are unchanged in our calculation, the results for the giant resonances are nearly the same as in[10].

The calculated level energies $E_j$ and spectroscopic factors $S_j$ of the one-nucleon transfer reactions, expressed in the QPM as $C_j^2$ and the experimental data[17] are shown in table 1 and table 2. As one can see, the experimental data for the considered nuclei are well described in our calculation. The results for $^{209}Bi$ are much improved in comparison with the spectrum[9]. For the levels far from the Fermi surface, we have got some disagreement between the calculation results and the experimental data for the spectroscopic factors. The improved description can be reached by taking into account more complex configurations of "quasiparticle plus two phonons" type in the wave functions (1). It has been shown in[18] that these configurations are very important in the calculation of the characteristics for the deep-lying hole states.

Using the formulas written above, we have calculated the cross-section for elastic dipole photon scattering from $^{208}Pb$. The calculations are performed with the chosen single-particle spectrum reported here. The experimental data and the results calculated in the RPA and with the wave function (3) are shown in fig.2. As one can see, the experimental data indicate the existence of the substructures in the photon scattering cross-section at energies near 5.5 MeV and 7.3 MeV. Such a behaviour of the cross-section disagrees with the Lorentz extrapolation of the GDR. The cross-sections, calculated with the RPA wave functions, have clear substructures at energies 5.9 MeV and 7.5 MeV. The appearance of the substructure of the energy 5.9 MeV is caused by the existence of a low-lying $1^-$ collective state and some other noncollective dipole states in this



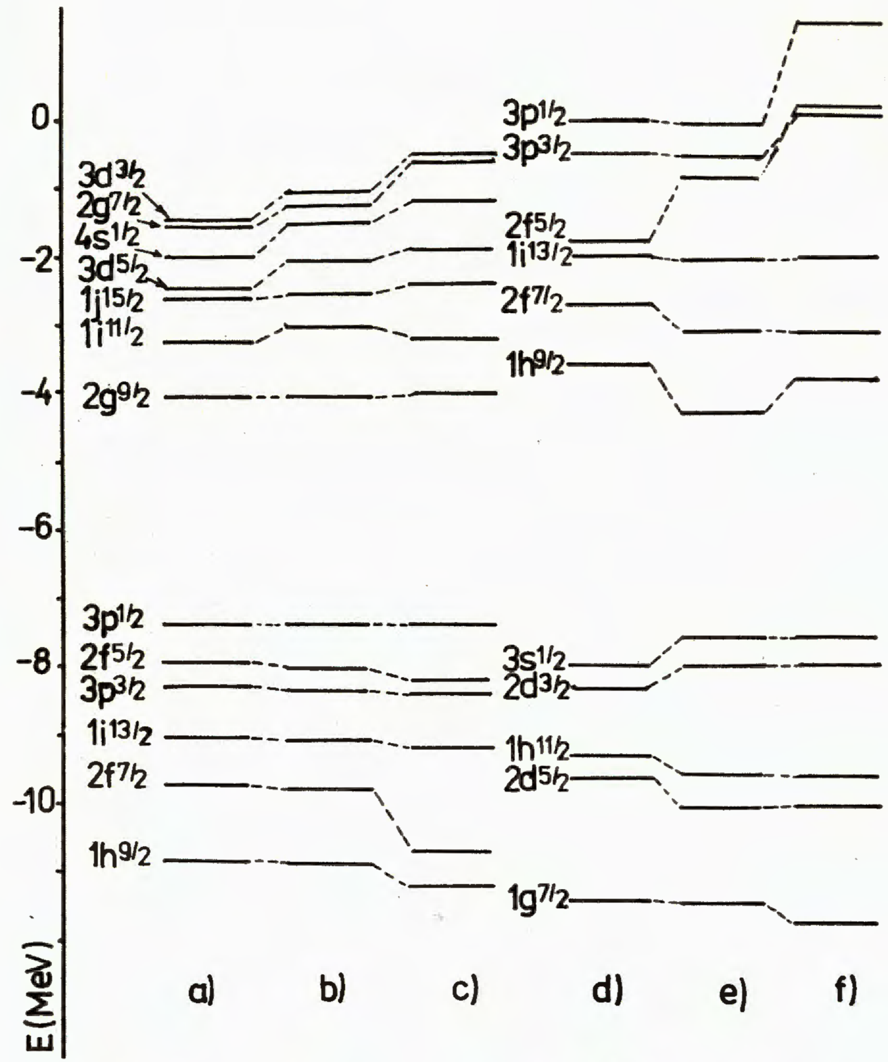


Fig.1. The single-particle level in $^{208}Pb$. a),b),c) - the neutron levels; d),e),f) - the proton levels; a),d) - the experimental data; b),e) - our calculation; c) and f) - calculation with the parameters from[9].

energy interval. The existence of these states in contrast with the previous calculations[7], can be explained by the energy shift of 4s 1/2 , 3d 5/2 , 3d 3/2 - neutron levels in the chosen single-particle spectrum used here. The dipole strength is pushed slightly down by taking into account the two-phonon

Table 1

Theoretical and experimental values of the energies and spectroscopic factors of the low-lying levels in $^{207,209}Pb$

| Nucleus | State | Calculation | | | | Experiment | |
|---|---|---|---|---|---|---|---|
| | | Parameters fr. /9/ | | This report | | | |
| | | $E_j$, MeV | $S_j$ | $E_j$, MeV | $S_j$ | $E_j$, MeV | $S_j$ |
| $^{209}Pb$ | 2g 9/2 | 0.0 | 0.93 | 0.0 | 0.93 | 0.0 | 0.78 |
| | 1i11/2 | 1.07 | 0.97 | 1.24 | 0.97 | 0.78 | 0.96 |
| | 1j15/2 | 1.50 | 0.84 | 1.52 | 0.83 | 1.42 | 0.53 |
| | 3d5/2 | 1.74 | 0.87 | 1.63 | 0.87 | 1.56 | 0.88 |
| | 4s1/2 | 2.55 | 0.83 | 1.92 | 0.84 | 2.03 | 0.88 |
| | 2g7/2 | 3.23 | 0.86 | 2.57 | 0.89 | 2.49 | 0.72 |
| | 3d3/2 | 2.68 | 0.78 | 2.17 | 0.81 | 2.54 | 0.88 |
| $^{207}Pb$ | 3p1/2 | 0.0 | 0.95 | 0.0 | 0.94 | 0.0 | 1.07 |
| | 2f5/2 | 0.68 | 0.96 | 0.50 | 0.95 | 0.57 | 1.13 |
| | 3p3/2 | 0.80 | 0.94 | 0.76 | 0.93 | 0.89 | 1.00 |
| | 1i13/2 | 1.64 | 0.94 | 1.57 | 0.94 | 1.63 | 1.04 |
| | 2f7/2 | 2.86 | 0.81 | 2.10 | 0.87 | 2.34 | 0.88 |
| | 1h9/2 | 3.71 | 0.90 | 3.37 | 0.91 | 3.41 | 1.10 |

components and the first substructure is now located at the energy 5.5 MeV. The peak of the cross-section calculated in the RPA at the energy 7.5 MeV is splitted and pushed down to 7.2 MeV. Thus, the modification of the single-particle spectrum and the inclusion of the two-phonon components in the wave functions of the excited states enable one to describe the experimentally observed substructures in the dipole photon scattering cross-section at energies 5.5 MeV and 7.3 MeV. In the energy interval of 5.0-7.8 MeV, the RPA calculation results give the total probability $\Sigma B(E1) = 0.75\ e^2fm^2$. The calculation with the wave function (3) gives $\Sigma B(E1) = 0.9\ e^2fm^2$, because in this case a part of the GDR strength is pushed down to the lower energies. The experimental estimation /20/ gives $\Sigma B(E1) = (1.2-1.8)\ e^2fm^2$. The experimental data for $\Sigma B(E1)$ in the energy interval of 7.3-8.3 MeV reported in /21/ is nearly 1.5 times smaller than the data from /20/. With such an experimental uncer-



Table 2

Theoretical and experimental values of the energies and spectroscopic factors of the low-lying levels in $^{209}Bi$, $^{207}Tl$

| Nucleus | State | Calculation | | | | Experiment | |
|---|---|---|---|---|---|---|---|
| | | Parameters fr./9/ | | This report | | | |
| | | $E_j$, MeV | $S_j$ | $E_j$, MeV | $S_j$ | $E_j$, MeV | $S_j$ |
| $^{209}Bi$ | 1h9/2 | 0.0 | 0.96 | 0.0 | 0.96 | 0.0 | 1.17 |
| | 2f7/2 | 0.26 | 0.86 | 0.85 | 0.87 | 0.89 | 0.78 |
| | 1i13/2 | 0.41 | 0.88 | 1.88 | 0.83 | 1.60 | 0.56 |
| | 2f5/2 | 3.55 | 0.70 | 2.94 | 0.83 | 2.81 | 0.88 |
| | 3p3/2 | 3.05 | 0.63 | 3.16 | 0.77 | 3.11 | 0.67 |
| | 3p1/2 | 4. | 0.73 | 3.31 | 0.74 | 3.62 | 0.49 |
| $^{207}Tl$ | 3s1/2 | 0.0 | 0.93 | 0.0 | 0.93 | 0.0 | 0.95 |
| | 2d3/2 | 0.23 | 0.95 | 0.26 | 0.94 | 0.35 | 1.15 |
| | 1h11/2 | 1.57 | 0.88 | 1.65 | 0.88 | 1.34 | 0.89 |
| | 2d5/2 | 1.78 | 0.83 | 1.88 | 0.83 | 1.67 | 0.62 |
| | 1g7/2 | 3.86 | 0.80 | 3.52 | 0.81 | 3.47 | 0.40 |

tainty our results give the correct integrated dipole strength in the energy region of 5.0-8.0 MeV.

The results of the RPA calculation and the experimental data for $^{206}Pb$ are shown in fig.3a. As one can see, the calculation gives a qualitatively good description of the substructures at energies 5.8 MeV and near 7.0 MeV. The first peak in the cross section for $^{206}Pb$ is of the same nature as for $^{208}Pb$. It was shown in /7/ that for $^{206}Pb$ the two-phonon components redistribute the dipole strength in the energy region near 7.0 MeV and lead to the fine structure in the photoabsorption cross section. But such a numerical calculation needs a lot of computer time, so we consider here qualitatively only the RPA result, having in mind that in the RPA the dipole strength distribution in the region 7.0 MeV has been changing weakly in the calculation with the new spectrum.

The experimental data and our calculation with the wave function (1) for $^{207}Pb$, $^{205}Tl$ and $^{209}Bi$ are shown in fig.3. There are substructures in either the calculated and experimental cross-sections, but the calculated substructures are moved

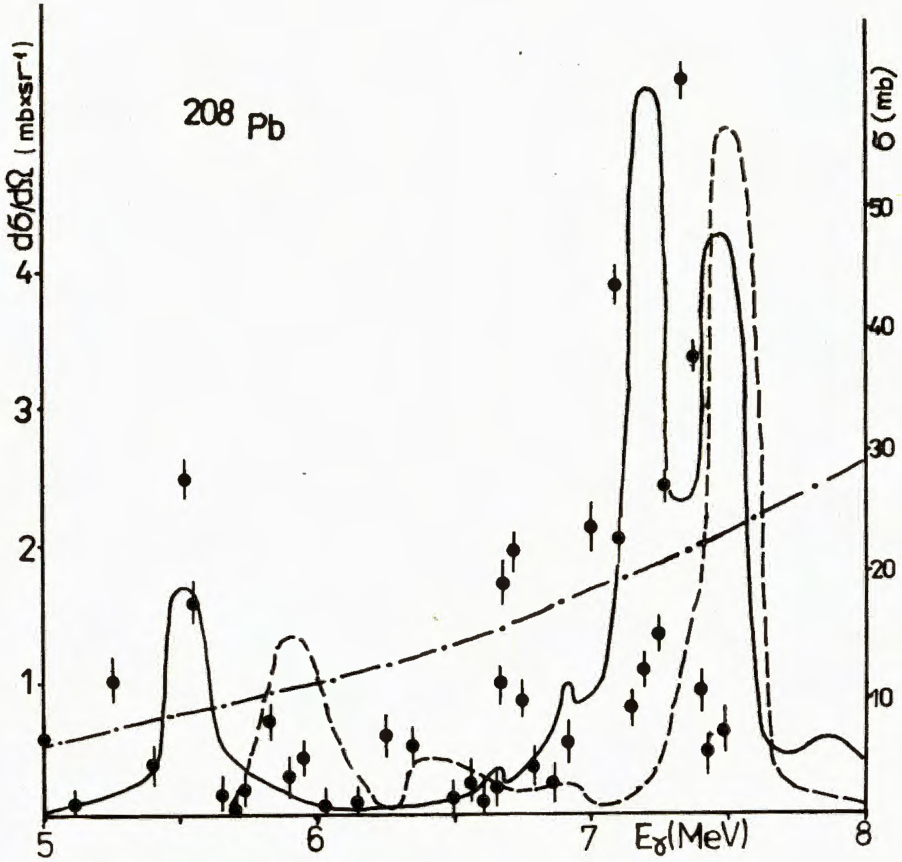


Fig.2. The dipole photo-scattering cross-section of $^{208}$Pb. Points are experimental data [1,2]; dashed line is calculation in the RPA; solid line is calculation with the wave function (3); dash-dotted line is the Lorentz extrapolation of the GDR with the parameters from [19].

up to the higher energies from the experimental data by 0.5-0.7 MeV. One may expect such a picture from our calculation, because we have not taken into account more complex components of "quasi-particle plus two phonons"-type in the wave function (1). These components, expectedly, do not change the whole picture qualitatively, but move the peaks to the region of lower energies. At the same time there is a fragmentation of "quasi-particle plus phonon" components in nonmagic nuclei and the strength of this fragmentation depends on the individual characteristics of the nuclei [22]. In near-magic nuclei $^{207}$Pb, $^{209}$Bi a weak fragmentation is expected, but in $^{205}$Tl the two-



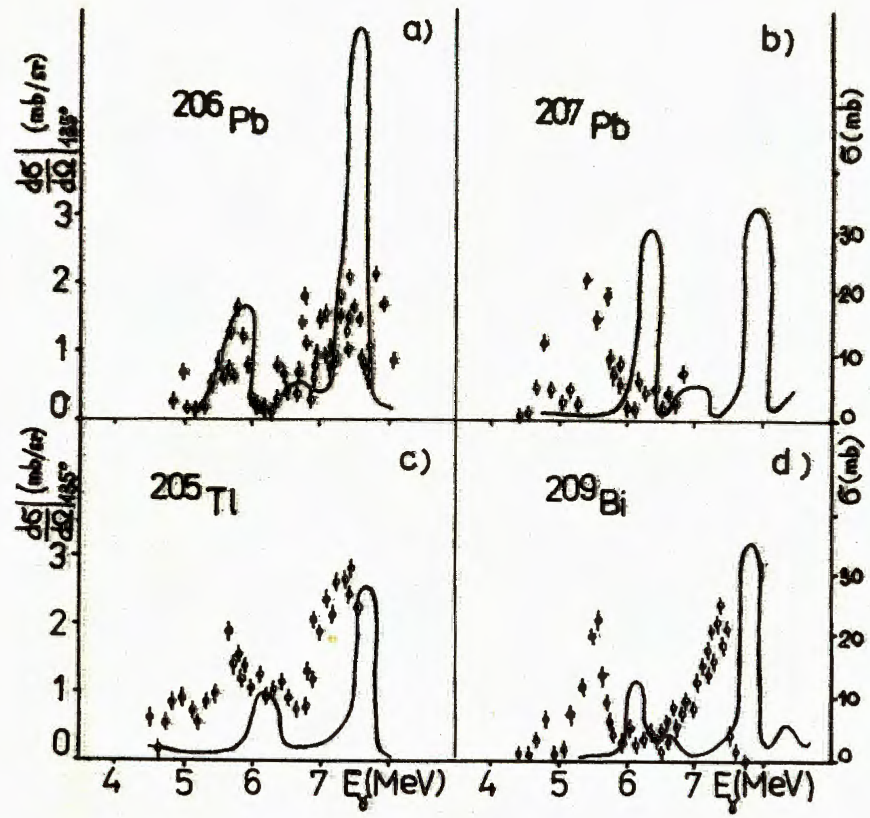


Fig.3. The dipole photo-scattering cross-sections. Points are experimental data [1,2]; solid line is our calculation; a) for $^{206}$Pb, b) for $^{207}$Pb, d) for $^{209}$Bi and c) for $^{205}$Tl.

phonon components have a strong influence. This effect is seen from the experimental data (see fig.3), namely the substructures in the cross section for $^{205}$Tl are not sharp as for $^{209}$Bi, for example. The existence of these substructures in the odd nuclei can be well explained from our calculations. They are related to the E1-transitions from the ground state with a large one-quasiparticle component to the state of one-quasiparticle plus a dipole phonon of the neighbouring even-even core. Thus, one can conclude that the dipole pigmy-resonances in $^{206,208}$Pb are responsible for the existence of the substructures in the dipole photon scattering cross-sections in the odd nuclei. The integrated cross-sections $\sigma_0 = \int_{\Delta E} \sigma_{\gamma\gamma}(E)dE$ in two energy regions are shown in table 3.

Table 3

The integrated cross-section $\sigma_0 = \int_{\Delta E} \sigma_{\gamma\gamma}(E)dE$

| Nucleus | $\Delta E$ =5.0-6.0 MeV | | $\Delta E$ =6.5-7.5 MeV | |
|---|---|---|---|---|
| | $\sigma_0$, mb MeV | | $\sigma_0$, mb MeV | |
| | Exper. | Calculation | Exper. | Calculation |
| $^{208}Pb$ | 15.2 | 10.1 | 24.4 | 24 |
| $^{206}Pb$ | 15.8 | 13.5 | 20.2 | 24.3 |
| $^{207}Pb$ | 12.6 | 11.5 | - | - |
| $^{209}Bi$ | 10.4 | 7.1 | 10.7 | 11.5 |
| $^{205}Tl$ | 8.3 | 5.4 | 7.8 | 9.4 |

In comparison with the experimental data the $\sigma_0$ -values have been integrated under the calculated peaks shown in fig.3, so some shift in energy has been made in the calculations for the odd nuclei. As one can see from table 3, on the whole our calculations give a correct dipole strength distribution of nuclei in the lead region. An improved quantitative agreement with the experimental data can be reached by including more complex wave functions into calculation. Such calculations are very complex and need a lot of computer time.

## CONCLUSION

Our calculations have shown that within the QPM one can correctly describe, using a modified single-particle spectrum, the low-lying states and the existence of substructures in the dipole photon scattering cross-section of the nuclei in the lead region. In the low-energy region the cross-sections differ from the Lorentz extrapolation of the GDR. The low-lying dipole pigmy-resonances in $^{206,208}Pb$, whose nature can be explained by the shell structure of these nuclei, are responsible for the substructure existence. These pigmy-resonances also influence strongly the photo-scattering cross-sections in the odd neighbouring nuclei.

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## REFERENCES


1. Axel P. et al. Phys.Rev., 1970, C2, p.689; Nucl.Phys. Research with Electrons from MUSL-2 and MUSL-3. Dep. of Phys., University of Illinois at Urbana-Champaign, 1977.
2. Lazewski R.M., Axel P. Phys.Rev., 1979, C19, p.342.
3. Knowles J.W. et al. Can.J.Phys., 1978, vol.56, p.1012.
4. Chapuran T. et al. Phys.Rev., 1980, C22, p.1420.
5. Soloviev V.G. Particles and Nuclei, 1978, 9, p.580; Nucleonika, 1979, 23, p.1149; Malov L.A., Soloviev V.G. Particles and Nuclei, 1980, 11, p.301; Vdovin A.I., Soloviev V.G. Particles and Nuclei, 1983, 14, p.237; Voronov V.V., Soloviev V.G. Particles and Nuclei, 1983, 14, p.1381.
6. Soloviev V.G., Stoyanov Ch., Voronov V.V. Nucl.Phys., 1978, A304, p.503.
7. Soloviev V.G., Stoyanov Ch., Voronov V.V. Nucl.Phys., 1983, A399, p.141.
8. Harvey H., Khanna C.F. Nucl.Phys., 1974, A221, p.77.
9. Ponomarev V.Yu. et al. Nucl.Phys., 1979, A323, p.446.
10. Voronov V.V., Chan Zuy Khuong. Izv.Akad.Nauk SSSR (ser. fiz.), 1981, 45, p.1909.
11. Chan Zuy Khuong, Soloviev V.G., Voronov V.V. J.Phys., 1981, G7, p.151.
12. Stoyanov Ch., Chan Zuy Khuong. JINR, P4-81-234, Dubna, 1981.
13. Eisenberg I., Greiner W. Excitation Mechanisms of the Nucleus. North-Holland Publ.Comp., Amsterdam, 1970.
14. Ponomarev V.Yu., Stoyanov Ch., Stoyanova O. JINR, P4-81-704, Dubna, 1981.
15. Chepurnov V.A. Yad.Fiz., 1967, 16, p.955.
16. Dehesa S.J. Preprint KFA-Jül-1425, 1977.
17. Ring P., Werner E. Nucl.Phys., 1973, A211, p.198.
18. Soloviev V.G., Stoyanov Ch., Vdovin A.I. Nucl.Phys., 1980, A342, p.261.
19. Veyssiere A.N. et al. Nucl.Phys., 1970, A159, p.561.
20. Raman S. Proc. of the 3rd Int.Symp.on Neutron Capture Gamma-Ray Spectroscopy and Related Topics. BNL, New York, 1978, p.193.
21. Holt R.J. et al. Phys.Rev., 1979, C20, p.93.
22. Soloviev V.G., Stoyanov Ch. Nucl.Phys., 1982, A382, p.206.


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Дао Тиен Кхоа, Воронов В.В. E4-84-6
Дипольное фоторассеяние на ядрах области свинца

В рамках квазичастично-фононной модели ядра рассчитаны усредненные сечения упругого рассеяния гамма-квантов на ядрах $^{206,207,208}Pb$, $^{205}Tl$ и $^{209}Bi$ в интервале энергий 5,0-8,0 МэВ. Расчеты проводились с модифицированным одночастичным спектром, позволяющим получить хорошее описание экспериментальных энергий и спектроскопических факторов низколежащих уровней, отличающихся на один нуклон от $^{208}Pb$. Расчеты правильно передают энергетическую зависимость сечений. Показано, что существование подструктур в ядрах области свинца обусловлено возбуждением коллективных дипольных состояний, формирующих пигми-резонансы.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1984

Dao Tien Khoa, Voronov V.V. E4-84-6
Dipole Photon Scattering from Nuclei in the Lead Region

The average cross-section for elastic photon scattering from nuclei in the lead region in the energy interval of 5.0-8.0 MeV is calculated within the quasiparticle-phonon nuclear model. Calculations have been performed with a single-particle spectrum, which gives a rather good description for the energies and spectroscopic factors of the low-lying levels in the nuclei differing from $^{208}Pb$ by one nucleon. The nature of the experimentally observed substructures in the photon scattering cross-sections is discussed.

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

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