a) the contribution to Rayleigh scattering is essentially by K-shell electrons[2];

b) the energies of gamma rays are much larger than the binding energy of K electrons. It is therefore possible, at least in the second order perturbation theory, to use the free electron propagator instead of a large number of intermediate states which would have to be taken into account in the exact calculation. (This approximation is known as the impulse approximation[3].)

c) The wave function of the K electron is taken in the lowest order in $Z\alpha$ (Ref.[4]), and the effect of other electrons is neglected.

Taking into account a), b) and c) we obtain the following form for the Rayleigh scattering amplitude by K-shell electrons

$$A \sim \int d^3 p \begin{pmatrix} 2m\,\Phi(\vec{p}')\,w \\ -\Phi(p')\,\vec{\sigma}\cdot\vec{p}'w \end{pmatrix}^{+} \gamma_0 \left[\hat{\varepsilon}_2 \frac{i f_1 - m}{f_1^2 + m^2}\hat{\varepsilon}_1 + \hat{\varepsilon}_1 \frac{i f_2 - m}{f_2^2 + m^2}\hat{\varepsilon}_2\right] \begin{pmatrix} 2m\Phi(\vec{p})w \\ -\Phi(p)\vec{\sigma}\cdot\vec{p}w \end{pmatrix}$$

If we drop the small components in the above relation we obtain the classical result in which the Z-dependence disappears[5].

In a rather rough estimate the above amplitude gives a simple analytical expression for polarization P at 90°,

$$P = \frac{1 - \frac{1}{4}\left[\left(\frac{\varepsilon_\gamma}{m}\right)^2 + \frac{1.8\,(Z\alpha)^2}{[1 + (1 - Z\alpha)^2]}\right]}{1 + \frac{1}{4}\left[\left(\frac{\varepsilon_\gamma}{m}\right)^2 + \frac{1.8\,(Z\alpha)^2}{[1 + (1 - Z\alpha)^2]}\right]},$$

where ε_γ is the photon energy, m the mass of the electron, Z the nuclear charge, and $\alpha = 1/137$ the fine structure constant.

Comparison with the experimental data[1] and the calculation of Brown et al.[2] is quite good, having in mind the roughness of the approximation.

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5.11. The E0 component in the $2^+ - 2^+$ transition of 879 keV in the ^{160}Dy

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The analysis of the $2^+ - 2^+$ transition in the ^{160}Dy is the continuation of a systematic work done by authors in the last few years[1-5]. Electron-gamma directional correlation measurement of the 2^+(879 keV)2^+(87 keV)0^+ cascade have been made. The electric monopole to quadrupole mixing ratio q_k for the 879 keV transition was determined. Under the assumption that there are no penetration effects result is:

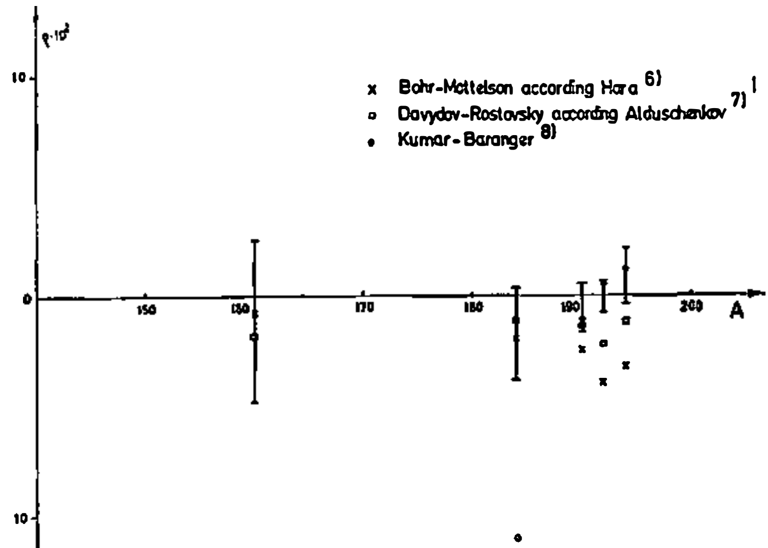

Fig. 1. The ϱ values for the $2^+ - 2^+$ transitions of 879 keV in the ^{160}Dy, 793 keV in the ^{184}W[2], 371 keV in the ^{190}Os[4], 296 keV in the ^{192}Pt[3] and 293 keV in the ^{194}Pt[5], compared with some theoretical predictions.

$$q_k = -0.03(10)$$

From that value the reduced matrix element of the EO transition ϱ was calculated. On the Fig. 1 our value of ϱ together with the results from the ref[2,3,4,5] are compared with some theoretical predictions.

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