5.8. Measurement of the gamma transition intensities in ^{185}Re

Đ. M. KURBANI, M. STANOJEVIĆ and M. BOGDANOVIĆ, *Institute »Boris Kidrič«, Beograd*

5.9. Search for the $\gamma\gamma$ decay of the 392-keV state in ^{113}In

K. ILAKOVAC, B. MOLAK and M. JURČEVIĆ, *Institute »Ruđer Bošković«, Zagreb*

An attempt to observe the double-gamma decay of the 1.7^h isomeric state of ^{113}In was made. A source of ^{113}Sn of about 60 μCi was used. Two coaxial Ge(Li) detectors of 17 cm^3 and 20 cm^3 detected photons emitted from the source at a relative angle of about 90°. Coincident events were analyzed in a fast coincidence system and a 128 × 256 × 256 channel three-dimensional analyzer. The time difference was measured by means of a time-to-amplitude converter and recorded in the first channel, and the amplitude of pulses from the two detectors were recorded in the other two channels. The 3D analyzer uses punched paper tape for the recording of data, and the tape is analyzed off-line in a CAE 9040 computer.

Energy and timing calibration were made by Compton scattering of 392-keV gamma rays from one detector into the other. By varying the scattering angle it was possible to change the fraction of energy released (to the Compton recoil electron) in the first detector, the rest being carried by the secondary Compton photon to the second detector. The timing (except for a negligible delay due to different distances) and the energy relations are the same as in the double gamma decay of the 392-keV state in ^{113}In.

The analysis of data has not been completed. A preliminary result for the ratio of the transition probability of gamma-gamma decay and of single gamma-ray emission, assuming an isotropic angular distribution, has been obtained:

$$T_{\gamma\gamma}/T_{\gamma} < 2 \cdot 10^{-5}$$

This result is to be compared with the single-particle theoretical estimate[1] of $1.6 \cdot 10^{-6}$.

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5.10. Z-dependence of linear polarization in Rayleigh scattering

N. BILIĆ, M. MARTINIS and K. PISK, *Institute »Ruđer Bošković«, Zagreb*

In the experiment of B. Molak et al.[1] it was shown that the degree of linear polarization in Rayleigh scattering decreases with increasing Z at 90°. The energy of gamma rays was 662 keV. The exact numerical approach of Brown et al.[2] would involve great computational dificulties. Since polarization is simply the ratio between cross sections, we are able to obtain the Z-dependence of linear polarization in a more direct way by taking into account the following approximations:

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

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

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 EO component in the $2^+ - 2^+$ transition of 879 keV in the ^{160}Dy

M. ŽUPANČIĆ, I. BIKIT and L. MARINKOV, *Institut of nuclear sciences »Boris Kidrič«, Beograd*

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