LINEAR POLARIZATION OF GAMMA RAYS PRODUCED IN THE (d, pγ) *STRIPPING REACTION*

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The linear polarization of γ rays produced in the (d, pγ) reaction is determined by the distorted-wave method. Our results show that as the interaction of deuteron and proton with the target nucleus becomes stronger, the polarization decreases and the polarization plane is displaced.

THE study of various phenomena has been proposed to clarify the mechanism of the stripping reaction. Thus, in the case of the (d, pγ) reaction, besides the measurement of the polarization and the angular distribution of protons, measurements of angular p-γ correlation[1] and correlation of circular γ-ray polarization[2,3] have been suggested.

As we know, a simple theory of stripping reactions based on the Born approximation has been inadequate to interpret the results of these measurements. Therefore the interactions of deuteron and proton with the target nucleus as treated by the distorted-wave method have been introduced[1] into the calculation. In this article the linear polarization of γ rays produced in the (d, pγ) reaction is computed with account of these interactions.

The correlation function was calculated by the usual method.[4] The linear polarization is given by the formula

$$[W(\varphi+\pi/2)-W(\varphi)]/[W(\varphi+\pi/2)+W(\varphi)],$$

where φ is the angle describing the γ-detector plane of sensitivity to linear polarization, reckoned from an arbitrary x axis in a plane perpendicular to the direction of γ-ray propagation. Choosing the z axis along the direction of γ-ray observation and assuming that the neutron is captured with a definite orbital angular momentum l_n, we obtain the following expression:

$$P_{lin}=\sum_{k\geqslant 2} h_k\,|d_{k2}|\cos 2\,(\varphi-\alpha_{k2})\Big/\sum_k g_k d_{k0},$$

where

$$h_k=\Big\{\sum_{j_n j_n'}\theta_{j_n l_n}\theta_{j_n' l_n}\eta_k(j_n j_n' j_a j_b)\Big\}$$
$$\times\Big\{\sum_{LL'} C_L C_{L'} F_k(LL' j_c j_b)(\pm)_{L'}\frac{(LL'\,11\,|\,k2)}{(L'L'1-1\,|\,k0)}\Big\},$$

g_k, d_{k2}, d_{k0}, α_k, $\theta_{j_n l_n}$, C_L, F_k, and η_k designate the same quantities as in [5]; j_a is the spin of the target nucleus, j_b the spin of the excited nucleus produced in the process of neutron capture; j_n and l_n are the total and orbital angular momenta of the captured neutron; j_c is the spin of the residual nucleus; 2^L is the multipolarity of the γ radiation. The quantity $(\pm)_{L'}$ is equal to $(-1)^{L'}$ multipled by the parity of radiation with multipolarity $2^{L'}$.

If we detect γ rays in the $\mathbf{k}_d\times\mathbf{k}_p$ direction and choose the z axis to be in this same direction, then when $l_n = 1$ ($k \leq 2$) we obtain

$$P_{lin}=\frac{\sqrt{6}}{4}\frac{h_2}{g_0-g_2/2}\lambda\cos 2\,(\varphi-\alpha_{22}),$$

$$\lambda=-\frac{2}{\sqrt{6}}\frac{|d_{22}|}{d_{20}}\qquad(0\leqslant\lambda\leqslant 1).$$

In the Born approximation $\lambda = 1$ and $\alpha_{22} = 0$, if φ is measured from the recoil direction. We see that the interaction of the deuteron and the proton with the target nucleus causes the polarization to decrease to the same extent as does the anisotropy of p-γ correlation (cf. [1]); on the other hand, the polarization plane undergoes a rotation by the same angle as does the symmetry axis of p-γ correlation.

It must be observed that since only the quantity α_{k2} participates in the general expression for P_{lin}, the rotation of the polarization plane can be characterized by a single parameter even when $l_n = 2$.

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