NEUTRON POLARIZATION IN THE DISINTEGRATION OF Be^9 *NUCLEI BY CIRCULARLY POLARIZED GAMMA QUANTA*

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The polarization of photoneutrons emitted in the reaction $Be^9(\gamma, n)Be^8$ is determined for circularly polarized γ quanta. It is shown that for certain neutron emission angles the polarization is as high as ~ 50 percent.

It is well known that an investigation of the polarization of photoprotons or neutrons, emitted by unpolarized nuclei, makes it possible to determine the circular polarization of the incident γ rays. Knowledge of this polarization has assumed particular importance since the discovery of parity nonconservation in weak interactions.

For low quantum energies, the most favorable target nuclei are H^2 and Be^9. However, as shown by Schopper,[1] in the case of the deuteron the protons are weakly polarized at these photon energies, so that a target of H^2 nuclei cannot be used effectively to determine the sign of the circular polarization of the gamma rays. As regards the Be^9 nucleus, the polarization of the photoneutrons released by circularly-polarized gamma quanta has not yet been determined. The present investigation concerns the polarization of photoneutrons from Be^9 nuclei.

The z component (in the direction of the incident γ quantum) of the polarization vector of photoneutrons knocked out from the Be^9 nucleus is given by the formula

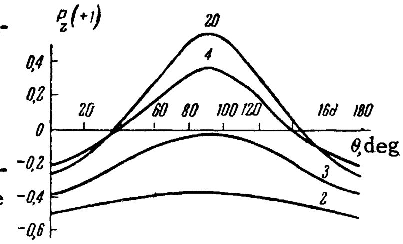
$$P_z(\pm 1)$$

$$= \pm \frac{0.5\left\{1{,}28A_2^2 - A_0^2 - [2A_0A_2\cos(\eta_0 - \eta_2) + 1{,}53A_2^2]P_2(\cos\theta)\right\}}{A_0^2 + 2A_0A_2\cos(\eta_0-\eta_2)P_2(\cos\theta) + 2.14A_2^2 - 0.76A_2^2P_2(\cos\theta)},$$

$$A_0 = \int R_{0_{1/2}} R_{1_{3/2}} r^3 dr, \quad A_2 = \int R_{2_{5/2}} R_{1_{3/2}} r^3 dr, \qquad (1)$$

where $\eta_0 = \eta_{0_{1/2}}$, $\eta_2 = \eta_{2_{3/2}} = \eta_{2_{5/2}}$ are the scattering phase shifts, θ is the angle of emission of the photoneutrons. The upper and lower signs in the argument of P_z correspond to the right-hand and left-hand polarizations of the gamma quantum. In view of the arbitrariness of the choice of axis directions, the values of P_x and P_y drop out after averaging over φ.

Formula (1) contains the scattering phase shifts η_0 and η_2 as well as the radial integrals A_0 and A_2. Using the values of the parameters[2,3] of the neutron potential in the Be^9 nucleus, namely $V_{1_{3/2}} = 12.16$ Mev, $V_{0_{1/2}} = 3$ Mev, and $r_0 = 5 \times 10^{-13}$ cm, we can readily determine these quantities for a specified γ-quantum energy, and thereby determine the angular dependence of the z component of the photoneutron polarization vector. The figure shows this dependence for γ-quantum energies 2, 3, 4, and 20 Mev. The choice of these energies is dictated by the fact that at these energies the effective cross section of elastic scattering of the He^4 nucleus (which, as is well known, enables us to determine their polarization) is sufficiently large, on the order of several barns. In addition,



Dependence of the z component of the polarization vector of photoneutrons on the angle θ for various values of the energy of the incident gamma quantum (the numbers on the curves are the values of E_γ in megavolts).

at γ-quantum energies $2-4$ Mev the effective cross section of the photonuclear process on the Be^9 nucleus also has a maximum, and consequently the use of such γ quanta is preferable from the point of view of increasing the overall effectiveness. As to the 20-Mev γ quantum, we know that none of the other methods of determining the sign of the circular polarization at such high energies are suitable, and only the photonuclear reaction can be used for this purpose.

It is seen from the figure that at some angles the polarization of the neutrons reaches almost 50 percent. We note that, depending on the direction of the circular polarization of the γ quantum, different signs are obtained for the photoneutron polarization (the curves in the figure correspond to right-hand polarization of the gamma quantum).

In conclusion, we take pleasure in thanking V. I. Mamasakhlisov and S. G. Matinyan for useful discussions.

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