CIRCULAR POLARIZATION OF γ-QUANTA FROM $np \to d\gamma$ REACTION WITH POLARIZED NEUTRONS

A.N.Bazhenov, L.A.Grigor'eva, V.V.Ivanov, E.A.Kolomensky,
V.M.Lobashev, V.A.Nazarenko, A.N.Pirozhkov, Yu.V.Sobolev

The circular polarization P_γ of the γ-quanta in $np \to d\gamma$ reaction with the polarized neutrons has been measured earlier in the connection with the possibility to extract in such a way the contribution of the triplet state in the continuous spectrum of np-system to the radiative capture section [1,2]. In the work [2] the P_γ of the γ- quanta has been found to be $P_\gamma = -(2.9 \pm 0.9) \cdot 10^{-3}$.

The recent theoretical calculations [3,4] give for the P_γ the value $-(1.1 + 1.4) \cdot 10^{-3}$ and require the increasing of the experimental accuracy. Also the contribution of the possible $6q$-configurations in the wave function of deuteron is considered in [3].

The scheme of the experimental setup is presented in a figure.

The solid parahydrogen target [5] has been used. To analyze the polarization of the γ-quanta magnetic transmission polarimeters with the 72 *mm* thickness of the absorber were used. The magnetization of the

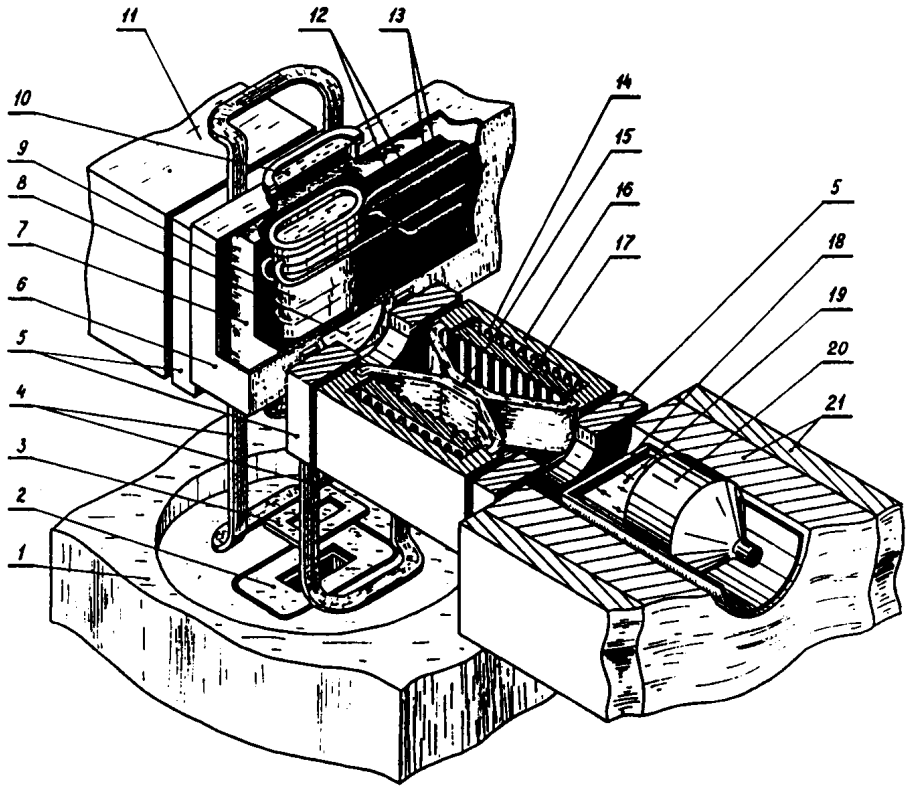

Fig. Scheme of experimental setup: *1* — shielding of reactor, *2* — RF flipper, *3* — ^{10}B collimator, *4* — guiding field coils, *5* — Pb collimators, *6* — evacuated housing of target, *7* — heating shielding, *8* — γ-quanta extract window, *9* — hydrogen vessel, *10* — neutron extract window, *11* — polarimeter block, *12,13* — nitrogen and helium cooling, *14* — polarimeter coil, *15* — absorber of polarimeter, *16* — magnetic flux return, *17* — Pb collimator of polarimeter, *18* — magnetic shielding of detector, *19* — NaI crystal, *20* — photomultiplier, *21* — combined Pb and polyethylene shielding

absorber amounted to 18.5 *kG*. The polarimeter's efficiency was calculated with the relative accuracy about 15%. The scintillation detectors used were NaI(Tl) crystals, 150 *mm* in diameter and 100 *mm* high in conjunction with photomultipiers PMT-49B. The spectroscopic system with transversal filter provided input counting rates $\approx 3.5 \cdot 10^5$ c.p.s., closely to the upper limit for NaI-spectroscopy. The counting rate in the peak of full absorption was $\approx 5 \cdot 10^4$ c.p.s. with 10% value of the count losses.

The experimental effect $\delta = 2\dfrac{N^+ - N^-}{N^+ + N^-}$ (N^+, N^- -are counting rates of the γ-quanta under opposite direction of the neutron polarization) was measured in 3 regions of the spectrum: in the compton region, in the peak of full absorption of the γ-quanta with $E_\gamma = 2.23$ *MeV*, and in the after-photopeak region of the background.

The various groups of the measurements were checked for statistical consistence by means of χ^2 criterion. To calculate P_γ only the value of δ in the region of the photopeak was used with taking account of the corrections for the background and the count losses. The δ measured is equal to:

$$\delta = -(4.77 \pm 0.76 \pm 0.63) \cdot 10^{-5},$$

where the 1-st and 2-nd uncertainties are external and internal errors.

The P_γ relates to δ measured as:

$$P_\gamma = \delta \cdot \varepsilon^{-1} \cdot P_n^{-1},$$

where ε is the polarimeter efficiency, P_n is the neutron beam polarization.

The final value for P_γ is

$$P_\gamma = -(1.5 \pm 0.3) \cdot 10^{-3}.$$

The experimental value for the P_γ agrees with the theoretical one from the view point that the P_γ originates due to the neutron capture from the triplet state. To extract the contributions of M1, E2-transitions and exchange currents to the P_γ, both experimental accuracy and theoretical one should be increased. Since the deuteron is the basic nucleon system, such a problem remains actual. The knowledge of the P_γ with the relative accuracy of some percent may be a good test for checking various approaches to describe the properties of nuclear matter.

References

1. Kolomensky E.A. et al. //Yad. Fiz,. 1977. V.25. P.233.
2. Vesna V.A. et al. //Nucl.Phys., 1981. V.A352. P.181.
3. Gragh I.L., Shmatikov M.Zh. //Yad.Fiz., 1987. V.45. P.933.
4. Burichenko A.P., Khriplovich I.B. //Nucl.Phys., 1990. V.A515. P.139.
5. Bazhenov A.N. et al. Preprint LNPI-1717. Leningrad. 1991. 23 p.