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7.5 Polarization of ^{12}B nuclei from $^9Be(\alpha,p)^{12}B$ reaction

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Investigation of polarization for nuclei produced in reaction with light and heavy ions gives an information on spin dependence of the interaction and reaction mechanisms. One of the methods to explore polarization is the measurement of anisotropy of the distribution for β-particles emitted by β-active residual nuclei. The angular distribution $I(\Psi)$ of β-particles for the polarized β-active nucleus ensemble is described by the formula:

$$I(\Psi) = I_0(\Psi)(1 + aP\cos\Psi).$$

Here $I_0(\Psi)$ is the angular distribution for unpolarized nuclei, a is a constant dependent on decay mode which is proportional to v/c, where v is the β-particle velocity, c is the light velocity, P is the vector polarization and Ψ is the angle between directions of the β-particle emission and the nucleus polarization.

An experiment on polarization measurement for β-active ^{12}B nuclei from the $^9Be(\alpha,p)^{12}B$ reaction was carried out with the 27.2 MeV α-particle beam at the cyclotron U-120. The experimental scheme is showed on fig.1. The α-particle beam is formed by the collimator 1 (two slits 3 mm x 4 mm at 250 mm distance) and enters the beryllium target 2 mounted in the centre of the scattering chamber 3. β-active ^{12}B nuclei leave the target and are stopped in the gold foil at angles 0°, 8° and 14° relatively to the beam direction; the angular spread constitutes $\Delta\theta = \pm 2{,}5°$. The design of the accumulation foil assembly 6 allows to make measurements at 3 angles simultaneously with 3 stopping foils for each angle to study energy dependence of the nucleus polarization. The absorber 5 is located in front of the assembly. The magnetic field of ~30 mT perpendicular to the reaction plane is generated by coils 10 in the stopping foils region. Counter telescopes consisting of two 2 mm thick and 10 mm in diameter ΔE Si(Li) detectors 7,8 and scintillation E detectors made of the 50 mm x 50 mm stilbene crystals 9 and photomultipliers FEU-13 are disposed symmetrically up and down about stopping foils. The solid angle for β-particle detection is 0,2 sr.

The scattering chamber design allows to change the angle θ by $\pm 37°$ and to rotate the chamber by the angle Ψ up to 180° in order to eliminate the instrumental asymmetry. False asymmetry is measured with magnetic field switched off, ^{12}B polarization in the gold foil in this case equals to zero as shown in [1-3]. Detectors and coils are located on the platform coupled stiffly with the chamber and move simultaneously with the foil assembly when angles θ and Ψ to be varied.

Detection of electrons from decays was made in the time intervals when current pulses of the accelerator were absent. Pulse repetition frequency and duty factor were 25 Hz and 4, respectively. Recording was started in 2-3 ms after the end of the cyclotron pulse and was stopped at 1-2 ms before the pulse beginning.

Spin and parity for the ground state of ^{12}B nucleus are $J^{\pi} = 1^+$, life time and boundary energy of β-spectrum are 20.3 ms and 13.37 MeV, respectively. Detection threshold for β-particles was 3 MeV.
The yield asymmetry of β-particles for ^{12}B nuclei emitted at angles 8° and 14° was measured: $\varepsilon(8°) = 0.020 \pm 0.018$; $\varepsilon(14°) = 0.019 \pm 0.016$. Errors of the results are only statistical. The small value of measured asymmetry can be an evidence of the small ^{12}B polarization. It can be probably connected with the great angle capture of emitted ^{12}B nuclei characteristic for the (α,p) reaction on ^9Be nuclei at 27.2MeV

(θ_L = 8° ± 2.5° corresponds to θ_{cm} = 25° - 45° and 160° - 170° and θ_L = 14° ± 2.5° corresponds to θ_{cm} = 50° - 75° and 135° - 155°). In these angular ranges polarization can change its magnitude and sign. Furthermore the processes of forming excited states of ^{12}B nuclei can reduce polarization due to different angular behaviour of polarization for nuclei in ground and excited states.

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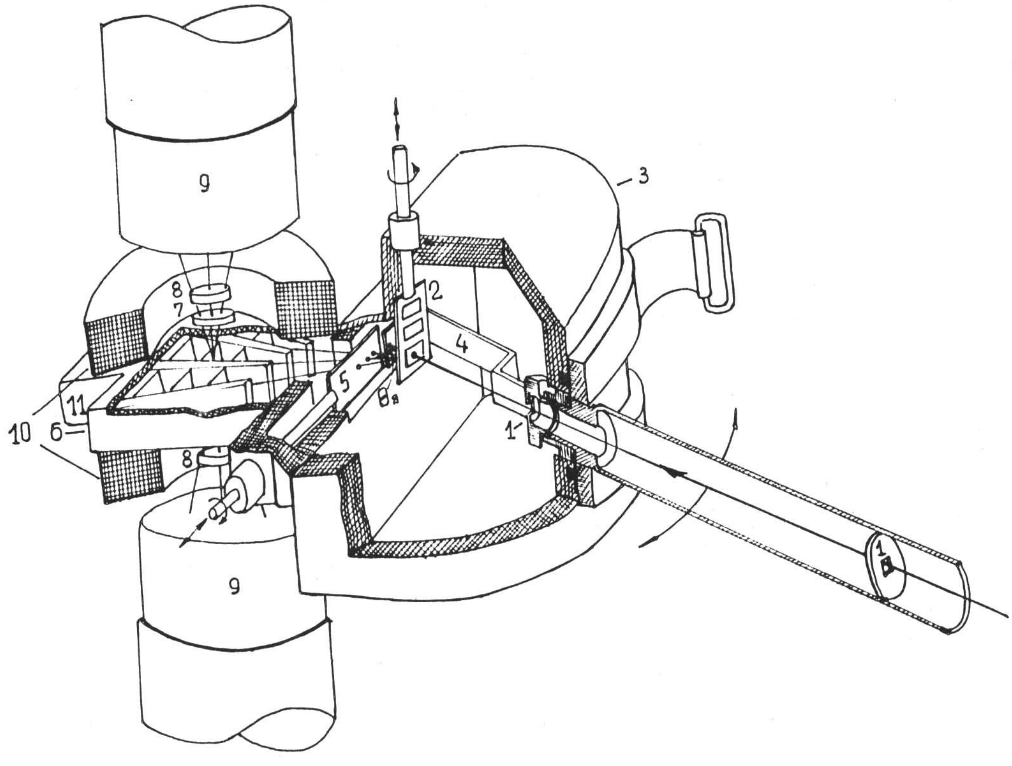

Fig. 1. Installation to measure polarization of β-active nuclei.

References

1) L. Pfeiffer, L. Madansky: Phys. Rev. 163 (1967) 999.
2) K. Sugimoto, K. Nakai et al: J. Phys. Soc. Japan 25 (1968) 1258.
3) N. Takahashi et al: Phys. Letters 78B (1978) 397.