Abstract

The T-noninvariant transverse polarization of neutrons is considered for muon capture by a $^6\text{Li}$ nucleus with decay into a quasistationary $2^+$ state of the three particle $\alpha + n + n$ continuum. This polarization is orthogonal to the plane spanned by the polarization axis of the initial mesic atom and the neutron momentum. The situation in which neutrons that are emitted in the plane orthogonal to the axis of the mesic-atom polarization and which have oppositely directed momenta equal in magnitude are selected is analyzed. The wave function of the final state is constructed by using the method of hyperspherical harmonics. In the approximation of the allowed Gamow-Teller transition $1^+ \rightarrow 2^+$, this neutron polarization is expressed in terms of the T-noninvariant relative phase of reduced matrix elements for transitions from the $^6\text{Li}$ ground state to various final-state configurations.

1 Introduction

Evidences for violation of time reversal invariance (T-invariance) are presently obtained only in $K^0$-meson decays. Attempts to find T-noninvariant effects in nuclear reactions, $\gamma$-transitions, $\beta$-decays of nuclei and free neutrons, along with searches of electric dipole moments of nuclei and elemental particles, have not been successful. However, the results of these investigations allowed to lower the upper limit of possible mixture of T-noninvariant interactions to $\sim 10^{-3} - 10^{-4}$ (see, e.g., [1]).

New approaches to T-invariance tests are of obvious interest. In Refs.[2]-[4] the possibilities of T-invariance studies in modern experiments on muon capture were considered. In particular, reactions with transition to continuum $\mu + d \rightarrow n + n + \nu_\mu$ and $\mu + ^3\text{He} \rightarrow d + n + \nu_\mu$ were discussed in Ref.[3]. It was pointed to the fact that neutron polarization along $[n_k \times n_\mu]$, where $n_k$ and $n_\mu$ are unit vectors along neutron momentum and muon polarization, respectively, should be sensitive both to T-noninvariant phases of formfactors in the weak semileptonic Hamiltonian and to T-invariance violation in nucleon-nucleon interaction.

Of special interest are few body systems for study of T-noninvariant components of nucleon-nucleon potentials. Only in such systems reliable connection between experimental results and constants of Hamiltonian may be established. Recently progress was made towards microscopic description of $A = 6$ nuclei as three body systems $\alpha + \text{N} + \text{N}$ in the framework of hyperspherical functions method (see, e.g., [5]-[7]). In particular, in Ref.[8] the calculation was performed of the probability of muon capture by nucleus $^6\text{Li}$ with transition to the ground state of $^6\text{He}$.

The binding energy of the nucleus $^6\text{He}$ equals 0.975 MeV. Above this value the three particle continuum $\alpha + n + n$ begins. There is a resonance in this continuum with spin and parity $2^+$, energy 1.8 MeV and width 0.1 MeV. Transition into this resonance state as the result of muon capture by nucleus $^6\text{Li}$ with spin and parity $1^+$ is of Gamow-Teller type. Thus the existence of the resonance simplify the description of muon capture with decay to continuum. This paper is devoted to estimation of T-noninvariant neutron polarization along the direction $[n_k \times n_\mu]$ after muon capture by $^6\text{Li}$ with decay to continuum.

2 Muon capture — general formalism

Non-relativistic transition Hamiltonian in nucleon space results from relativistic Hamiltonian by Foldy-Wouthuysen transformation (see, e.g., [3]) and is expressed as a power series in the ratio $E_\nu/Mc^2$, where
\( E_{\nu} \) is neutrino energy, and \( M \) is nucleon mass. To estimate the effect in a Gamow-Teller transition we restrict our consideration to zero-order terms. Thus a dimensionless Hamiltonian is of the form

\[
\hat{h}' = \sum_{j=1}^{A} \exp \left( -i \frac{p_{j} F_{j}}{\hbar} \right) \left( -ig_{\nu} \mathbf{b}_{j}^{+} (\sigma_{\mu}, \sigma_{\nu}) + g_{A} \mathbf{b}_{j}^{+} (\sigma_{\mu}, \sigma_{\nu}) \hat{\sigma}_{j} \right) \hat{\tau}_{-}(j). \tag{1}
\]

We use here 4-vectors

\[
b_{\lambda} (\sigma_{\mu}, \sigma_{\nu}) = i \, u_{\mu}(0, \sigma_{\mu}) \gamma_{\lambda} (1 + \gamma_{5}) u_{\nu}(p_{\nu}, \sigma_{\nu}), \tag{2}
\]

which are introduced in accordance with Ref.\,[8] and expressed in terms of muon and electron 4-spinors. The matrices \( \gamma_{\lambda} \) are taken in pseudoeuclidian metric. The Hamiltonian \( \hat{h}' \) is a matrix in a space of spin projections of muon \( \sigma_{\mu} \) and neutrino \( \sigma_{\nu} \). It contains formfactors of vector \( g_{\nu} \) and axial-vector \( g_{A} \) interactions, depending on squared transferred 4-momentum \( k^{2} = k_{\lambda} k_{\lambda} \). Summation over all \( A \) nucleons enters in the Hamiltonian. Spin operator \( \hat{\sigma}_{j} \) and lowering isospin operator \( \hat{\tau}_{-}(j) \) act in a space of \( j \)-th nucleon. We have

\[
\hat{\sigma}_{j} |p \rangle = |n \rangle, \quad \hat{\tau}_{-}(j) |n \rangle = 0. \tag{3}
\]

Nucleon coordinates \( \mathbf{r}_{j} \) are reckoned from the center-of-mass of the nucleus. In the non-relativistic approximation a muon 4-spinor is of the form

\[
u_{\mu}(0, \sigma_{\mu}) = \left( \varphi_{\mu}(\sigma_{\mu}) \right), \tag{4}
\]

where \( \varphi_{\mu}(\sigma_{\mu}) \) is a usual two-component spinor.

The nucleus captures a muon from the 1s-state. If nucleus spin \( J_{i} \) differs from zero, the state is splitted into two hyperfine sublevels with angular momenta \( F_{\pm} = J_{i} \pm 1/2 \) and energies \( E_{\pm} \). Interference terms \( \sim \exp (\pm i (E_{+} - E_{-}) t/\hbar) \) of differential capture probability oscillate rapidly and go to zero on averaging over life time of mesoatom. So angular correlations in muon capture should be calculated separately for each hyperfine sublevel, even though these sublevels are not distinguished in the experiment.

Let the wave function \( \Psi_{J_{i}, M_{i}} \) describes initial nucleus in a state with projection \( M_{i} \) of spin \( J_{i} \) on an axis \( z \). The mesoatom state from which the muon is captured is determined by the function

\[
| F \rangle = \sum_{\xi} \alpha_{\xi}(F) \sum_{M_{i}, \sigma_{\mu}} C_{J_{i}, M_{i}, \sigma_{\mu}}^{F \xi} \Psi_{J_{i}, M_{i}, \sigma_{\mu}} \varphi_{\mu}(\sigma_{\mu}). \tag{5}
\]

The amplitudes \( \alpha_{\xi}(F) \) contain an information on mesoatom polarization. They are normalized to the unity \( \sum_{\xi} | \alpha_{\xi}(F) |^{2} = 1 \), where \( \xi \) is a projection of the angular momentum \( F \) on the polarization axis (axis \( z \)). Let us introduce a unit vector \( \mathbf{n}_{\mu} \) along this axis. Mesoatom polarization is given as usual by the quantity

\[
p_{1}(F) = \frac{< \xi >}{F}, \quad < \xi > = \sum_{\xi} \xi | \alpha_{\xi}(F) |^{2}. \tag{6}
\]

Let the final state of the system \( \alpha + n + n \), formed after muon capture by the nucleus \( ^{6}\text{Li} \), is described by the function \( \Psi_{f}^{\sigma_{1} \sigma_{2}} \), where \( \sigma_{1} \) and \( \sigma_{2} \) are spin projections of 1-st and 2-nd neutrons on an axis \( z' \). Thus we have for the amplitude of probability to find the 1-st neutron with spin projection \( \sigma_{1} \) and the 2-nd neutron with spin projection \( \sigma_{2} \) on an axis \( z' \)

\[
a_{f}^{F} (\sigma_{1}, \sigma_{2}) \sim \sum_{\xi} \alpha_{\xi}(F) \sum_{M_{i}, \sigma_{\mu}} C_{J_{i}, M_{i}, \sigma_{\mu}}^{F \xi} < \Psi_{J_{i}, M_{i}}^{\sigma_{1} \sigma_{2}} | \hat{h}' | \Psi_{J_{i}, M_{i}} >. \tag{7}
\]

The probability of finding of the 2-nd neutron summed over non-observed spin projections of the 1-st neutron and neutrino is proportional to the equation

\[
w_{0}^{F} \sim \sum_{\sigma_{2}} \sum_{\sigma_{1} \sigma_{\nu}} | a_{f}^{F} (\sigma_{1}, \sigma_{2}) |^{2}. \tag{8}
\]

While for the averaged spin projection of the 2-nd neutron we obtain

\[
w_{1}^{F} \sim \sum_{\sigma_{2}} \sum_{\sigma_{1} \sigma_{\nu}} | a_{f}^{F} (\sigma_{1}, \sigma_{2}) |^{2}. \tag{9}
\]
Neutron polarization along an axis $z'$ is determined by the ratio

$$p_{l}^{F} = \frac{u_{l}^{F}}{u_{0}^{F}}.$$  \hspace{1cm} (10)

This polarization depends on angular momentum of mesoatom.

3 Wave functions

At low excitation energies nuclei with mass number $A = 6$ behave as systems built up from three bodies — $\alpha$-particle and two nucleons. It is convenient to construct the wave functions in the form of series on hyperspherical harmonics (see, e.g., [10]). In particular in the framework of this method the wave function was calculated of the $^6\text{Li}$ ground state $1^+$ with isospin $T = 0$ in Ref. [7].

In Ref. [7] the same method was used to study the structure of $2^+$ continuum state of the system $\alpha + n + n$ with isospin $T = 1$. Generally a three-body continuum state is described in a center-of-mass system by the function $\Psi_{p_{x}p_{y}}$, depending on asymptotic momenta $p_{x}$ and $p_{y}$, which are conjugated to normalized Jacobi coordinates $x$ and $y$. In the system $\alpha + n + n$ these coordinates

$$x = \sqrt{\frac{M}{2}}(r_{n2} - r_{n1}), \quad y = \sqrt{\frac{4M}{3}} \left( r_{\alpha} - \frac{r_{n1} + r_{n2}}{2} \right),$$  \hspace{1cm} (11)

are proportional to the relative radius-vectors of two neutrons $\rho_{n2} = r_{n2} - r_{n1}$ and of the $\alpha$-particle with respect to the center-of-mass of the nucleon pair $\rho_{\alpha} = r_{\alpha} - (r_{n1} + r_{n2})/2$. The momenta $p_{x}$ and $p_{y}$ are expressible in terms of neutron and $\alpha$-particle momenta in the laboratory system

$$p_{x} = \frac{1}{\sqrt{2M}}(p_{n2} - p_{n1}), \quad p_{y} = \frac{1}{\sqrt{3M}} \left( \frac{p_{\alpha}}{2} - (p_{n1} + p_{n2}) \right).$$  \hspace{1cm} (12)

Hyperspherical harmonics $\Phi_{KLm}^{I_{x}I_{y}}(\Omega)$ depend on five variables $\Omega = (\theta, \theta_{x}, \varphi_{x}, \theta_{y}, \varphi_{y})$ and are fixed by five quantum numbers — hypermoment $K$, orbital momenta $l_{x}, l_{y}$, total orbital momentum $L$ and its projection $M$ on an axis $z$. Hyperspherical harmonics are of the form

$$\Phi_{KLm}^{I_{x}I_{y}} = \frac{N_{KLm}^{I_{x}I_{y}}}{\sqrt{\Gamma(n + l_{x} + l_{y} + 2)}} \left( \frac{\Gamma(n + l_{x} + l_{y} + 2)}{\Gamma(n + l_{x} + \frac{3}{2})} \right)^{1/2} \times$$

$$\sum_{m_{x}m_{y}} C_{l_{x}m_{x}l_{y}m_{y}}^{I_{x}}(\theta_{x}, \varphi_{x})Y_{l_{y}}m_{y}(\theta_{y}, \varphi_{y}),$$  \hspace{1cm} (13)

where $P_{n\beta}^{\alpha}$ are Jacobi polynomials, variable $n$ takes the values $n = 0, 1, 2 \ldots$, hypermoment $K$ equals $2n + l_{x} + l_{y}$, and $Y_{lm}$ are usual spherical harmonics. Normalized factor is determined by the formula

$$N_{KLm}^{I_{x}I_{y}} = \left( \frac{2\pi(2n + l_{x} + l_{y} + 2)}{\Gamma(n + l_{x} + l_{y} + 2)\Gamma(n + l_{x} + \frac{3}{2})} \right)^{1/2}.$$  \hspace{1cm} (14)

Let us introduce wave vectors $k_{x} = p_{x}/\hbar = (k_{x}, \theta_{kx}, \varphi_{kx}), \quad k_{y} = p_{y}/\hbar = (k_{y}, \theta_{ky}, \varphi_{ky})$, where polar $\theta_{kx}$ and azimuth $\varphi_{kx}$ angles specify the direction of the vector $k_{x}$, as well as the angles $\theta_{ky}$ and $\varphi_{ky}$ give the direction of $k_{y}$. Variables $k$ and $\theta_{k}$ are determined as follow

$$k = \sqrt{k_{x}^{2} + k_{y}^{2}}, \quad k_{x} = k \sin \theta_{k}, \quad k_{y} = k \cos \theta_{k}.$$  \hspace{1cm} (15)

Note, that the energy in the center-of-mass system equals

$$E = \hbar^{2}k^{2}/2.$$  \hspace{1cm} (16)

So parameter $\theta_{k}$ determines how this energy is distributed between the subsystems $n + n$ and $\alpha + (2n)$. In according with Ref. [7] the continuum wave function of $\alpha + n + n$ may be written as series on the states with definite angular momenta $J_{f}$ and their projections $M_{f}$ on an axis $z$

$$\Psi_{\mathbf{P}, \mathbf{P}}^{J_{f}M_{f}} = \sum_{J_{f}M_{f}} \sum_{K\gamma} \sum_{m\sigma} C_{LMS\sigma}^{J_{f}M_{f}} C_{\sigma_{1}+\sigma_{2}}^{J_{f}M_{f}} \left( \Phi_{KLm}^{I_{x}I_{y}}(\Omega_{k}) \right)^{\dagger} \Psi_{J_{f}M_{f}}^{K\gamma},$$  \hspace{1cm} (17)
Here $S$ is the total spin of two neutrons, and the index $\gamma$ denotes a set $\{l_x l_y LS\}$. The expansion coefficients contain the hyperharmonics, depending on variables $\Omega_k = (\theta_k, \theta_{kx}, \phi_{kx}, \theta_{ky}, \phi_{ky})$.

Calculations of Ref. [7] have shown that the continuum resonance state $2^+$ of the $\alpha + n + n$ system is formed mainly by two terms of the above expansion, corresponding to the same hypermoment $K = 2$. The contribution of the component $\gamma 1 = \{0220\}$ in the internal region varies from 45 to 70% depending on the calculation method, while the contribution of the component $\gamma 2 = \{1111\}$ changes from 35 to 20%. We shall restrict our consideration to these two terms in the expansion (17) for the wave function of the final state.

The wave functions $\Psi_{J,M_i}$ and $\Psi_i^{f,\sigma_i, \pi_i}$ are, of course, antisymmetrized over transposition of space, spin and isospin coordinates of two nucleons of the system $\alpha + N + N$. Therefore matrix element of Hamiltonian (1) $h' = h'_1 + h'_2$ is equal to the sum of two identical matrix elements of the operators $h'_1$ and $h'_2$. In this paper we take into account only the contribution of the allowed $s$-wave matrix element to the amplitude of Gamow-Teller transition $1^+ \to 2^+$. Introducing the reduced matrix elements in accordance with Ref. [11], we get for the matrix element of spherical component of the operator $\hat{\sigma}$

$$< \Psi_{J,M_1}^{K\gamma} | \hat{\sigma}_\alpha | \Psi_{J,M_2} > \simeq \frac{4\pi}{\sqrt{3}} C_{J,M_1}^{J'1M_1}[101]_{K\gamma}. \tag{18}$$

Spherical components are determined by usual rule $\hat{\sigma}_{\pm 1} = \mp (\hat{\sigma}_x \pm \hat{\sigma}_y) / \sqrt{2}$, $\hat{\sigma}_0 = \hat{\sigma}_z$.

If T-invariance holds, thus the phases of the wave functions may be chosen in accordance with the standard condition [12]

$$\hat{T} |JM > = (-1)^{J+M} |J-M >, \tag{19}$$

where $\hat{T}$ is the time reversal operator. In this case the reduced matrix elements $[101]_{K\gamma}$ are real. In another way the coefficients of expansion of the wave functions $\Psi_{J,M_i}$ and $\Psi_i^{K\gamma}$ on hyperspherical harmonics are hyperradial functions which satisfy the set of coupled differential equations of second order. The reduced matrix elements are the one-dimension integrals of these functions. Following the rule (19), one may make real all hyperradial functions and, consequently, reduced matrix elements.

With nucleon-nucleon potentials violating time reversal invariance the set of coupled differential equations have no real solutions. The rule (19) does not hold. So the reduced matrix elements become complex. The procedure of calculating of imaginary T-noninvariant corrections to functions satisfying the set of coupled differential equations of second order was considered in Ref. [13]. In this paper we express the neutron polarization induced by time reversal violation in terms of imaginary parts of matrix elements.

### 4 Analysis of T-noninvariant effect

In the framework of our formalism the neutron polarization (10) depends on three momenta — on neutrino momentum $p_\nu$, which is equal by magnitude and opposite by direction to the momentum of the center-of-mass of the system $\alpha + n + n$, and on Jacobi momenta $p_x$ and $p_y$. In principle, these three momenta may be determined by measuring the momenta $p_{n1}$, $p_{n2}$ and $p_\alpha$ in the laboratory coordinate system. However, such experiment is non-realistic.

As the other limiting case one may consider the situation when the momentum of only one neutron is measured, while the integration over all possible momenta of the other neutron, $\alpha$-particle and neutrino holds. In such experiment it is impossible to control the decay into the resonance state $2^+$. Therefore this case is not interesting for us. Note in addition, that recalculation of the effect, expressed in terms of natural for three-body problem Jacobi momenta $p_x$, $p_y$, to laboratory momenta $p_{n1}$, $p_{n2}$ and $p_\alpha$ needs the cumbersome numerical procedure. Such recalculation would complicate the interpretation of observable effect.

The optimal experiment should be not-too-complex on setting, on the one hand, and simple on interpretation, on the other hand. We consider the following situation. Lets assume that the momenta of two neutrons are detected in the experiment. We select the events when these momenta are equal by magnitude and opposite by direction. Thus the magnitude and direction of Jacobi momentum $p_x$ is determined by equation (12). Furthermore, the total momentum of two neutrons equals zero, therefore in accordance with formula (14) the momentum $p_\nu$ coincides by direction with the $\alpha$-particle momentum. Besides, due to the fact that the total momentum of four particles in the final state equals zero

$$p_{n1} + p_{n2} + p_\alpha + p_\nu = 0, \tag{20}$$
in the selecting cases $p_\alpha = -p_\nu$. This means that the direction of Jacobi momentum $p_\nu$ is exactly opposite to the neutrino momentum. Thus the integration over all non-observable direction $p_\nu$ and $p_\alpha$ easily performs. To control the decay into the resonance $2^+$ continuum state one need to measure only the total energy of the $\alpha$-particle. In addition the integration over the parameter $\theta_\nu$ holds if the distribution of the total energy between the subsystems $n + n$ and $\alpha + (2n)$ is not taken into account. We normalize the continuum wave functions of the system $\alpha + n + n$ as in Ref.[7]. Thus we obtain the following expression for the differential probability (8) of detecting of two neutrons with opposite momenta ($p_{n1} = -p_{n2}$) and with Jacobi momentum $p_x$ in the solid angle $d\Omega_x$ for the Gamow-Teller transition $J_i \to J_f = 2$

$$d\omega^F_{\nu} = A_\mu |g_A|^2 \frac{2J_f + 1}{2J_i + 1} C(J_i, F) \left( \frac{|101|_\gamma_1|^2 + |101|_\gamma_2|^2}{|101|_\gamma|^2} \right) \frac{d\Omega_x}{4\pi} \Delta\Omega_y dk.$$  

(21)

Here we use the constant

$$A_\mu = \lambda_\mu \frac{8R(Z)Z^3}{3} \frac{(E_\nu/m_\mu c^2)^2}{(1 + E_\nu/E_f)(1 + m_\mu c^2/E_i)^3},$$

(22)

where

$$\lambda_\mu = \left( \frac{E^3}{\hbar c} \right)^3 \frac{(G \cos \theta_C)^2 (m_\mu c^2)^5}{\hbar^6 e^6} \simeq 1.005 \cdot 10^3 \ \text{s}^{-1},$$

(23)

$G$ is the weak constant, $\theta_C$ is the Cabbibo angle, $m_\mu$ is the muon mass, $Z$ is the charge of the initial nucleus, and $R(Z)$ is the correction for nucleus size [11]. Neutrino energy $E_\nu$ is determined by the total energy $E_f$ of the final system $\alpha + n + n$, which includes rest masses of the particles, and by the total energy $Q_\mu$, released in muon capture, as follow

$$E_\nu = E_f \left[ \left( 1 + \frac{2Q_\mu}{E_f} \right)^{1/2} - 1 \right] \simeq Q_\mu \left( 1 - \frac{Q_\mu}{2E_f} + \ldots \right).$$

(24)

Differential $dk$ is related with differential $dE$ of the final system energy according the formula [11]:

$$dk = dE/(h\sqrt{2E}),$$

where $E$ and $dE$ should be taken equal to the energy and width of the resonance state $2^+$. The solid angle $\Delta\Omega_y$ fixes the value of the possible deviation of the momentum $p_\nu$ from the direction, opposite to neutrino momentum. The coefficient $C(J_i, F)$ depends on spin $J_i$ of initial nucleus and on total angular momentum of mesoatom $F = J_i \pm 1/2$ and is of the form

$$C(J_i, F) = 1 + \sqrt{\frac{6}{5}} U(F^\frac{1}{2} J_1, J_1^\frac{1}{2}) U(2J_1, 11, J_1),$$

(25)

where $U(abed, ef) = ((2e + 1)(2f + 1))^{1/2} W(abed, ef)$ is the normalized Racah function [4].

Note, that the differential probability (21) does not contain the terms like $\sim \cos \theta$, where $\theta$ is the angle between the momentum $p_x$ and the mesoatom polarization axis $n_\mu$. This is associated with the identity of emitting neutrons and, consequently, with ambiguity of the choice of the direction $p_x$. There exists also the other special feature of the coefficient $C(J_i = 1, F)$. Let $J_i = 1$, thus $F = 1/2$ or $3/2$. It is easy to check that $C(J_i = 1, F)$ equals zero, if the total angular momentum of the initial state is $F = 1/2$. This is the result of angular momentum conservation. Indeed, the expression (21) is obtained in the approximation of the s-wave neutrino emission with respect to the center-of-mass of the system $\alpha + n + n$. It is clear that as neutrino spin equals 1/2 and the spin of the final resonance state is $J_f = 2$, the total angular momentum in the final state is 3/2 or 5/2. So this state can not be obtained from the initial state with $F = 1/2$. We turn now to the situation when neutron momenta $p_{n1} = -p_{n2}$ are perpendicular to the polarization axis $n_\mu$ of the initial mesoatom. By convention we assign a number 1 to one neutron and a number 2 to the other neutron and fix the direction of the vector $p_x$. According to the equation (22) this vector coincides by direction with momentum $p_{n2}$. Choosing an axis $z'$ along $[p_x \times n_\mu]$, we calculate the polarization of the 2-nd neutron along the axis $z'$ using the formulas (8)-(10). We get

$$p^F_x = \frac{32}{27\pi} \sqrt{\frac{6}{5}} p_1(F) D(J_i, F) \text{Im} \left( \frac{|101|_\gamma_1|101|^*_\gamma_2}{C(J_i, F) \frac{|101|_\gamma_1|^2 + |101|_\gamma_2|^2}.\right.\right.$$

(26)
work was supported by International Science Foundation, grant number is M7C300.

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5 Conclusion

In this paper T-noninvariant transverse polarization is considered for neutrons from reaction of muon
capture by $^6$Li nucleus with decay to resonance $2^+$ continuum state of three particles $\alpha + n + n$. This
polarization is normal to the plane formed by polarization axis of initial mesoatom and neutron momentum. We analyze the situation when selected neutrons have equal and opposite directed momenta which are perpendicular to the axis of mesoatom polarization.

To estimate T-noninvariant effect we use an explicit expression for the wave function of the final
state in the hyperspherical harmonics method. An analysis of the structure of $2^+$ resonance, performed
in Ref.[7], allowed us to take into account only two leading terms in this wave function. Only the
allowed matrix element of Gamow-Teller transition $1^+ \to 2^+$ was considered. In these approximations
the neutron polarization is expressed in terms of T-noninvariant relative phase of reduced matrix elements
for transitions from the ground state of $^6$Li nucleus into the different configurations of the final state.

The current level of microscopic description of nuclei $A = 6$ as three-body systems $\alpha + N + N$ in the
method of hyperspherical harmonics [3]-[6] allow to calculate the reduced matrix elements. We intend to
perform such calculations as the next step. This will enable to relate the effect considered with parameters
of nucleon-nucleon potentials violating time reversal invariance (see, e.g., [18]).

The author is grateful to Yu.V.Gaponov, B.V.Danilin and N.B.Shul’gina for useful discussions. This
work was supported by International Science Foundation, grant number is M7C300.
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