PARITY VIOLATION INVESTIGATION IN ^{10}B (n, α) ^{7}Li REACTION WITH POLARIZED NEUTRONS

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Two α-particle lines take place in $^{10}B(n,\alpha)^{7}Li$ reaction ($E_{\alpha 1}=1470\,keV$, $E_{\alpha 0}=1780\,keV$, relative intensity is $I_{\alpha 1}=0.93$, $I_{\alpha 0}=0.07$). If we shall follow O.P.Sushkov and V.V.Flambaum /1/ *P*-odd asymmetry may be realized by the interference of *p*-wave resonance ($E_p=530\,keV$, $J=5/2^-$) and *s*-wave resonance (E_s=170 *keV*, $J=5/2^+$) only for α_0-line ($E_{\alpha 0}=1780\,KeV$). *P*-odd asymmetry is impossible for the α_1-line since the *s*-wave reconance has zero width for the channel of α-decay $E_{\alpha 1}=1479\,keV$ [2]. The theoretical estimate of possible *P*-odd asymmetry coefficient is $\alpha^0_{pn}\approx 10^{-7}-10^{-6}$ in assumption that spin factor is equal to 1 and the matrix element of weak interaction $W_{sp}\approx 0.1\text{—}1\ eV$ [3,4]. An accuracy of *P*-odd asymmetry coefficients measurements today is insufficient for the theoretical estimates [5]:

$$\alpha_0-\text{line}\quad \alpha^{exp}_{pn}=-(13.5\pm 14.5)\cdot 10^{-7},$$
$$\alpha_1-\text{line}\quad \alpha^{exp}_{pn}=(1.6\pm 2.8)\cdot 10^{-7}.$$

The necessity of essential improvement of the previous measurements leads to this work.

The measurements were performed using a beam of polarized neutrons with an integral flux $2\cdot 10^{10}\ n/s$, 80% polarization and average wave length $\lambda=4.5$ Å at LNPI reactor [6]. A multisection chamber working in an ionization current mode [7] was used in the geometry $\vec{P}_n \,||\, \vec{P}_\alpha \,||\, \vec{\sigma}_n$, where $\vec{\sigma}_n$ is the neutron spin, $\vec{P}_\alpha$, $\vec{P}_n$ are the unit vectors in the direction of the α-particle emission and neutron incidence, respectively.

The ^{10}B targets were obtained by atomic transplantation of grain with fixed size on the aluminum foil with thickness $d=20\ \mu m$. The pressure of argon in the chamber was $P_1=0.33\ atm$ and $P_2=0.78\ atm$, ratio of currents for different components of the reaction calculated by Monte-Carlo method was $I^0_\alpha : I^1_\alpha : I^0_{Li} : I^1_{Li}$=12.7:83:0.5:3.7 under $P_1=0.33\ atm$ $I^0_\alpha=100\%$ under $P_2=0.78\ atm$. The obtained experimental values of *P*-odd asymmetry coefficient with respect to neutron polarization and average COS of α-particles emission are:

$$P_1=0.33\ atm\quad \alpha^{exp}_{pn}=-(1.9\pm 1.2)\cdot 10^{-7},$$
$$P_2=0.78\ atm\quad \alpha^{exp}_{pn}=(3.6\pm 6.7)\cdot 10^{-7}.$$

Using the experimental data we may calculate *P*-odd asymmetry coefficient for single α-line, corresponding to [5]:

$$\alpha_0\text{-line}\quad \alpha^{0}_{pn}=(3.6\pm 6.7)\cdot 10^{-7},$$
$$\alpha_1\text{-line}\quad \alpha^{1}_{pn}=-(2.45\pm 1.6)\cdot 10^{-7}.$$

It does not contradict to the theoretical estimate, provided by the model used in [1].

The nuclei ^{10}B, ^{11}B, ^{7}Li have the distinct cluster structure /2/ and the $^{10}B(n,\alpha)^{7}Li$ reaction may be represented as:

$$^{10}B + n \to \{\alpha + {}^{6}Li\} + n \to \{2\alpha + d\} + n \to \{nd\} + 2\alpha \to 2\alpha + t \to \alpha + {}^{7}Li,$$

therefore the mechanism of P-odd asymmetry may take place in the output channel, connected with a weak interaction in {nd}-apex [8]. Such an effect may be determined by *P*-odd mixture of the ^{7}Li levels (E= =0.477 *MeV*, $J=1/2^-$) and ($E=7.2\,MeV$, $J=1/2^+$). The estimate of *P*-odd effect in the output channel for the weak matrix element $W_{pn}=1\ eV$ is $\alpha^{theor}_{pn}\sim(5-10)\cdot 10^{-8}$. Since the ^{7}Li has 100% cluster structure up to the excitation energies ~10 *MeV*, the task of matrix element calculation is reduced to the threebody problem

and may be solved correctly. We suppose that investigation of parity violation on the intensive α_1-line is a good test on the constants of weak interaction for neutral and charged currents [3].

References

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