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Corrigendum: Corrected value of the beta-emission asymmetry in the decay of polarized neutrons measured in 1990

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Abstract

A correction is noted to a previously published value of the asymmetry coefficient in the beta decay of polarized neutrons. © 1997 Published by Elsevier Science B.V.

Several years ago the value of the constant A characterizing the asymmetry of emitted electrons relative to the direction of neutron spin in polarized neutron beta-decay process derived in the experiment carried out in the St-Petersburg Institute of Nuclear Physics (Gatchina, Russia) was published in [1] and [2]. Now it became clear that this value must be increased due to the fact that we did not take in account the distortion of the polarized neutron energy spectrum caused by air and aluminum foils, which were on the way of the neutron beam. This distortion is connected with the energy dependence of the total cross-sections of any material on the path of the neutrons, and it must lead to some change of the averaged beam polarization $\langle P \rangle = \int F(\lambda)P(\lambda)d\lambda$, where $F(\lambda)$ is the neutron energy spectrum and $P(\lambda)$ – the energy dependence of neutron polarization. Unfortunately, the geometry and the amounts of materials in the neutron beam during the measurements of polarization differed from those during the decay asymmetry experiment, and thus a correction of the polarization value used in the calculations of the A-constant had to be taken in account. The authors would like to acknowledge A. Serebrov, who turned their attention to this effect been missed in 1990.

Using all the data concerning this experiment (the energy spectrum $F(\lambda)$, the energy dependence of polarization $P(\lambda)$, shown in Fig. 1) and taking in account all the conditions during the measurements of the neutron polarization and of the asymmetry in neutron decay we carried out two independent sets of estimations of the correction needed. The first one was a calculation based on the energy dependencies of total neutron cross-sections of nitrogen, oxygen and aluminum from the Neutron Cross-sections album [3]. These data (concerning ^{7}N and ^{8}O) are presented as $\sigma_t(\lambda)$ in Fig. 1 too. The second one was based on the experimental data derived in 1994 and published in [4], where these effects were measured immediately.

[1] Previous spelling of the last name – Erozolimskii.

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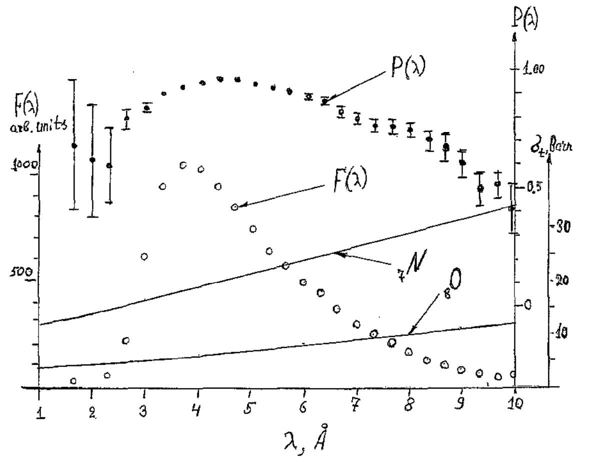

Fig. 1. Open dots: Neutron spectrum $F(\lambda)$. Solid dots: Polarization $P(\lambda)$ as a function of the neutron wavelength from [1]. Continuous lines: Total neutron cross-sections $\sigma_{tot}(\lambda)$ for $_7N$ and $_8O$ from [3] (BNL album).

In order to calculate the amounts of materials in the neutron beam we had to take in account, that the polarization measurements consisted of two parts: one was a calibration of the wide-angle analyzer with the help of Stern–Gerlach absolute measurement; the second one – the measurement of the neutron polarization itself of the beam used in neutron decay experiment. During the first part the neutron path through the air towards the detector was 1510 mm longer in the Stern–Gerlach measurement if compared with the analyzer calibration measurement. During the second part 2600 mm of the neutron path was through the air, but in the asymmetry measurement there was vacuum. Besides, 0.3 mm thick aluminum window of the neutron detector and an additional 0.05 mm aluminum foil were present during the polarization measurement and absent in the decay experiment.

As a result, the effect of 4110 mm of air and of 0.35 mm aluminum had to be taken in account.

The calculation based on the $\sigma_t(\lambda)$ data (Fig. 1) showed the need of 1.59% reduction of the polarization data due to the effect of air and less than 0.1% reduction due to the aluminum.

The recalculation of experimental data derived in 1994 [4] gave 1.55% due to the air and 0.2% due to neutron absorption in aluminum. (It must be emphasized that all these data mean relative corrections – $\Delta P/P$ in %). Thus, it seems to be reasonable to reduce the value of neutron polarization in our experiment 1990 on 1.65%. The possible error of this estimation does not exceed $\pm 0.15\%$.

Accordingly, the value of A must be taken equual to $A = -0.1150 \pm 0.0014$. There is no reason to change the full error of the result, because the additional uncertainty connected with the correction introduced is to low. The new value of the A-constant from the experiment 1990 differs from the published one on 1.4 σ.

The corresponding value of A_0 – the zero transfer limit – is $A_0 = -0.1135 \pm 0.0014$, and the fundamental ratio of the weak interaction coupling constants comes out to be $g_A/g_V = -1.2594 \pm 0.0038$.

Such are the results of the experiment 1990, which can be accepted instead of the published ones in [1,2]. It is worthwhile to mention that these data are complying better with the results of other investigators [5–7]. The summary of the A_0-constant experimental data looks like this now:

- Dubbers et al. (1986) [5] $A_0 = -0.1146$ (19)
- Our result derived in 1990 [1,2] after correction $A_0 = -0.1135$ (14)
- Schreckenbach et al. (1995) [6] $A_0 = -0.1160$ (15)
- Dubbers et al. (1996) [7] $A_0 = -0.1190$ (13)

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