ESTIMATE OF ELECTRIC POLARIZABILITY OF NEUTRON

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The results of the total cross section measurements for ^{208}Pb in the energy range from 1 eV to 10 keV performed at the GNEIS facility for the purpose of estimating a value of the electric polarizability of the neutron α_n are given in this article. The first results of this measurement have been published earlier in a review [1]. Simultaneously the total cross section measurements for carbon were carried out as a zero-test of the experiment. This work is a continuation of the previous measurements [2] when a value of $\alpha_n = (25 \pm 11) \cdot 10^{-3}\ Fm^3$ was obtained for the case of Bi. One cannot obtain better precision of α_n for Bi data because of the large contribution of 800 eV resonance. Ref. [2] points that it is possible to achieve better precision of α_n in the case of ^{208}Pb, because for this nucleus the resonance contribution to the cross section in the investigated energy range is much less than that of Bi. The experimental arrangement and the measuring method have been described in [2].

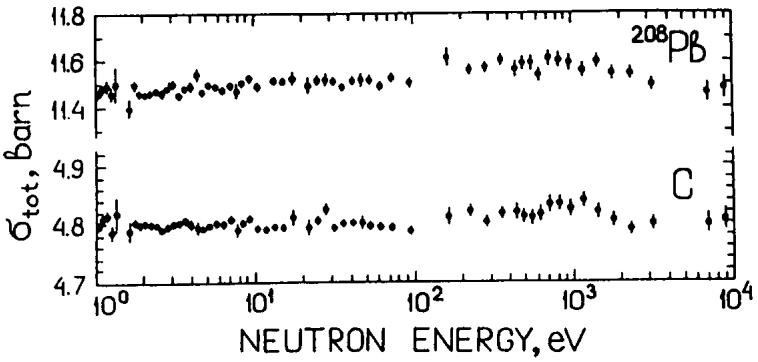

Fig. Measured total cross sections of ^{208}Pb and C

The measured total cross sections of ^{208}Pb and C are shown in the figure (preliminary results). The given errors are statistical ones and reflect uncertainties of the cross section energy dependence. In order to evaluate a value of polarizability it is necessary to subtract from a total cross section the corrections for Schwinger and (n,e)-interactions, a solid state correction, an absorption cross section and a neutron resonances contribution. In residual total cross section parameterization [3]

$$\sigma(k) = \sigma_0 + \sigma_1 k + \sigma_2 k^2 + 0(k^4)$$

presence of the polarizability leads to the addendum linear depending on k, where k is the wave number.

After the subtraction of all the corrections mentioned above and suggesting a full account of the reconances contribution, the polynomial fit for ^{208}Pb leads to

$$\sigma(k) = (12.475 \pm 0.003) + (1.60 \pm 0.88)\, k$$

and value $\alpha_n = (2.6 \pm 1.4) \cdot 10^{-3}\ Fm^3$.

The fit for carbon leads to

$$\sigma(k) = (4.8015 \pm 0.0012) + (0.50 \pm 0.35)\, k.$$

In our opinion, the estimated value of α_n is in agreement with zero value. Analysis of the total experimental statistics will permit, apparently, to decrease the error of α_n to $1 \cdot 10^{-3}\ Fm^3$. A further progress in increasing the precision of the α_n-measurements could be connected with a substitution of the neutron detector for a more effective one and with a more detailed background analysis and therefore increasing the high-energy boundary of the measured cross section. That leads to an increase of polarizability contribution to the total cross section because it depends on energy as $\sqrt{E_n}$.

Quite recently, the two communications appeared about the analogous measurements performed at Garching [4] with a value of $\alpha_n = (0.4 \pm 1.5) \cdot 10^{-3} Fm^3$ $\alpha_n = (-1.1 \pm 1.5) \cdot^{-3} Fm^3$ depending on a value chosen for the (n,e)-interaction amplitude, and at Oak Ridge [5] where a nonzero value was obtained for polarizability $\alpha = (1.20 \pm 0.20) \cdot 10^{-3} Fm^3$.

We think that Oak Ridge value of α_n does not close the problem of neutron polarizability. Thus analysis of our data for Bi has shown [2] that the α_n-value and its uncertainly significantly depend on the data processing method involved. For example, analysis of the measured cross section of Bi using the method given in [6] but with simultaneous variation of the two parameters - polarizability and resonances contribution (parameter P_2 from [6]) leads to value $\alpha_n = (25 \pm 11) \cdot 10^{-3} Fm^3$. The method proposed in [6] when in fact only one parameter α_n is varied gives an error 7 times smaller but we think it would be very underestimated. Authors of ref. [7] have pointed at the analogous problems.

The obtained value of α_n and the analysis of both our and other results do not have final character; a continuation of the investigations is intended.

References

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