International Atomic Energy Agency

INDC(CCP)-239/L

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

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Translated by the IAEA

June 1985

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Reproduced by the IAEA in Austria
June 1985

85-02952

UDK 539.173 INDC(CCP)-239/L

REVIEW OF MEASUREMENTS OF THE AVERAGE NUMBER OF PROMPT FISSION NEUTRONS

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The survey by Manero and Kon'shin [1] contains a full collection and evaluation of measurements published up to 1972 for the average number of prompt neutrons $\bar{\nu}_p$ and delayed neutrons $\bar{\nu}_d$ during spontaneous and induced fission of heavy nuclei ($Z \geqslant 90$). The appearance of a large number of new results, together with improvements in methods of measurement and processing of experimental data, renders a review of the recommendations made in that survey necessary. The authors of the present paper examine data from measurements of $\bar{\nu}_p$ for spontaneous and neutron-induced fission carried out after 1972 and also analyse some material [2-116] contained in [1]. This is the first stage in the systemization and evaluation of experimental data on $\bar{\nu}_p$.

1. Standards

The generally accepted standard for measurements of the average number of fission neutrons is $\bar{\nu}$ for spontaneous fission of ^{252}Cf. Table 1 contains the measurements of $\bar{\nu}$ for ^{252}Cf, examined in detail in Refs [2-4]. The figures correspond to a whole number of fission neutrons $\bar{\nu}_t = \bar{\nu}_p + \bar{\nu}_d$. The weighted mean values shown, correspond to the version recommended in the ENDF/B-V nuclear data library with an estimated uncertainty of $\pm$ 0.015 [4, 5]. Given the existing 0.25% requirement for accuracy of the standard [11], the spread of data adopted in Table 1 is 0.023 or 0.6%.

The recommended values of $\bar{\nu}$ for fission induced by thermal neutrons take account of the results of direct measurements of $\bar{\nu}$ for thermal or monoenergetic neutrons and data of integral experiments. The systematic discrepancy in the results of these groups of measurements is known as the ν-η-discrepancy. The most recently published multiparameter analysis of the various experiments is that of Stehn et al. [12]. Table 2 shows the recommended values of $\bar{\nu}$ given by them; some revised values of $\bar{\nu}$ (for thermal neutron-induced fission of nuclei and spontaneous fission of ^{252}Cf, taking account of new measurements and more accurate correction for the thickness of the fissile material layer [13]); and also values of $\bar{\nu}$ used in Ref. [1] to reduce the data to a single standard.

Later in this paper, a set of data from Boldeman et al. [13] is used to reduce the values of $\bar{\nu}_p$ to a single standard.

2. Measurements of $\bar{\nu}_p$ for spontaneous fission

Table 3 shows the results of measurements of $\bar{\nu}_p$ for spontaneous fission. The text comments on papers which have been published since 1972.

The authors are not familiar with the details of the measurements of Hwang et al. [14]. Popeko and Ter-Akopian [15] used a detector consisting of 28 ^{3}He-counters in a paraffin moderator. Three series of measurements were made with a fission chamber (about 4 x 10^4 fissions) and one series with a uranium block in a 1100-m-deep shaft to reduce background. In the latter case a system was used whereby the coincidence of pulses from two or more neutrons was used to identify the fission events. The number of background random coincidences in the shaft was less than one per year [16]. Measurements were made relative to $\bar{\nu}_p$ for fission of ^{242}Pu and the neutron multiplicity distribution was determined. The value of $\bar{\nu}_p$ is given in Table 3. The error indicated takes account of statistical error in the measurement, instability of the equipment and inaccuracy in the constants used. $\bar{\nu}_p$ for ^{256}Fm was measured using a similar detector consisting of 56 ^{3}He-counters in a Plexiglas moderator [17]. The fission fragments were recorded using an ionization chamber, the detector efficiency for ^{252}Cf fission neutrons was 0.483 and the number of fission events recorded was 13 382. Correction for the difference in energy spectra was not made, since it is small in this case (0.1-0.2%). The statistical error is given. $\bar{\nu}_p$ for spontaneous fission of ^{246}Cm, ^{246}Cf and ^{256}Fm was measured in the same laboratory using a similar method [18-20]. A fission neutron detector consisting of 36 ^{3}He-counters was employed, and the fission events were recorded with a semiconductor detector. Measurements were performed relative to $\bar{\nu}_p$ (^{244}Cm). Some 20-30% of the fission events were lost owing to the high α-activity of the fissile material layers, but, according to the authors' estimates, this has little effect on the results (not more than 0.4%). Corrections were made for errors in the pulse count of the neutron detectors and for the isotopic composition of the sample. The difference in the fission neutron spectra of the isotope and the standard was not considered. The statistical error is given. The same neutron detector was used by Lazarev et al. [21] to measure $\bar{\nu}_p$ for fission of the element ^{252}102. The main difficulty in conducting the experiment was the short life-time of the isotope studied. The fragments were recorded by a semiconductor surface-barrier detector, 178 fission events being recorded. The only correction made to the results was a small one for the resolving time of the apparatus. The statistical error is given.

In order to measure $\bar{\nu}_p$ for spontaneous fission of ^{240}Pu, Frehaut et al. used the method examined in section 5 [22]. The error given includes systematic errors of about 0.45%. Boldeman [23, 24] lists the results of earlier measurements of $\bar{\nu}_p$ for spontaneous fission of ^{240}Pu, ^{242}Pu and ^{248}Cm [25]. Data from the energy calibration of a large liquid scintillator and on delayed fission γ-quanta were used. An estimate is given of the total measurement error and values for the following corrections: statistical (0.16%); for the difference in fission neutron spectra (0.91 ± 0.14%; 0.87% for ^{242}Pu); for the dead time of the apparatus (-0.40 ± 0.08%); and for the contribution of delayed fission γ-quanta (± 0.1%). Zhang et al. make two measurements of $\bar{\nu}_p$ for ^{240}Pu [26, 27]. In their first paper [26] the efficiency of a large liquid scintillator was measured by neutron scattering on hydrogen. The value of $\bar{\nu}_p$ obtained is absolute. Their second paper [27] describes measurements with the same detector relative to $\nu_p^{sp}(^{252}Cf) = 3.743$, a figure which was obtained earlier by two of these authors [6]. Values of $\bar{\nu}_p$ and the widths of the prompt neutron multiplicity distributions for ^{240}Pu and ^{242}Cm are determined, these being 1.49 ± 0.047 and 1.159 ± 0.074 respectively. The total measurement error is indicated without taking into account error in the standard.

Edwards et al. [9] used a neutron detector consisting of 56 BF_3-counters in a moderator containing hydrogen, measurements were made simultaneously of $\bar{\nu}_p$ for ^{252}Cf and ^{242}Pu and the detector efficiency was determined using neutron sources calibrated in a manganese bath, which meant that it was possible to obtain an absolute value of $\bar{\nu}_p$. A detailed study was made of the dependence of the measured value of $\bar{\nu}_p$ on fission chamber efficiency, since for ^{242}Pu only 88% of the fission events were recorded [9]. During processing of the results for $\bar{\nu}_p$, corrections were made to take account of the background (-0.011 ± 0.000), the change in the detector efficiency (-0.017 ± 0.001), and absorption of neutrons in the fission chamber (0.022 ± 0.003). In calculating the error, account was also taken of the error in calibrating the detector efficiency (± 0.012), the average energy of the fission neutron spectrum (± 0.010), the accuracy in determining the rate of fissions in the layer (0.001), the position of the fission chamber and its angle relative to the axis of symmetry of the neutron detector (0.001 and 0.008). The total error in the absolute measurements of $\bar{\nu}_p$ for ^{242}Pu was ± 0.019 and the statistical error of the ratio $\bar{\nu}_p(^{242}Pu)/\bar{\nu}_p(^{252}Cf)$ was about 0.15%.

Halperin et al. [28] use a detector comprising 30 ^{3}He-counters placed in a cylindrical paraffin and polyethylene matrix. The detector efficiency during recording of ^{252}Cf spontaneous fission neutrons was 0.4394 ± 0.0008. About 500 μg of ^{242}Am was coated onto the three convex surfaces of the chamber using semispherical electrodes. ^{242}Cm is formed after isomeric transition and β-decay of ^{242}Am. Correction was not made for fission of americium nuclei. The distribution and average number of fission neutrons were recorded. The recording efficiency was calculated to be the same for ^{252}Cf and ^{242}Am fission neutrons. The total measurement error is given and the statistical error was 0.2%.

A similar detector (with 20 ^{3}He-counters) was used by Stoughton et al. [29]. A semiconductor surface-barrier detector was used to count the fragments, and the fission neutron multiplicity distributions were measured for ^{246}Cm and ^{248}Cm relative to ^{252}Cf. The efficiency of fission counting was about 50%. Corrections were made to the results for background neutrons, the fragment recording efficiency and the isotopic composition of the samples. Statistical error made a significant contribution to the error given. Golushko et al. [30] used a neutron detector consisting of 18 ^{3}He-counters in a paraffin moderator. The efficiency of the detector for ^{252}Cf fission neutrons was 29%. The fission fragments were recorded with a gas scintillation detector. The measurements were made relatively to ^{252}Cf. Corrections to the results were made for the random coincidence background, isotopic composition and errors in the pulse count of the neutron detector. The dependence of the detector efficiency on the mean fission neutron energy was not considered and the corrections are not indicated. $\bar{\nu}_p$ is measured for ^{244}Cm, ^{246}Cm and ^{248}Cm, and the total measurement error is given.

Khokhlov et al. [31] employed the method described in section 5. The fission fragments were recorded with a fast ionization fission chamber. A detector consisting of β-counters in a polyethylene moderator was also used to measure $\bar{\nu}_p$ for ^{244}Cm, ^{246}Cm, ^{248}Cm relative to $\bar{\nu}_p^{sp}(^{252}Cf)$. The fission neutron recording efficiency of the large liquid scintillator was 54%; the efficiency of the other detector is not given. The measurement results are corrected for background, pulse counting errors, the difference in neutron fission spectra and the isotopic composition of the samples. The errors given are obtained from the spread of results of the individual series of measurements. In the case of ^{244}Cm, the results are given only for the β-counter detector.

The method used by Prokhorova et al. [32] is described in section 5. $\bar{\nu}_p$ is derived for ^{244}Cm, ^{246}Cm and ^{248}Cm and an estimate of the total measurement error is given. Kosyakov et al. [33] used the same method to measure $\bar{\nu}_p$ for ^{249}Bk. Zhuravlev et al. [34] describe measurements of prompt fission neutron spectra (cf. section 4), from which $\bar{\nu}_p$ for ^{246}Cm and ^{248}Cm is obtained by integration. The measurements were made relative to neutron spectra for fission of ^{235}U by thermal neutrons.

The results of measuring the neutron multiplicity for fission of ^{250}Cf, ^{252}Cf, ^{254}Cf and ^{257}Fm are given by Hoffman et al. and Balagna et al. [35, 36]. A large liquid scintillator was used by Vesser et al. [37, 38] (cf. section 5). The fission events were recorded with two surface-barrier silicium semiconductor detectors. The layers of fissile materials, coated onto film which channelled the fragments, were placed between the detectors. The efficiency of simultaneous recording of fission fragment pairs was 20%. The authors describe measurements of the number of neutrons for fragments with different kinetic energy. The neutron recording efficiency was about 78%. In the case of ^{257}Fm, the fissile layer was placed at the edge of the detector, the neutron recording efficiency being 31%. The objective was to derive the fission neutron multiplicity distribution as a function of the total kinetic energy and the mass ratio of the fragments. Table 3 gives only the values of $\bar{\nu}_p$. The error in $\bar{\nu}_p$ for ^{250}Cf includes uncertainty in the corrections for the ^{252}Cf impurities and error in determining the detector efficiency. The statistical error was $\pm$ 0.006. In the error for ^{254}Cf and ^{257}Fm [35], an important contribution was made by uncertainty regarding the detector efficiency, since simultaneous calibration relative to ^{252}Cf was not carried out. Balagna et al. [36] made continuous measurement of the efficiency, but a significantly lower number of fission events was taken and only the statistical error is given. Table 3 also gives the measurements made with the radiochemical method, which may be useful for qualitative assessments.

3. The weighted mean values of $\bar{\nu}_p$ for spontaneous fission

The weighted mean value can be regarded as a satisfactory estimate of $\bar{\nu}_p$. The inverse squares of the total errors were used as weights. Although this procedure is correct for statistical and uncorrelated errors, its application is also justified in this case. Statistical error plays a significant part in the majority of the results presented. Measurements by different authors are generally given for each element and the correlation between the results is negligible. In addition to the data given in Ref. [1], Table 3 also contains new data on $\bar{\nu}_p$ for spontaneous fission, the weighted mean (in terms of least squares) values and the corresponding dispersion evaluations. It should be noted that uncertainty in the standard [usually $\bar{\nu}_p^{sp}(^{252}Cf)$] is present in most of the estimates obtained. In the case of measurements relative to $\bar{\nu}_p$ for other isotopes, the data have been normalized to the corresponding weighted mean values. If the results given in the survey contained in Ref. [1] have been revised by the authors, then only the new values are given in the table. The data obtained by the radiochemical method have not been taken into account in the average and are given only as an indication. The results of the averaging are shown in Fig. 1.

4. Measurements of $\bar{\nu}_p$ for fission induced by thermal neutrons

There has been very little data published since the survey by Manero and Kon'shin [1]. Measurements have been made for ^{235}U and ^{239}Pu for monoenergetic neutrons by Gwin et al. [41] and for three curium isotopes by Zhuravlev et al. [34]. Data have been obtained by the radiochemical method for some elements by Flynn et al. [39], Unik et al. [40] and Thierens et al. [42]. The latter three papers are not discussed here, although data from them are given in Table 4.

Zhuravlev et al. [34] measured the fission neutron spectra in the 0.4-6 MeV range using the time-of-flight method of Zamyatnin et al. [43]. The fission events were recorded by a gas scintillation chamber and the fission neutrons by a plastic scintillator with diameter 100 mm and length 30 mm. The measurements were performed relative to the ^{235}U fission neutron spectrum and $\bar{\nu}_p$ was obtained by integrating the measured spectrum. The error in the relative measurements was about 3%. The error given is obtained from the spread of the results over several series of measurements. Allaert et al. [44] give an example of an indirect measurement of $\bar{\nu}_p$ for fission of ^{241}Pu by thermal neutrons: the energy distributions and mass of the fission fragments which were measured by the time-of-flight method, made it possible to estimate $\bar{\nu}_p$ (although not very accurately). Table 5 gives the weighted mean values for $\bar{\nu}_p$ obtained mainly from the data in Ref. [1]. The necessary corrections are made for ^{243}Cm and ^{247}Cm.

5. Values of $\bar{\nu}_p$ as a function of energy

Evaluations made in the survey contained in Ref. [1] are used for characterizing the results obtained up to 1972: all the experimental values published are described by polynomials to the 8th or 9th degree using the least squares method. The curves obtained well represent the 1972 measurements of the energy dependence of $\bar{\nu}_p$.

The data in Tables 6-16 indicate the statistical error of measurements where it was possible to deduce it from the original papers. The characteristics of the systematic error are examined in the text. In some cases, indications are given of possible alterations to the data taking account of new results. The tables give the original values and also the values reduced to a single standard (cf. section 1).

The vast majority of the measurements examined are performed relative to $\bar{\nu}_p$ for spontaneous fission of ^{252}Cf. Therefore, the text mentions only those cases where another standard is used.

5.1. $\bar{\nu}_p$ for ^{230}Th. The measurements of $\bar{\nu}_p$ for ^{230}Th have been published only by Boldeman and Walsh [45]. A large liquid scintillator with a capacity of 240 litres was used as a fission neutron detector. The fission events were recorded with an ionization chamber containing 20 mg of 99.85% enriched ^{230}Th, in the form of four one-sided layers 1 mg/cm^2 thick. Monoenergetic neutrons were obtained from the ^{7}Li(p,n) and T(p,n) reactions using a Van de Graaff accelerator operating in the steady-state regime. The efficiency of this detector was calibrated earlier for absolute measurements of $\bar{\nu}_p$ (^{252}Cf) [24]. Corrections to the results are made for dead time (-0.3%), the difference in ^{230}Th and ^{252}Cf fission neutron spectra, and the anisotropy of fission fragment emission (up to 0.2%). Statistical error is apparently given. The data are contained in Table 6 and Fig. 2.

5.2. $\bar{\nu}_p$ for ^{232}Th. Caruana et al. [47] measured $\bar{\nu}_p$ for ^{232}Th. The corrections made and the nature of the errors in the work described in Ref. [46] and in Ref. [47] are the same.

The neutron detector used by Malinovsky et al. [48] consisted of 16 ^{3}He-counters in a polyethylene moderator. The fission events were recorded by an ionization chamber containing thorium dioxide layers 1.0 mg/cm^2 thick. The measurements were carried out in an electrostatic accelerator operating in the steady-state regime. The uncertainty in the neutron energy was 30-40 keV for the T(p,n) reaction and about 80 keV for the D(d,n) reaction. Corrections to the results were made for the difference in energy spectra of the fission neutrons [(-2.3 - 1.0) $\pm$ 0.5%]; the dependence of the neutron recording efficiency on the position of the ^{232}Th layers inside the detector (3.45 $\pm$ 0.05%); the difference in diameter of the ^{232}Th and ^{252}Cf layers (-0.3 ± 0.2%); pulse counting errors caused by neutrons [(-2.3 - 1.4) ± 0.2%]; the dependence of the number of neutrons recorded on the fission fragment recording efficiency (1.1 ± 0.3%); the loss of fragments in the fissile layer (0.4 ± 0.1%); the angular anisotropy of the fission fragments (0.0 ± 0%); and the presence of background neutrons in the case of the D(d,n) reaction (1.4 ± 0.8%). A detailed description of the method is given in Refs [49, 50] and an analysis of errors with an estimate of the covariation matrix of the data is given in Ref. [51]. Table 7 and Fig. 3 show only the statistical errors. The data of Frehaut et al. [52], Trochon et al. [53] and Frehaut et al. [64] were obtained using a large liquid scintillator (cf. section 5.4). The authors of the present work did not have available numerical data from Ref. [53].

Figure 3 shows that recent results considerably refine the energy dependence of $\bar{\nu}_p$. The interval from 4-14 MeV has been filled (before 1972 there was only one point in this range). Between the results of Malinovskij et al. [48] and those of Frehaut et al. [52] and Trochon et al. [53] there is a systematic discrepancy which is possibly accounted for by the different methods of allowing for the loss of fission events. At the same time the relative progression of the energy dependence in these works is similar and agrees with the increase in $\bar{\nu}_p$ reflected in Ref. [1] for reduction in neutron energy near the fission barrier.

5.3. $\bar{\nu}_p$ for ^{233}U. Since 1972, three articles have been published reporting measurements of $\bar{\nu}_p$ for ^{233}U [54-56]. Nurpeisov et al. [54] used a neutron detector consisting of 24 ^{3}He-counters in a paraffin moderator with an efficiency of 21%. A multilayer ionization chamber contained layers of ^{233}U with a thickness of about 3.5 mg/cm^2 and a total mass of 100 mg. Results are given of simultaneous measurements of ^{233}U, ^{238}U and ^{239}Pu [55]. The detector used consisted of 21 ^{3}He-counters (which was longer than that described in Ref. [54]) in a polyethylene block. Corrections to the results were made for the dependence of the detector efficiency on the position of the fission chamber on the detector axis (2.59 ± 0.25%), the difference in diameter of the fissile layers of ^{233}U and ^{252}Cf (0.29 ± 0.10%), pulse overlap (-0.65 ± 0.10%), the dependence of the detector efficiency on neutron energy (-0.89 ± 0.25%), the angular anisotropy of the detector efficiency (0.09 ± 0.02%), slow neutron impurities (0.28 ± 0.09%) and also for discrimination of a proportion of the fission chamber pulses (1.53 ± 0.42%) (the recording efficiency of the fission fragments was about 83%) [55]. The corrections given correspond to a neutron energy of 2.0 MeV [22]. In comparison with Ref. [54], the correction for dead time of the detector (cf. Table 8) has been reduced by a factor of 1.5. The total uncertainty of corrections for neutron energies below 3.5 MeV was approximately 0.3-0.4% and for energies above 3.5 MeV it was about 1%.

Using the method described in section 5.4 [41, 71], $\bar{\nu}_p$ for ^{233}U was measured by a large liquid scintillator for neutrons with energies of 500 eV-10 MeV and below 0.3 eV [56]. Figure 4 shows the results contained in Refs [54, 55] and the evaluation in Ref. [1], which seems to give somewhat lower values for $\bar{\nu}_p$.

5.4. $\bar{\nu}_p$ for ^{235}U. Savin et al. [31, 57, 58] used a large liquid scintillator with a capacity of 400 litres with a cadmium addition. A linear electron accelerator served as a neutron source, and neutron energy was determined by the time-of-flight method. The fission events were recorded by the pulse of a prompt fission γ-quanta scintillator [31, 58], or of a fission chamber [57]. A ^{235}U sample in the form of metal disks with a total mass of 17.4 was used in the measurements [31, 58]. In calculating $\bar{\nu}_p$, the angular anisotropy of the escape of the fission fragments, the difference in neutron spectra for fission of ^{235}U and ^{252}Cf, and multiplication of neutrons in the sample were all taken into account. The evaluation allowed for statistical fluctuations, instability in the detector efficiency (about 0.5%), errors in determining background (about 1%) and false start-up of the time channel (about 0.5% for neutron energies below 0.9 MeV). The total systematic error of these experiments [31, 58] was about 1.2%. Instead of a metal ^{235}U sample, a fission chamber was used with a fragment recording efficiency of about 80%. This made it possible to improve the background measuring conditions for neutron energies below 1 MeV. The numerical data have been published in Ref. [59]. The errors shown in Table 9 include the statistical error (obtained from the spread of the series of measurements) and the systematic error (0.5%, allowing for uncertainty in the detector efficiency).

Frehaut et al. [60] provide measurements of $\bar{\nu}_p$ for ^{235}U which correct previous data by these same authors [62, 63]. The neutron detector was a large liquid scintillator with a volume of 240 litres and the fission events were recorded with a multi-layer fast ionization chamber containing layers of ^{235}U having a thickness of only 0.75 mg/cm^2 and a total mass of 50 mg. The neutrons were obtained from the T(p,n) and D(d,n) reactions in an electrostatic tandem accelerator operating in the pulsed regime, and fissions produced by background neutrons were allowed for by the time-of-flight method. Corrections to the results are made for the difference in fission neutron spectra [-(0.5 - 1) $\pm$ (0.2 - 0.4)%] and dead time [-(0.8 - 1.5) $\pm$ (0.1 - 0.2)%]. In Ref. [61] the same authors indicate the correction of errors in subtracting the background, as a result of which correction the later results [60] exceed those of 1969 [63] by 1-3% for neutron energies up to 8 MeV, while above 9.5 MeV both sets of data agree. In Ref. [60] the authors recommend that averaged results be used. The data obtained are given in Table 9 and in Figs 5 and 6. The statistical error is given, and the systematic error was 0.3-0.4%. The report by Frehaut et al. [64] contains the latest measurements of $\bar{\nu}_p$.

Kappeler and Bandl [65] used the fast coincidence method to measure the energy progression of the dependence of $\bar{\nu}_p$. The fission neutrons from the metal ^{235}U sample (a 70 mm-diameter disk with a thickness of 0.15 mm) were recorded using a liquid scintillation detector with a diameter of 11 cm and thickness of 3 cm. A Van de Graaff accelerator working in the pulsed regime was the neutron source, and the number of fissions in the sample was determined by a scintillation chamber with thin layers of ^{235}U. Corrections to the results were made for the isotopic impurities in the ^{235}U sample [-(0 - 3) $\pm$ 0.2%], the anistropy of the escape of the fission neutrons and self-shielding in the sample [(0.5 - 0.1) $\pm$ 0.2%], multiple scattering [-(2 - 0) $\pm$ 0.2%], instability of the neutron detector efficiency (systematic error 0.3%, statistical error 0.3%) and change in the fission neutron spectrum 0.2%. The total correction error was 0.6%. Table 9 gives absolute values for statistical errors rather than percentages as in the original [65]. Since the measurement method gave only a relative dependence of $\bar{\nu}_p$, the authors of Ref. [65] normalized their data to the integral $\int_{E_1}^{E_2} \nu_p dE$ for E_1 = 225 keV, E_2 = 1363 keV, where the evaluation for $\bar{\nu}_p$ given in Ref. [1] was used. The data produced by Kappeler and Bandl [65] are given in Table 9 with the same normalization.

In Refs [66, 67] the authors briefly revise their measurements of $\bar{\nu}_p$ for ^{235}U for neutron energies below 2 MeV. The correction is refined for delayed fission γ-quanta, and this is important for measurements made using a liquid scintillator [46]. Boldeman and Frehaut [66] calculate the corresponding values of corrections for measurements made by their associated group [62, 63, 68, 69]. An identical scintillation detector was used in all these works. The data of Refs [68, 69] were corrected by -0.16% and those of Refs [62, 63] by -0.67%. The authors also altered by 0.05% the data of Refs [68, 69] and by -0.3% the data of Refs [62, 63] taking into account recalculations of the correction for the difference in fission neutron energy spectra. This correction then became identical for both authors. Table 9 contains the corrected data from Refs [66, 67], the statistical errors, and the systematic error (about 0.3%). The authors have shown that if the energy spectrum of the fission neutrons is described by Watt's formula instead of using the Maxwell formula, all the results quoted should increase by 0.21%. This was done to obtain the ENDF/B-V evaluation. However, the necessity for this correction is disputed.

Frehaut gives results of measurements of $\bar{\nu}_p$ for ^{235}U fission by neutrons with an energy of 22-28 MeV [70]. The statistical error is stated.

Gwin et al. [41, 71] used a large liquid scintillator with a volume of 910 litres and a high neutron recording efficiency in conjunction with very thin (about 0.1 mg/cm^2) layers of ^{235}U, which made it possible to achieve a fission chamber efficiency of about 95%. A linear electron accelerator was used as a neutron source. The neutron energies were determined using the neutron time-of-flight method over 21.6 m [41] and 83.4 m [71]. The fact that neutron counting was started 2 μs after the fission chamber pulse meant that it was possible virtually to exclude correction for delayed γ-quanta. Corrections to the measurements were made for the 0.25% uncertainty in calibrating the efficiency of the detector by the ^{252}Cf source (using various fission chambers with a ^{252}Cf layer), the position of the fission chambers with ^{235}U and ^{252}Cf inside the detector $-0.3 \pm 0.06\%$, false start-ups $2.5 \pm 0.25\%$ for a neutron energy of about 500 eV and $0.3 \pm 0.03\%$ for 2.5 MeV, the scintillator background $-0.1 \pm 0.05\%$, counting errors $0.3 \pm 0.09\%$ for a total detector dead time of 0.095 μs, and the difference in fission neutron spectra $0.13 \pm 0.04\%$. Table 9 contains all the data of Gwin et al. [41, 71], although the authors recommend that the results for ^{235}U in the 0.05 keV-6.4 MeV region should not be used in evaluations due to unexplained experimental difficulties in determining the background. The results of the later work [71] should be taken into account. In the earlier work [41] the total measurement error is given, and in the later work [71], the statistical error is given (with a systematic error of about 0.3%). For measurements of $\bar{\nu}_p$ with layers of ^{235}U 2 mg/cm^2 thick, the values obtained were 3% lower than for 0.1 mg/cm^2 layers. This dependence on the thickness of the layer is about three times greater than that obtained in Refs [13, 72, 73]. It seems that the difference measured by Gwin et al. [71] takes account both of the effect of non-uniform absorption of fragments in the layer and the change in the recording efficiency of the fission chamber, whereas in the work reported in Refs [13, 72, 73] the change in chamber efficiency is less. By using 0.75 mg/cm^2 thick layers, the results were increased in comparison with the data reported in Refs [63, 68] by 0.8% [71]. The values of $\bar{\nu}_p$ for thermal neutrons quoted in Ref. [41] and Ref. [68] also differed by 0.8%. However, after corrections were made for the thickness of the layer [13] the difference was reduced to only 0.59% [68]. Threefold increase of this correction is hardly justified if only one factor is taken into account. Gwin et al. [56] show that the data of their earlier experiments [41, 71] are possibly 0.25% too high.

Figures 5 and 6 show the original data. To the results reported in Refs [66, 67] it seems that a correction of about 0.25% should be made. In Ref. [71], the neutron energy is given in intervals. For the purposes of clarity, some data are grouped on the graph. On the whole, the results which agree with each other do not confirm the complex energy dependence of the evaluation of $\bar{\nu}_p(E_n)$ found in Ref. [1]. Subsequently simpler models of $\bar{\nu}_p$ were normally used [5].

5.5. $\bar{\nu}_p$ for ^{236}U. The results of measuring $\bar{\nu}_p$ for ^{236}U as a function of neutron energy have been published in Refs [50, 75]. Data of Conde and Holmberg [75] were included in the survey by Manero and Kon'shin [1]. In the work by Malinovskij et al. [50] the measurements were made using the method examined above (cf. section 5.2). The only differences from the data for ^{232}Th are the corrections for the length of the fission chamber along the axis of the detector (4.8 ± 0.2%), for the thickness of the fissile layers (0.3% - the same as in Ref. [50], since 1 mg/cm^2 layers were used), and for pulse discrimination of the fission chamber (1.5 ± 0.3%). Table 10 contains the data and the statistical error of the measurements. The difference in results does not exceed the measurement errors except in the 4-6 MeV region. The two lines in Fig. 7 show the description of both sets of data obtained in Ref. [50].

5.6. $\bar{\nu}_p$ for ^{238}U. The work of Nurpeisov et al. [55] is described above (cf. section 5.3). The only differences are the corrections for the position of the fissile layers on the detector axis (4.95 ± 0.30%), pulse discrimination of the fission chamber (0.9 ± 0.3%), and angular anisotropy of the detector efficiency (0.18 ± 0.04%); the other corrections are the same as for ^{233}U. Fairly thick layers (about 4 mg/cm^2) were used.

The method used by Malinovskij et al. [76, 77] is described in section 5.2. In contrast to the later work by the same authors [48], a fission ionization chamber was used with fast current accelerators and higher fission fragment recording efficiency. Differences were found in the corrections for the length of the fission chamber (4.6 ± 0.3%), discrimination of fission events (0.2 ± 0.1%), spontaneous fissions and false start-ups [(0.2-0.5) ± 0.2%]. Table 11 and Fig. 8 show the statistical errors.

Frehaut et al. [78] examine the results of measurements of $\bar{\nu}_p$ for ^{238}U and ^{239}Pu published in 1969 [63]. The authors have already changed their data twice (cf. [60, 61] and section 5.4). Table 11 gives the measurements of the same group for the neutron energy range 22-28 MeV [70]. Figures 8a and 8b show the results of the work examined and the evaluation contained in Ref. [1], which is slightly higher than the recent data. The reason for this discrepancy lies in the inclusion in the evaluation in [1] of data from [64] which have since been altered [78].

5.7. $\bar{\nu}_p$ for ^{237}Np. When Ref. [1] was published, $\bar{\nu}_p$ had been measured for ^{237}Np fission by continuous energy spectrum neutrons using reactor neutron beams [79, 80], and $\bar{\nu}_t$ for ^{237}Np was determined in integral experiments on critical assemblies [81, 82].

The results for monoenergetic neutrons were first published by Veeser [37]. The neutron detector was a large liquid scintillator with a volume of 240 litres and efficiency of 66-69%. A spiral fission chamber was used with a 1 mg/cm^2 layer of ^{237}Np. The neutrons were obtained from the T(p,n), D(d,n) and T(d,n) reactions in an electrostatic accelerator. Corrections to the results were made for dead time (0.4%), isotopic impurities (less than 0.2%), the difference in the fission neutron spectra (up to 0.9%); the statistical and systematic (about 1%, dependent mainly on the uncertainty in the neutron detector efficiency) measurement errors are given.

References [49, 83, 84] describe measurements using the method already examined. The correction for pulse discrimination of the fission chamber was refined and a further measurement was made using a spiral fission chamber with a 1 mg/cm^2 ^{237}Np layer [84]. The final corrections for discrimination were 3.7 ± 0.5, 1.2 ± 0.2 and 2.0 ± 0.4% for the three types of fission chamber used with various quantities of ^{237}Np. The values obtained for $\bar{\nu}_p$ are given in Table 12 with an indication of the statistical error. The difference in the results compared to the earlier data [49, 83] was -0.8%.

In the work by Frehaut et al. [85] the measurement method described above [54] was used. The fission chamber contained 100 mg ^{237}Np for a layer 1 mg/cm^2 thick. At the same time the mean energy of prompt fission γ-quanta was measured.

Figure 9 and Table 12 show only the statistical errors. The results reported in Refs [37, 84] agree with one another and those of Frehaut et al. [85] are 2-3% lower. Frehaut [86] explains the difference by stating that Veeser [37] underestimates the background and Vorob'eva et al. [49] overestimate the correction for pulse discrimination of the fission chamber. However, Malinovskij et al. [84] point out that refinement of the correction for discrimination and measurements with a spiral fission chamber led to little change in the data of Ref. [49] and the point about inaccurate determination of background by Veeser [37] is questionable. It is possible that Frehaut et al. [85] underestimate the effect of losses of fission events. The reasons for the discrepancy thus remain obscure.

5.8. $\bar{\nu}_p$ for ^{239}Pu. Volodin et al. [87] measured $\bar{\nu}_p$ using two methods. The first was similar to that examined above [55] (cf. section 5.3). The fission chamber contained 16 double layers of plutonium dioxide 0.5 mg/cm^2 thick (7 mg per layer). The estimated systematic measurement error was -0.4 ... +0.5%. The total error is given in the results. In the second measurement method the neutrons were recorded with a multilayer fission chamber containing 4 g of thorium dioxide. A 30 g plutonium metal disk was used, and the number of fissions in the sample was determined with a chamber incorporating a thin layer of plutonium dioxide. Corrections to the measurement results were made for the dependence of the number of fissions in the sample on the neutron energy, the angular correlation of fission fragments and fission neutrons, change in the energy spectrum of fission neutrons, multiple scattering and neutron breeding in the sample. The fact that in this method the accelerator was operating in the steady-state regime made it possible to measure the relative dependence of $\bar{\nu}_t$. Table 13 shows the results obtained using both methods. The authors reject their previous results [88] in which the contribution of neutrons from spontaneous fission of ^{240}Pu was not calculated accurately enough. The total errors are given.

The data of Walsh and Boldeman [89] are quoted in Ref. [1] as preliminary data. The method used is described in section 5.1. The statistical error is apparently given. The experiments by Nurpeisov et al. [55] are described in section 5.3. The fission chamber contained 80 g of ^{239}Pu in 0.5 mg/cm^2 layers. Table 13 contains the statistical error. Kokhlov et al. [31] give two values of $\bar{\nu}_p$ for ^{239}Pu. The work reported in Refs [70, 78, 90] correct the values for $\bar{\nu}_p$ for ^{239}Pu published earlier [62, 63] and the results of measurements in the 22-28 MeV neutron energy range.

Gwin et al. [41] obtained results for neutron energy ranges of 0.005-41 eV, 0.05-6400 keV and 0.5 keV-10 MeV. The first two ranges were measured for a flight path of 21.6 m and the third for one of 83.4 m. A description of the experiment and errors is given in section 5.4.

Zhang Huan-Qiao et al. [26] used the absolute measurement method for $\bar{\nu}_p$. The neutron detector was a large liquid scintillator in a spherical aluminium vessel, 60 cm in diameter which contained 0.33 wt% gadolinium. The detector efficiency was measured by elastic scattering of neutrons in hydrogen and by recording of the recoil protons in a stilbene crystal. Layers of ^{239}Pu, 0.5 mg/cm^2 thick, were produced by electrolytic deposition on a stainless steel backing. A Van de Graaff accelerator with a maximum energy of 2.5 MeV and operating in the steady-state regime was used as a neutron source, and the targets were of solid ^7Li and Ti-T material 0.5-1 mg/cm^2 thick. The detector efficiency for ^{239}Pu fission neutrons was 0.595-0.596. The corrections to the measurement results made in determining the detector efficiency took account of: statistical accuracy ± 0.16%; counting errors 0.28 ± 0.06%; edge effect in the stilbene crystal -0.02 ± 0.00%; proton scattering in carbon -0.75 ± 0.15% and in hydrogen -0.64 ± 0.13%; uncertainty in the fission neutron spectrum ± 0.3%; the effect of grouping data by channels -1.95 ± 0.29%; and anisotropy of the fission neutrons -0.05 ± 0.01%. In estimating the error in the number of fission neutrons, account was taken of the statistical accuracy ± 0.3-0.5%; false start-ups 0.3±0.06%; dead time 0.57 ± 0.0%; the contribution of fissions by fast neutrons 3.6%; ^{238}U impurities 0.77 ± 0.07% and 0.9%; ^{240}Pu impurities 0.00 ± 0.02% for 1.44 MeV neutrons; the contribution of delayed γ-quanta -0.64 ± 0.16% for 1.44 MeV neutrons; the contribution of fissions by slowed-down neutrons 0.0 ± 0.5%. The total correction was 4.03 ± (0.8 - 0.9)%, the statistical component of the error was 0.3-0.5%. Table 13 shows the total error.

Figures 10-12 show all the results that have been discussed and those of Ref. [1]. It is clear that the new data and corrections to some of the earlier published results should be incorporated in the latter.

5.9. $\bar{\nu}_p$ for ^{240}Pu and ^{241}Pu. Since 1972 only one work with measurement of $\bar{\nu}_p$ for these isotpes has been published [22]. The data for ^{240}Pu

published in Ref. [60] are preliminary. The measurement method is examined in section 5.4. Layers of ^{240}Pu 0.15 mg/cm^2 thick and of ^{241}Pu 1.0 mg/cm^2 thick were used. The correction for the difference in the plutonium and californium fission neutron energy spectra used as basis for the calculations in Ref. [91] diverged somewhat from those in Ref. [60]. Tables 14 and 15 show the results together with the statistical error of 0.5–0.6% [22]. The measurements of the energy dependence of $\bar{\nu}_p$ for ^{240}Pu are also given in Figs 13 and 14 [92, 93]. The data of D'yachenko et al. [94] are not given since they were obtained by indirect measurement.

5.10. <u>$\bar{\nu}_p$ for ^{242}Am^m fission</u> was measured by Howe et al. [95]. The fission neutron detector was a liquid scintillator, 12.5 cm in diameter and 7.5 cm long, and the neutron source a linear electron accelerator with an energy of 100 MeV. The neutron energy was determined by the time-of-flight over 13.4 m. A fission chamber was used in which a layer of ^{242}Am^m 200 μg/cm^2 thick was coated onto semi-spherical electrodes and a layer of ^{235}U (500 μg/cm^2) onto parallel-plane electrodes. Measurements were made relative to $\bar{\nu}_p$ for ^{235}U fission. Corrections to the results were made for the background of random coincidences, spontaneous ^{242}Cm fission, the dead time of the detector, geometrical efficiency (0.6%) and the difference in fission neutron spectra (0.3%). Correction was not made for the anisotropy of emission of fission neutrons owing to a lack of data for ^{242}Am^m (estimate of this correction is 1-2%). Table 16 shows the data of the measured ratio $\bar{\nu}_p$ (^{242}Am^m)/$\bar{\nu}_p$ (^{235}U) and the statistical measurement error. In contrast to the data by Howe et al. [95], the data in Fig. 15 are standardized to the ENDF/B-V values [5].

Comparison of the present measurements of $\bar{\nu}_p$ with those of 1972 [1] shows that:

- The energy dependence of $\bar{\nu}_p$ for ^{232}Th, ^{233}U, ^{236}U, ^{240}Pu and ^{241}Pu has been significantly refined and results have been obtained for fission of ^{237}Np and ^{242}Am^m. It seems that the accuracy which has now been obtained in measurements of $\bar{\nu}_p$ for 233, 235, 236 and ^{238}U and ^{239}Pu corresponds to practical requirements;

- The differences between the various measurements for the standard ($\bar{\nu}_p$ for spontaneous fission of ^{252}Cf) have been reduced, as well as the differences between the results of differential and integral measurements of $\bar{\nu}_p$ for thermal neutrons.

As has been noted, for example by Howe et al. [95], the accuracy of the existing systems is not yet good enough to make satisfactory predictions of $\bar{\nu}_p$. The range of fissile nuclei studied should therefore be widened further.

Physical explanations must be found for such peculiarities in the energy dependence of $\bar{\nu}_p$ as the change in slope of $\bar{\nu}_p$ near the 2.5-3 MeV energy mark [63, 77, 88] and the increase $\bar{\nu}_p$ as the excitation energy is reduced close to the fission barrier for ^{232}Th [48, 52]. In this connection, the work of Trochon et al. [53] and Frehaut et al. [85] in which both the average number of prompt neutrons and the average energy of prompt fission γ-quanta are measured simultaneously is of interest.

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Table 1. Results of measuring $\bar{\nu}_t$ for spontaneous fission of ^{252}Cf

Detector and references	Average number of prompt neutrons $\bar{\nu}_t$
Large liquid scintillator	
Spenser* [11]	3,782±0,007
Boldeman*	3,755±0,016**
Asplund-Nillson*	3,792±0,040**
Hopkins-Diven	3,777±0,031**
Zhang, Liu [6]	3,752±0,018
Weighted mean	3,774±0,006
Manganese bath	
Axton*	3,743±0,019**
DeVolpi*	3,747±0,019**
Bozorgmanesh*	3,744±0,023**
White, Axton*	3,815±0,040**
Aleksandrov [7]	3,758±0,015
Smith [8]	3,764±0,014
William*	3,789±0,037
Weighted mean	3,757±0,007
Boron pile	
Colvin*	3,739±0,037
BF_3-counters in a moderator	
Edwards [9]	3,752±0,029
Weighted mean of all the measurements	3,766±0,005

* Where there is no reference, the data are taken from [4].

** Data used in the ENDF/B-V evaluation from where the results of Spenser 3.792 ± 0.010 [46] and preliminary results of Aleksandrov 3.747 ± 0.036 [10] are also taken.

Table 2. Values of $\bar{\nu}$ for thermal neutron-induced and spontaneous fission of ^{252}Cf

Parameter	^{233}U	^{235}U	^{239}Pu	^{241}Pu	^{252}Cf
			Stehn, et al [12], 1982		
$\bar{\nu}_t$	2,492±0,004	2,430±0,004	2,881±0,006	2,943±0,009	3,767±0,004
			Boldeman, Frehaut [13], 1980		
$\bar{\nu}_t$	2,484	2,424	2,882	2,938	3,764
$\bar{\nu}_p$	2,477	2,408	2,876	2,922	3,755
			Manero, Kon'shin [1], 1972		
$\bar{\nu}_t$	2,4866	2,4229	2,8799	2,934	3,765
$\bar{\nu}_p$	2,480	2,407	2,874		3,756

Table 3. Values of ν_p for spontaneous fission

References	Measured $\bar{\nu}_p$	Standard	Renormalized ν_p^*
	^{232}Th		
Barclay [74]**	I,07±0,I0	$\bar{\nu}_p^{sp}(^{238}U)=1$	2,I4±0,20
	^{236}U		
Conde, Holmberg [75]**	I,90±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	I,90±0,05
	^{238}U		
Kuz'minov [96]**	2,I ±0,I	$\bar{\nu}_p^{sp}(^{240}Pu)=2,26$	2,0 ±0,I
Leroy [97]**	2,I0±0,08	$\bar{\nu}_p^{T}(^{235}U)=2,47$	2,05±0,08
Asplund-Nillson et al. [98]**	I,97±0,07	$\bar{\nu}_p^{sp}(^{252}Cf)=3,80$	I,95±0,07
Conde, Holmberg [75]**	2,00±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	2,00±0,05
Hwang Sheng-Nian [14]	I,96±0,05	$\bar{\nu}_p^{sp}(^{242}Pu)=2,109$	I,96±0,05
Popeko et al. [15]	I,99±0,03		2,02±0,03
	Weighted mean	2,00±0,02	
	^{236}Pu		
Crane [99]**	I,89±0,20	$\bar{\nu}_p^{sp}(^{252}Cf)=3,52$	2,02±0,2I
Hicks [100]**	2,30±0,I9	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,I8±0,I8
	Weighted mean	2,I2±0,I4	
	^{238}Pu		
Crane [99]**	2,04±0,I3	$\bar{\nu}_p^{sp}(^{252}Cf)=3,52$	2,I8±0,I4
Hicks [100]**	2,33±0,08	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,2I±0,07
	Weighted mean	2,2I±0,06	
	^{240}Pu		
Moat [101]**	2,I3±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,69$	2,I6±0,05
Asplund-Nillson [98]**	2,I54±0,028	$\bar{\nu}_p^{sp}(^{252}Cf)=3,80$	2,I29±0,028
Hopkins, Diven et al. [102]**	2,I89±0,026	$\bar{\nu}_p^{sp}(^{252}Cf)=3,771$	2,I80±0,026
Colvin, Sowerby et al. [103]**	0,888±0,005	$\bar{\nu}_p^{T}(^{235}U)=1$	2,I38±0,0I2
Prokhorova et al. [104]**	2,I6I±0,0I6	$\bar{\nu}_p^{sp}(^{252}Cf)=3,782$	2,I46±0,0I6
Boldeman [23]	2,II9±0,007	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	2,I37±0,007
Frehaut [22]	2,I48±0,0I5	$\bar{\nu}_p^{sp}(^{252}Cf)=3,732$	2,I6I±0,0I5
Zhang [26]	2,I37±0,0I7	Absolute value	2,I37±0,0I7
Zhang [27]	2,I4I±0,0I7	$\bar{\nu}_p^{sp}(^{252}Cf)=3,743$	2,I48±0,0I7
	Weighted mean	2,I42±0,005	
	^{242}Pu		
Crane [99]**	2,32±0,I6	$\bar{\nu}_p^{sp}(^{252}Cf)=3,53$	2,47±0,I7
Hicks [100]**	2,I8±0,09	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,08±0,09
Prokhorova [105]**	2,I57±0,009	$\bar{\nu}_p^{sp}(^{252}Cf)=3,784$	2,II3±0,05
Boldeman [23]	2,I09±0,007	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	2,I27±0,007

Table 3 (continued)

References	Measured	Standard	Renormalized
Edwards et al. [9]	2,153±0,019	Absolute value	2,153±0,019
	0,5738±0,0033	$\bar{\nu}_p^{sp}(^{252}Cf)=1$	2,155±0,012
	Weighted mean	2,134±0,006	
	^{244}Pu		
Orth [106]**	2,30±0,19	$\bar{\nu}_p^{sp}(^{252}Cf)=3,77$	2,29±0,19
	^{242}Cm		
Crane [99]**	2,33±0,11	$\bar{\nu}_p^{sp}(^{252}Cf)=3,53$	2,48±0,12
Hicks [100]**	2,65±0,09	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,52±0,08
Jaffey [107]**	0,933±0,043	$\bar{\nu}_p^{sp}(^{244}Cm)=1$	2,509±0,12
Halperin et al. [28]	2,532±0,013	$\bar{\nu}_p^{sp}(^{252}Cf)=3,760$	2,529±0,013
Zhang et al. [29]	2,573±0,019	$\bar{\nu}_p^{sp}(^{252}Cf)=3,743$	2,581±0,019
	Weighted mean	2,544±0,011	
	^{244}Cm		
Hicks et al. [108]**	2,66±0,11	$\bar{\nu}_p^{sp}(^{252}Cf)=3,53$	2,83±0,12
Hicks et al. [100]**	2,84±0,09	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,70±0,08
Crane et al. [99]**	2,61±0,13	$\bar{\nu}_p^{sp}(^{252}Cf)=3,53$	2,67±0,14
Diven et al. [109]**	2,810±0,059	$\bar{\nu}_p^{sp}(^{240}Pu)=2,257$	2,668±0,056
Bol'shov et al. [110]**	2,71±0,04	$\bar{\nu}_p^{sp}(^{240}Pu)=2,17$	2,68±0,04
Jaffey et al. [107]**	2,692±0,024	$\bar{\nu}_p^{sp}(^{252}Cf)=3,764$; $\bar{\nu}_p^{T}(^{235}U)=2,407$; $\bar{\nu}_p^{T}(^{239}Pu)=2,884$; $\bar{\nu}_p^{T}(^{233}U)=2,478$	2,693±0,024
Zamyatnin et al. [43]**	2,77±0,08	$\bar{\nu}_p^{T}(^{235}U)=2,426$	2,75±0,08
Prokhorova et al. [104]**	2,690±0,015	$\bar{\nu}_p^{sp}(^{252}Cf)=3,782$	2,671±0,015
Prokhorova et al. [32]	2,700±0,014	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	2,699±0,014
Golushko et al. [30]	2,680±0,027	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	2,679±0,027
Khokhlov et al. [31]	2,685±0,020	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	2,707±0,020
	Weighted mean	2,690±0,008	
	^{246}Cm		
Thompson [111]**	3,20±0,22	$\bar{\nu}_p^{sp}(^{252}Cf)=3,79$	3,17±0,22
Prokhorova [32]	2,950±0,015	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	2,949±0,015
Golushko [30]	2,927±0,027	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	2,926±0,027
Zhuravlëv [34]	2,98±0,12	$\bar{\nu}_p^{T}(^{235}U)=2,407$	2,98±0,12
Dakovski [18]	1,107±0,009	$\bar{\nu}_p^{sp}(^{244}Cm)=1$	2,977±0,024
Stoughton [29]	2,86±0,06	$\bar{\nu}_p^{sp}(^{252}Cf)=3,73$	2,879±0,06
Khokhlov [31]	2,902±0,025	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	2,926±0,025
	2,907±0,015		2,931±0,015
	Weighted mean	2,941±0,008	

Table 3 (continued)

References	Measured	Standard	Renormalized
	^{248}Cm		
Orth [106]**	3,II±0,09	$\bar{\nu}_p^{sp}(^{252}Cf)=3,77$	3,I0±0,09
Prokhorova [32]	3,I57±0,0I5	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	3,I56±0,0I5
Zhuravlev [34]	3,I4±0,I2	$\bar{\nu}_p^{T}(^{235}U)=2,407$	3,I4±0,I2
Boldeman [23]	3,092±0,007	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	3,II8±0,007
Stoughton [29]	3,I4±0,06	$\bar{\nu}_p^{sp}(^{252}Cf)=3,73$	3,I6I±0,06
Khokhlov [31]	3,I85±0,040	$\bar{\nu}_p^{sp}(^{252}Cf)=3,724$	3,222±0,040
	3,I73±0,025		3,I99±0,025
	Weighted mean	3,I34±0,006	
	^{250}Cm		
Orth [106]**	3,3I±0,08	$\bar{\nu}_p^{sp}(^{252}Cf)=3,77$	3,30±0,08
	^{249}Bk		
Pyle [112]**	3,72±0,I6	$\bar{\nu}_p^{sp}(^{240}Pu)=2,23$	3,58±0,I6
Kosyakov [33]	3,395±0,026	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	3,394±0,026
	Weighted mean	3,339±0,026	
	^{246}Cf		
Pyle [112]**	2,92±0,I9	$\bar{\nu}_p^{sp}(^{240}Pu)=2,23$	2,806±0,I9
Dakovskij [20]	3,I4±0,09	$\bar{\nu}_p^{sp}(^{244}Cm)=2,69$	3,I4±0,09
	Weighted mean	3,08±0,08	
	^{249}Cf		
Volodin et al. [113]**	3,4±0,4	$\bar{\nu}_p^{sp}(^{252}Cf)=3,756$	3,4±0,4
	^{250}Cf		
Orth [106]**	3,53±0,09	$\bar{\nu}_p^{sp}(^{252}Cf)=3,77$	3,52±0,09
Hoffman et al. [35]	3,49±0,04	$\bar{\nu}_p^{sp}(^{252}Cf)=3,735$	3,5I±0,04
	Weighted mean	3,5II±0,037	
	^{252}Cf		
	Adopted in this paper (cf. Table 1) 3,755		
	^{254}Cf		
Pyle [112]**	3,90±0,I4	$\bar{\nu}_p^{sp}(^{240}Pu)=2,23$	3,75±0,I4
Orth [106]**	3,93±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,77$	3,9I±0,05
Hoffman et al. [35]	3,77±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,735$	3,79±0,05
	Weighted mean	3,844±0,034	
	^{253}Es		
Unik et al. [40]	4,7	PM***	
Flynn et al. [114]	4,7	PM	

Table 3 (continued)

References	Measured	Standard	Renormalized
	^{254}Fm		
Choppin et al. [115]**	4,05±0,I9	$\bar{\nu}_p^{sp}(^{252}Cf)=3,82$	3,98±0,I9
Unik et al. [40]	3,7	PM	
	^{256}Fm		
Dakovskij [19]	I,387±0,006	$\bar{\nu}_p^{sp}(^{244}Cm)=1$	3,73±0,I8
Unik [40]	3,2	PM	
Flynn [39]	3±I	PM	
Ter-Akopian [17]	3,59±0,06	$\bar{\nu}_p^{sp}(^{252}Cf)=3,735$	3,6I±0,06
	Weighted mean	3,62I±0,057	
	^{257}Fm		
Cheifetz et al. [116]**	3,97±0,I3	$\bar{\nu}_p^{sp}(^{252}Cf)=3,72$	4,0I±0,I3
Balagna et al. [36]	3,769±0,0I4	$\bar{\nu}_p^{sp}(^{252}Cf)=3,735$	3,789±0,0I4
Hoffman [35]	3,85±0,05	$\bar{\nu}_p^{sp}(^{252}Cf)=3,735$	3,87±0,05
	Weighted mean	3,797±0,0I3	
	^{252}I02		
Lazarev et al. [21]	4,I5±0,30	$\bar{\nu}_p^{sp}(^{244}Cm)=2,69$	4,I5±0,30

* The chart gives the values of $\bar{\nu}_p^{sp}$, renormalized according to the standard adopted by Boldeman et al. [13] (cf. Table 2).

** The data of these works are given in the survey [1].

*** Measurements are made by the radiochemical method.

Table 4. Values of $\bar{\nu}_p$ for thermal-neutron-induced fission

Reference	Nuclear	Measured $\bar{\nu}_p$	Standard
Unik et al. [40]	^{229}Th	2,5	PM*
Thierens et al. [42]	^{237}Np	2,47±0,I5	PM
Allaert [44]	^{241}Pu	2,927	Values obtained from distributions of fragments by mass
Zhuravlev [34]	^{243}Cm	3,39±0,I4 (3,39±0,I4)**	$\bar{\nu}_p^{sp}(^{252}Cf)=2,407$
Zhuravlev [34]	^{247}Cm	3,79±0,I5 (3,79±0,I5)	$\bar{\nu}_p^{T}(^{235}U)=2,407$
Unik et al. [40]	^{249}Cf	4,4	PM
Unik et al. [40]	^{251}Cf	4,0	PM
Flynn et al. [39]	^{251}Cf	4,I±0,5	PM
Unik et al. [40]	^{254}Es	4,2	PM
Unik et al. [40]	^{255}Fm	4,0	PM
Flynn et al. [39]	^{255}Fm	4,0±0,5	PM

* Measurements made using the radiochemical method.

** The brackets contain the values of $\bar{\nu}_p$, renormalized according to the standard which is given in Table 2.

Table 5. Weighted means of $\bar{\nu}_p$ for thermal-neutron-induced fission [1]

Nucleus	Weighted mean for $\bar{\nu}_p$
^{229}Th	2,08±0,02
^{232}U	3,132±0,060
^{238}Pu	2,889±0,023
^{241}Am	3,121±0,023
^{242m}Am	3,257±0,023
^{243}Cm	3,426±0,047
	3,422±0,045*
^{245}Cm	3,825±0,032
^{247}Cm	3,79±0,15**
^{249}Cf	4,08±0,04

* Value obtained taking into account the results of Zhuravlev et al. [34].

** Only one value from the work of Zhuravlev et al. [34].

Table 6.
Results of measurements of $\bar{\nu}_p$ for ^{230}Th [45] relative to the standard $\bar{\nu}_p^{sp}$ (^{252}Cf)=3,738

Neutron energy, MeV	$\bar{\nu}_p$	
	Experimental	Normalized
0,715±0,015	2,027±0,032	2,036±0,032
1,100±0,017	2,089±0,042	2,099±0,042
1,350±0,050	2,095±0,031	2,105±0,031
1,650±0,050	2,123±0,031	2,133±0,031
1,900±0,050	2,147±0,029	2,157±0,029

Table 7.
Results of measurements of $\bar{\nu}_p$ for ^{232}Th

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[47], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,745$		
I,350±0,050	2,I26±0,058	2,I32±0,058
I,500±0,050	2,I4I±0,03I	2,I47±0,03I
I,625±0,050	2,I74±0,026	2,I80±0,026
I,700±0,050	2,II6±0,026	2,I22±0,026
I,800±0,050	2,II3±0,027	2,II9±0,027
I,9I3±0,050	2,I7I±0,030	2,I77±0,030
2,I00±0,050	2,208±0,034	2,2I4±0,034
I6,000±0,050	4,045±0,077	4,056±0,077
[48], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,733$		
I,350	2,I94±0,022	2,207±0,022
I,500	2,208±0,0I9	2,22I±0,0I9
I,600	2,I42±0,022	2,I55±0,022
I,700	2,I45±0,020	2,I58±0,020
I,800	2,I55±0,024	2,I68±0,024
I,900	2,I69±0,020	2,I82±0,020
2,000	2,2I5±0,0I5	2,228±0,0I5
2,I00	2,202±0,0I9	2,2I5±0,0I9
2,I50	2,224±0,022	2,237±0,022
2,200	2,2I3±0,024	2,226±0,024
2,300	2,223±0,025	2,236±0,025
2,400	2,I85±0,020	2,I98±0,020
2,500	2,226±0,03I	2,239±0,03I
2,600	2,232±0,026	2,245±0,026
2,700	2,234±0,024	2,247±0,024
2,800	2,200±0,027	2,2I3±0,027
2,900	2,232±0,027	2,245±0,027
3,000	2,233±0,025	2,246±0,025
3,I00	2,274±0,02I	2,287±0,02I
3,200	2,276±0,0I9	2,289±0,0I9
3,300	2,270±0,030	2,283±0,030
3,400	2,328±0,022	2,342±0,022
3,500	2,3I6±0,027	2,330±0,027
3,600	2,3I0±0,026	2,324±0,026
3,700	2,387±0,044	2,40I±0,044
5,600	2,683±0,030	2,699±0,030
5,900	2,689±0,022	2,705±0,022
6,350	2,887±0,026	2,904±0,026

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[64], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,732$		
2,37±0,02	2,I46±0,0I2	2,I59±0,0I2
2,59±0,08	2,I84±0,02I	2,I98±0,02I
2,93±0,02	2,2I5±0,0I5	2,229±0,0I5
3,39±0,06	2,236±0,0I4	2,250±0,0I4
3,9I±0,06	2,289±0,0I5	2,303±0,0I5
4,43±0,05	2,369±0,0I5	2,384±0,0I5
4,49±0,I2	2,338±0,020	2,352±0,020
4,95±0,05	2,440±0,0I5	2,455±0,0I5
5,I3±0,09	2,490±0,0I7	2,505±0,0I7
5,47±0,05	2,5I9±0,0I8	2,535±0,0I8
5,72±0,07	2,547±0,023	2,563±0,023
5,98±0,04	2,623±0,020	2,639±0,020
6,27±0,06	2,776±0,0I4	2,793±0,0I4
6,49±0,04	2,849±0,0I8	2,867±0,0I8
6,82±0,05	2,776±0,024	2,793±0,024
7,00±0,04	2,984±0,02I	3,002±0,02I
7,5I±0,04	3,035±0,023	3,054±0,023
6,90±0,20	3,0I5±0,0II	3,034±0,0II
7,35±0,25	3,066±0,0I4	3,085±0,0I4
7,88±0,22	3,055±0,0I3	3,074±0,0I3
8,39±0,20	3,II5±0,0I2	3,I34±0,0I2
8,90±0,I8	3,I50±0,0I4	3,I69±0,0I4
9,40±0,I7	3,2II±0,0I6	3,23I±0,0I6
9,90±0,I6	3,278±0,0I5	3,298±0,0I5
I0,39±0,I5	3,329±0,0I7	3,350±0,0I7
I0,88±0,I4	3,44I±0,020	3,462±0,020
II,37±0,I3	3,487±0,0I6	3,509±0,0I6
II,86±0,I6	3,586±0,02I	3,608±0,02I
I2,34±0,I2	3,623±0,0I9	3,645±0,0I9
I2,85±0,II	3,692±0,0I8	3,7I5±0,0I8
I3,3I±0,II	3,792±0,02I	3,8I5±0,02I
I3,80±0,I0	3,89I±0,020	3,9I5±0,020
I4,29±0,I0	3,978±0,026	4,003±0,026
I4,74±0,I0	4,06I±0,023	4,086±0,023

Table 8.
Results of measurements of $\bar{\nu}_p$ for ^{233}U

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
/54/, $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
0,000*	2,485±0,007	2,484±0,007
0,080**	2,469±0,014	2,468±0,014
0,325±0,048	2,482±0,012	2,481±0,012
0,400±0,044	2,484±0,014	2,483±0,014
0,500±0,045	2,518±0,015	2,517±0,015
0,600±0,043	2,531±0,014	2,530±0,014
0,700±0,041	2,552±0,012	2,551±0,012
0,800±0,036	2,546±0,016	2,545±0,016
0,900±0,042	2,556±0,015	2,555±0,015
1,000±0,038	2,594±0,015	2,593±0,015
1,100±0,037	2,605±0,014	2,604±0,014
1,200±0,030	2,604±0,014	2,603±0,014
1,300±0,030	2,612±0,015	2,611±0,015
1,400±0,029	2,633±0,020	2,632±0,020
/55/, $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
0,000	2,489±0,008	2,488±0,008
0,700±0,055	2,556±0,032	2,555±0,032
0,900±0,059	2,553±0,016	2,552±0,016
1,000±0,064	2,520±0,024	2,519±0,024
1,200±0,060	2,602±0,018	2,601±0,018
1,400±0,061	2,599±0,016	2,598±0,016
1,500±0,059	2,600±0,014	2,599±0,014
1,600±0,060	2,635±0,013	2,634±0,013
1,700±0,057	2,663±0,018	2,662±0,018
1,800±0,060	2,669±0,026	2,668±0,026
1,900±0,054	2,658±0,013	2,657±0,013
2,000±0,053	2,696±0,025	2,695±0,025
2,100±0,053	2,719±0,015	2,718±0,015
2,200±0,055	2,723±0,023	2,722±0,023
2,300±0,050	2,717±0,020	2,716±0,020
2,400±0,051	2,757±0,019	2,756±0,019
2,500±0,048	2,765±0,013	2,764±0,013
2,600±0,046	2,760±0,018	2,759±0,018
2,700±0,047	2,736±0,015	2,735±0,015
2,900±0,059	2,773±0,023	2,772±0,023
3,100±0,057	2,868±0,022	2,867±0,022
3,300±0,055	2,895±0,015	2,894±0,015
3,780±0,250	2,989±0,017	2,988±0,017
4,170±0,200	3,054±0,015	3,053±0,015
4,610±0,160	3,114±0,015	3,113±0,015
4,890±0,140	3,146±0,017	3,145±0,017
/56/***, $\bar{\nu}_p^{sp}(^{252}Cf)$ = 1		
0,5200-1,0520	0,6579±0,0033	2,470±0,012
1,0520-5,0930	0,6593±0,0019	2,476±0,007
5,0930-10,140	0,6652±0,0027	2,498±0,010
10,140-51,120	0,6629±0,0017	2,489±0,006
51,120-102,80	0,6657±0,0023	2,500±0,009
102,80-207,80	0,6682±0,0019	2,509±0,007
207,80-303,40	0,6700±0,0021	2,516±0,008
303,40-420,60	0,6765±0,0022	2,540±0,008
420,60-529,90	0,6715±0,0024	2,521±0,009
529,90-621,40	0,6781±0,0032	2,546±0,012
621,40-738,70	0,6849±0,0034	2,572±0,013
738,70-854,40	0,6970±0,0047	2,617±0,018
854,40-968,20	0,6978±0,0066	2,620±0,025
968,20-1054,0	0,6929±0,0091	2,602±0,034
1054,0-2164,0	0,7067±0,0030	2,654±0,011
2164,0-3262,0	0,7477±0,0050	2,808±0,019
3262,0-4536,0	0,8044±0,0067	3,021±0,025
4536,0-6732,0	0,8847±0,0059	3,322±0,022
6732,0-9625,0	1,0032±0,0064	3,767±0,024
9625,0-12731,0	1,1400±0,0100	4,281±0,038

* Data for E = 0 obtained for 0.3 MeV neutrons slowed down in a polyethylene block.

** The proton energy was given 2 keV higher than the T(p,n) reaction threshold.

*** The data are preliminary, the neutron energy is given in kiloelectronvolts.

Table 9.

Results of measurements of $\bar{\nu}_p$ for ^{235}U

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[57], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,756$		
0,I98	2,469±0,027	2,468±0,027
0,2I2	2,435±0,026	2,434±0,026
0,235	2,422±0,026	2,42I±0,026
0,262	2,392±0,026	2,39I±0,026
0,282	2,468±0,027	2,467±0,027
0,305	2,475±0,027	2,474±0,027
0,332	2,404±0,026	2,403±0,026
0,363	2,486±0,027	2,485±0,027
0,385	2,47I±0,027	2,470±0,027
0,399	2,468±0,027	2,467±0,027
0,4I4	2,494±0,027	2,493±0,027
0,430	2,520±0,027	2,5I9±0,027
0,447	2,442±0,026	2,44I±0,026
0,465	2,4I2±0,026	2,4II±0,026
0,484	2,454±0,026	2,453±0,026
0,504	2,4I8±0,026	2,4I7±0,026
0,525	2,492±0,027	2,49I±0,027
0,557	2,5II±0,030	2,5I0±0,030
0,579	2,5I3±0,032	2,5I2±0,032
0,606	2,494±0,03I	2,493±0,03I
0,620	2,475±0,03I	2,474±0,03I
0,634	2,490±0,03I	2,489±0,03I
0,649	2,436±0,03I	2,435±0,03I
0,673	2,476±0,03I	2,475±0,03I
0,706	2,476±0,03I	2,475±0,03I
0,733	2,469±0,03I	2,468±0,03I
0,77I	2,477±0,03I	2,476±0,03I
0,79I	2,474±0,03I	2,473±0,03I
0,823	2,50I±0,03I	2,500±0,03I
0,856	2,477±0,03I	2,476±0,03I
0,880	2,479±0,03I	2,478±0,03I
0,9I7	2,484±0,03I	2,483±0,03I
0,957	2,520±0,032	2,5I9±0,032
0,985	2,484±0,03I	2,483±0,03I
[60,63], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,782$		
I,87 ±0,I50	2,666±0,030	2,647±0,030
2,45 ± 0,I25	2,750±0,037	2,730±0,037
2,96 ± 0,I05	2,772±0,037	2,752±0,037
3,50 ± 0,I00	2,876±0,040	2,856±0,040
4,03 ± 0,090	2,957±0,037	2,936±0,037
4,54 ± 0,080	3,044±0,046	3,022±0,046
5,06 ± 0,070	3,I46±0,048	3,I24±0,048
5,8I ± 0,2I0	3,226±0,044	3,203±0,044
6,97 ± 0,I70	3,487±0,030	3,462±0,030
7,48 ± 0,I60	3,542±0,040	3,5I7±0,040
7,99 ± 0,I45	3,637±0,040	3,6II±0,040
8,49 ± 0,I30	3,646±0,032	3,620±0,032
9,00 ± 0,I20	3,766±0,03I	3,739±0,03I
9,49 ± 0,II0	3,8I2±0,0I7	3,785±0,0I7
9,98 ± 0,I00	3,880±0,0I2	3,852±0,0I2
[60,63], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,782$		
I0,47 ± 0,095	3,932±0,0I8	3,899±0,0I8
I0,96 ± 0,090	3,974±0,0I8	3,946±0,0I8
II,44 ± 0,085	4,077±0,0I7	4,048±0,0I7
II,93 ± 0,080	4,I39±0,02I	4,II0±0,02I
I2,88 ± 0,080	4,259±0,022	4,229±0,022
I3,84 ± 0,075	4,407±0,020	4,376±0,020
I4,79 ± 0,070	4,504±0,022	4,472±0,022
[70], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,782$		
22,79 ± 0,I40	5,493±0,049	5,454±0,049
23,94 ± 0,II5	5,634±0,054	5,594±0,054
25,05 ± 0,I05	5,672±0,054	5,632±0,054
26,I5 ± 0,090	5,766±0,042	5,725±0,042
27,22 ± 0,080	5,960±0,062	5,9I7±0,062
28,28 ± 0,075	6,080±0,090	6,037±0,090
[65,68,69], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,745$		
Тепловые	2,389±0,004	2,395±0,004
0,II0±0,070	2,39I±0,0I9	2,397±0,0I9
0,220±0,033	2,4I8±0,0I3	2,425±0,0I3
0,300±0,032	2,42I±0,0I6	2,428±0,0I6
0,350±0,032	2,429±0,0I4	2,436±0,0I4
0,400±0,032	2,4I2±0,0I4	2,4I8±0,0I4
0,425±0,025	2,429±0,009	2,436±0,009
0,450±0,029	2,429±0,0I2	2,436±0,0I2
0,485±0,025	2,447±0,008	2,454±0,008
0,540±0,032	2,429±0,0II	2,436±0,0II
0,600±0,032	2,447±0,0I2	2,454±0,0I2
0,700±0,032	2,465±0,0I2	2,472±0,0I2
I,000±0,032	2,509±0,0I7	2,5I6±0,0I7
I,500±0,050	2,56I±0,0I4	2,568±0,0I4
I,900±0,050	2,596±0,0I4	2,603±0,0I4
[62,63,67], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,745$		
0,2I0±0,0I0	2,384±0,054	2,390±0,054
0,230±0,0I0	2,400±0,04I	2,406±0,04I
0,250±0,0I0	2,4I7±0,037	2,424±0,037
0,270±0,0I0	2,445±0,03I	2,452±0,03I
0,290±0,0I0	2,4I4±0,029	2,420±0,029
0,3I0±0,0I0	2,423±0,026	2,430±0,026
0,330±0,0I0	2,399±0,024	2,405±0,024
0,350±0,0I0	2,469±0,024	2,476±0,024
0,370±0,0I0	2,426±0,023	2,433±0,023
0,390±0,0I0	2,43I±0,023	2,438±0,023
0,4I0±0,0I0	2,485±0,02I	2,492±0,02I
0,430±0,0I0	2,449±0,02I	2,456±0,02I
0,450±0,0I0	2,429±0,0I8	2,436±0,0I8
0,470±0,0I0	2,4I0±0,0I8	2,4I6±0,0I8
0,490±0,0I0	2,453±0,0I6	2,460±0,0I6
0,5I0±0,0I0	2,449±0,0I6	2,456±0,0I6

Table 9 (continued)

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[62,63,67], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,745$		
0,530±0,0I0	2,467±0,0I6	2,474±0,0I6
0,550±0,0I0	2,426±0,0I5	2,433±0,0I5
0,570±0,0I0	2,44I±0,0I4	2,448±0,0I4
0,590±0,0I0	2,426±0,0I4	2,433±0,0I4
0,6I0±0,0I0	2,446±0,0I7	2,453±0,0I7
0,630±0,0I0	2,445±0,0I6	2,452±0,0I6
0,650±0,0I0	2,463±0,0I7	2,470±0,0I7
0,670±0,0I0	2,452±0,0I7	2,459±0,0I7
0,690±0,0I0	2,445±0,020	2,452±0,020
0,725±0,025	2,448±0,0I3	2,455±0,0I3
0,775±0,025	2,474±0,0I4	2,48I±0,0I4
0,825±0,025	2,486±0,0I5	2,493±0,0I5
0,875±0,025	2,499±0,0I7	2,506±0,0I7
0,925±0,025	2,50I±0,0I7	2,508±0,0I7
0,975±0,025	2,506±0,0I9	2,5I3±0,0I9
I,025±0,025	2,499±0,023	2,506±0,023
I,075±0,025	2,530±0,024	2,537±0,024
I,I25±0,025	2,530±0,028	2,537±0,028
I,I75±0,025	2,528±0,029	2,535±0,029
I,225±0,025	2,530±0,030	2,537±0,030
I,275±0,025	2,588±0,040	2,595±0,040
I,325±0,025	2,5I0±0,040	2,5I7±0,040
I,360±0,I65	2,5I7±0,0I7	2,524±0,0I7
I,375±0,I25	2,534±0,032	2,54I±0,032
I,870±0,I50	2,582±0,023	2,589±0,023
[31], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,756$		
0,88	2,499±0,040	2,498±0,040
0,95	2,48I±0,040	2,480±0,040
0,99	2,478±0,040	2,477±0,040
I,06	2,5I0±0,040	2,509±0,040
I,I9	2,555±0,040	2,554±0,040
I,4I	2,6II±0,040	2,6I0±0,040
I,73	2,637±0,040	2,636±0,040
I,8I	2,63I±0,040	2,630±0,040
2,05	2,659±0,038	2,658±0,038
2,24	2,683±0,035	2,682±0,035
2,42	2,7I6±0,035	2,7I5±0,035
3,00	2,8I7±0,035	2,8I6±0,035
4,40	2,984±0,060	2,983±0,060
4,68	3,02I±0,065	3,020±0,065
5,73	3,256±0,080	3,255±0,080
[65]*, $\bar{\nu}_p^{sp}(^{252}Cf) = 3,756$		
0,225±0,0I0	2,476± 0,9	2,475±0,034
0,27I±0,0I2	2,457± I,0	2,456±0,038
0,323±0,0I8	2,469± 0,7	2,468±0,026
0,364±0,0I8	2,496± I,2	2,495±0,045
0,429±0,0I7-	2,477±0,70	2,476±0,026
0,463±0,022	2,488±I,I0	2,487±0,04I
0,522±0,0I6	2,5I6±0,90	2,5I5±0,034
0,6I6±0,022	2,456±0,70	2,455±0,026

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[65]*, $\bar{\nu}_p^{sp}(^{252}Cf) = 3,756$		
0,673±0,022	2,487± 0,70	2,486±0,026
0,723±0,024	2,452± 0,70	2,45I±0,026
0,782±0,022	2,5I0± I,00	2,509±0,038
0,832±0,020	2,5I7± I,00	2,5I6±0,038
0,887±0,023	2,5I6± I,00	2,5I5±0,038
0,930±0,025	2,475± I,00	2,474±0,038
0,983±0,027	2,489± I,00	2,488±0,038
I,046±0,035	2,509± 0,70	2,508±0,026
I,097±0,026	2,536± I,I0	2,535±0,04I
I,I48±0,026	2,530± I,I0	2,529±0,04I
I,I99±0,034	2,567± I,I0	2,566±0,04I
I,265±0,030	2,540± I,I0	2,539±0,04I
I,323±0,040	2,548± I,00	2,547±0,038
I,363±0,035	2,53I± I,I0	2,530±0,04I
[41]**		
0,050÷0,I00	0,6339±0,0037	2,380±0,0I4
0,I00÷0,200	0,63I0±0,0067	2,369±0,025
0,200÷0,300	0,634I±0,0073	2,38I±0,027
0,300÷0,400	0,6345±0,0058	2,383±0,022
0,400÷0,500	0,64I0±0,0048	2,407±0,0I8
0,5I0÷0,6I0	0,6435±0,0053	2,4I6±0,020
0,6I0÷0,7I0	0,6458±0,0072	2,425±0,027
0,7I0÷0,800	0,6346±0,0063	2,383±0,026
0,800÷0,900	0,63I4±0,0073	2,37I±0,027
0,900÷I,000	0,6295±0,0070	2,364±0,026
I,000÷2,000	0,6440±0,0043	2,4I8±0,0I6
2,000÷3,000	0,6439±0,0055	2,4I8±0,02I
3,000÷4,000	0,6442±0,0I37	2,4I9±0,05I
4,000÷5,000	0,6220±0,0I43	2,336±0,054
5,000÷6,000	0,6400±0,0I28	2,403±0,048
6,000÷7,000	0,6380±0,0I09	2,396±0,04I
7,000÷8,000	0,6262±0,0I9I	2,35I±0,072
8,000÷9,000	0,6537±0,0I65	2,455±0,062
9,00÷I0,000	0,6465±0,0I25	2,428±0,047
I0.00÷20,000	0,6406±0,0I39	2,405±0,052
20,00÷30,000	0,6367±0,0I89	2,39I±0,07I
30,00÷40,000	0,6443±0,0I27	2,4I0±0,048
40,00÷50.000	0,647I±0,0099	2,430±0,037
50,00÷60,000	0,6529±0,0097	2,452±0,036
60,00÷74,000	0,6488±0,0II7	2,436±0,044
74,00÷85,000	0,65I8±0,0I8I	2,448±0,068
85,00÷94.000	0,6735±0,0I65	2,529±0,062
94,00÷I00,00	0,6635±0,0I28	2,49I±0,048
I00,00÷200,00	0,6632±0,0072	2,490±0,027
200,00÷300,00	0,6684±0,0060	2,5I0±0,023
300,00÷400,00	0,6738±0,0094	2,530±0,035
400,00÷500,00	0,6753±0,0094	2,536±0,035
500,00÷600,00	0,6752±0,0083	2,535±0,03I
600,00÷7I0,00	0,673I±0,0085	2,527±0,032
7I0,00÷800,00	0,67I7±0,0I2I	2,522±0,045
800,00÷920,00	0,6933±0,0I48	2,603±0,056

Table 9 (continued)

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[4I]**		
920,00-I000,0	0,6863±0,0097	2,577±0,036
I000,00-2I00,0	0,6972±0,0I75	2,6I8±0,066
2I00,00-3I00,0	0,7373±0,0225	2,769±0,084
3I00,00-4I00,0	0,7845±0,0II5	2,946±0,043
4I00,00-5I00,0	0,796I±0,0376	2,989±0,I4I
5I00,00-6400,0	0,8775±0,0230	3,295±0,086
6400,00-7200,0	0,9I95±0,0266	3,453±0,I000
0,005-0,0I0***	0,6470±0,00I4	2,429±0,0053
0,0I0-0,020	0,643I±0,0009	2,4I5±0,0034
0,020-0,030	0,6426±0,0009	2,4I3±0,0034
0,030-0,040	0,6444±0,0009	2,420±0,0034
0,040-0,050	0,6455±0,00I0	2,424±0,0038
0,050-0,060	0,6423±0,00II	2,4I2±0,004I
0,060-0,070	0,6464±0,00I3	2,427±0,0046
0,070-0,080	0,6467±0,00I5	2,428±0,0056
0,080-0,090	0,6454±0,00I6	2,423±0,0060
0,090-0,I00	0,6395±0,00I8	2,40I±0,0068
0,I00-0,I20	0,64I9±0,00I6	2,4I0±0,0060
0,I20-0,I40	0,6447±0,00I9	2,42I±0,007I
0,I40-0,I60	0,6383±0,0023	2,397±0,0086
0,I60-0,I80	0,6429±0,0025	2,4I4±0,0094
0,I80-0,200	0,648I±0,0027	2,434±0,0I0I
0,200-0,220	0,6450±0,0029	2,422±0,0I09
0,220-0,240	0,6460±0,0030	2,426±0,0II3
0,240-0,260	0,6453±0,0030	2,423±0,0II3
0,260-0,280	0,643I±0,0030	2,4I5±0,0II3
0,280-0,300	0,64I8±0,003I	2,4I0±0,0II6
0,300-0,350	0,6455±0,0024	2,424±0,0090
0,350-0,400	0,64I0±0,0029	2,407±0,0I09
0,400-0,500	0,6420±0,0027	2,4II±0,0I0I
0,500-0,700	0,6466±0,0027	2,428±0,0I0I
0,700-I,000	0,65I6±0,0028	2,447±0,0I05
I,000-I,800	0,64I4±0,0026	2,408±0,0098
I,800-7,400	0,6452±0,0024	2,423±0,0090
7,400-I0,000	0,643I±0,0024	2,4I5±0,0090
I0,000-I5,000	0,76I0±0,00I2	2,858±0,0045
I5,000-20,500	0,7598±0,0024	2,853±0,0090
20,500-33,000	0,7609±0,0023	2,857±0,0086
33,000-4I,000	0,7604±0,0065	2,855±0,0244
4I,000-60,000	0,7632±0,002I	2,866±0,0079
[7I], $\bar{\nu}_p^{sp}(^{252}Cf)$ = I,0		
0,0005-0,00II	0,6398±0,0030	2,4024±0,0II
0,00II-0,005I	0,6395±0,00I2	2,40I3±0,0045
0,005I-0,0I0I	0,64I7±0,00I7	2,4096±0,0064
0,0I0I-0,05I6	0,64I2±0,0023	2,4077±0,0086
[7I], $\bar{\nu}_p^{sp}(^{252}Cf)$ = I,0		
0,05I6-0,I04I	0,6384±0,0032	2,3972±0,0I2
0,I04I-0,2II6	0,6472±0,00I7	2,4202±0,0064
0,2II6-0,3I77	0,657I±0,0029	2,4674±0,0II
0,3I77-0,420I	0,650I±0,0023	2,44II±0,0086
0,420I-0,5293	0,6557±0,0027	2,4622±0,0I0I
0,5293-0,6206	0,66I6±0,0034	2,4843±0,0I28
0,6206-0,7379	0,662I±0,005I	2,4862±0,0I92
0,7379-0,8574	0,6668±0,0052	2,5038±0,0I95
0,8574-0,9672	0,67I4±0,0III	2,52II±0,04I7
0,9672-I,0525	0,6579±0,0087	2,4704±0,0327
I,0525-2,I628	0,6876±0,003I	2,58I9±0,0II6
2,I628-3,2637	0,7244±0,0045	2,720I±0,0I69
3,2637-4,5430	0,7670±0,0058	2,880I±0,02I8
4,5430-6,0730	0,8345±0,0069	3,I335±0,0259
6,0730-8,5330	0,9263±0,0060	3,4783±0,0225
8,5330-II,II5	I,0II6±0,008I	3,7986±0,0304
[64], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,732		
I,I4±0,24	2,475±0,0I8	2,490±0,0I8
I,73±0,I9	2,557±0,0I7	2,573±0,0I7
2,30±0,I6	2,6I0±0,0I9	2,626±0,0I9
2,85±0,I4	2,685±0,0I9	2,702±0,0I9
3,38±0,I3	2,75I±0,02I	2,768±0,02I
3,9I±0,I2	2,8I6±0,022	2,833±0,022
4,43±0,II	2,9I9±0,022	2,937±0,022
4,95±0,I0	2,98I±0,023	2,999±0,023
5,47±0,09	3,084±0,023	3,I03±0,023
5,99±0,09	3,I70±0,023	3,I90±0,023
6,50±0,08	3,278±0,025	3,298±0,025
6,03±0,34	3,I78±0,02I	3,I93±0,02I
6,6I±0,29	3,3II±0,02I	3,33I±0,02I
7,I7±0,25	3,387±0,0I9	3,408±0,0I9
7,7I±0,23	3,460±0,020	3,48I±0,020
8,23±0,2I	3,537±0,02I	3,559±0,02I
8,75±0,I9	3,609±0,023	3,63I±0,023
9,26±0,I7	3,68I±0,022	3,704±0,022
9,77±0,I6	3,768±0,025	3,79I±0,025
I0,27±0,I5	3,843±0,026	3,867±0,026
I0,76±0,I4	3,903±0,029	3,927±0,029
II,26±0,I4	3,993±0,029	4,0I8±0,029
II,75±0,I3	4,068±0,035	4,093±0,035
I2,24±0,I2	4,II2±0,030	4,I37±0,030
I2,72±0,I2	4,2I5±0,03I	4,24I±0,03I
I3,2I±0,II	4,279±0,027	4,305±0,027
I3,69±0,II	4,365±0,036	4,392±0,036
I4,I8±0,I0	4,408±0,032	4,435±0,032
I4,66±0,I0	4,459±0,040	4,487±0,040

* The statistical error for the experimental value of $\bar{\nu}$ is given as a percentage.

** The neutron energy is given in kiloelectronvolts. The total error of $\bar{\nu}_p$ is given. The results are preliminary.

*** From here until the end of the data of Gwin et al. [41], the neutron energy is given in electronvolts.

Table 10.
Results of measurements of $\bar{\nu}_p$ for ^{236}U $[\bar{\nu}_p^{sp}(^{252}Cf) = 3,733]$ /50/

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized	Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
0,800	2,451±0,029	2,465±0,029	2,250	2,611±0,016	2,626±0,016
0,850	2,446±0,027	2,460±0,027	2,300	2,604±0,015	2,619±0,015
0,900	2,434±0,022	2,448±0,022	2,400	2,588±0,015	2,603±0,015
0,950	2,430±0,023	2,444±0,023	2,500	2,626±0,029	2,641±0,029
1,000	2,465±0,033	2,480+0,033	2,600	2,684±0,028	2,700±0,028
1,100	2,472±0,022	2,487±0,022	2,700	2,667±0,023	2,683±0,023
1,200	2,501±0,017	2,516±0,017	2,800	2,669±0,032	2,685±0,032
1,300	2,469±0,030	2,484±0,030	2,900	2,678±0,024	2,694±0,024
1,350	2,476±0,031	2,491±0,031	3,000	2,690±0,013	2,706±0,013
1,400	2,480±0,015	2,495±0,015	3,100	2,704±0,023	2,720±0,023
1,500	2,514±0,020	2,529±0,020	3,200	2,727±0,016	2,743±0,016
1,600	2,515±0,017	2,530±0,017	3,300	2,732±0,021	2,748±0,021
1,700	2,518±0,023	2,533±0,023	3,400	2,780±0,022	2,796±0,022
1,800	2,556±0,026	2,571±0,026	3,500	2,772±0,015	2,788±0,015
1,900	2,549±0,012	2,564±0,012	3,600	2,775±0,022	2,791±0,022
2,000	2,545±0,035	2,560±0,035	3,700	2,819±0,019	2,836±0,019
2,100	2,575±0,033	2,590±0,033	5,050	3,007±0,016	3,025±0,016
2,200	2,558±0,024	2,573±0,024	5,600	3,167±0,026	3,186±0,026
			5,900	3,154±0,042	3,173±0,042

Table 11.

Results of measurements of $\bar{\nu}_p$ for ^{238}U

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[55], $\bar{\nu}_p^{sp}(^{252}Cf)$ =3,756		
I,200±0,060	2,545±0,032	2,544±0,032
I,300±0,056	2,450±0,032	2,449±0,032
I,400±0,06I	2,48I±0,027	2,480±0,027
I,500±0,059	2,533±0,0I2	2,532±0,0I2
I,600±0,060	2,557±0,0I0	2,556±0,0I0
I,700±0,057	2,555±0,009	2,554±0,009
I,800±0,060	2,59I±0,0I6	2,590±0,0I6
I,900±0,054	2,610±0,0I4	2,609±0,0I4
2,000±0,053	2,60I±0,023	2,600±0,023
2,I00±0,053	2,625±0,0I5	2,624±0,0I5
2,200±0,055	2,606±0,0I6	2,605±0,0I6
2,300±0,050	2,639±0,0I2	2,638±0,0I2
2,400±0,05I	2,65I±0,0I2	2,650±0,0I2
2,500±0,048	2,652±0,0I6	2,65I±0,0I6
2,600±0,046	2,696±0,0I3	2,695±0,0I3
2,700±0,047	2,699±0,0I2	2,696±0,0I2
2,900±0,059	2,738±0,0I4	2,737±0,0I4
3,I00±0,057	2,766±0,009	2,765±0,009
3,300±0,055	2,774±0,0I6	2,773±0,0I6
3,720±0,250	2,828±0,025	2,827±0,025
4,I70±0,200	2,92I±0,026	2,920±0,026
4,610±0,I60	2,984±0,026	2,983±0,026
4,890±0,I40	3,063±0,023	3,062±0,023
[76,77], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,733		
I,30±0,05	2,43I±0,045	2,445±0,045
I,40±0,05	2,458±0,042	2,473±0,042
I,50±0,04	2,473±0,02I	2,488±0,02I
I,60±0,04	2,533±0,0I9	2,548±0,0I9
I,70±0,04	2,5I0±0,030	2,525±0,030
I,75±0,06	2,6I0±0,0I4	2,625±0,0I4
I,80±0,04	2,537±0,0I9	2,552±0,0I9
I,90±0,04	2,547±0,0I9	2,562±0,0I9
2,00±0,04	2,565±0,0I5	2,580±0,0I5
2,I0±0,04	2,6I3±0,026	2,628±0,026
2,20±0,03	2,625±0,0I9	2,64I±0,0I9
2,30±0,03	2,655±0,0I5	2,67I±0,0I5
2,40±0,03	2,587±0,0I5	2,602±0,0I5
2,50±0,03	2,632±0,0I5	2,648±0,0I5
2,60±0,03	2,638±0,0I9	2,654±0,0I9
2,70±0,03	2,66I±0,023	2,677±0,023
2,80±0,03	2,687±0,0II	2,703±0,0II
2,90±0,04	2,693±0,0I5	2,709±0,0I5
3,00±0,04	2,683±0,0I5	2,699±0,0I5
3,I0±0,04	2,693±0,023	2,709±0,023
3,20±0,04	2,735±0,0I5	2,75I±0,0I5
3,30±0,04	2,765±0,0I5	2,78I±0,0I5
3,40±0,03	2,745±0,0I9	2,76I±0,0I9
3,50±0,03	2,735±0,0I5	2,75I±0,0I5
3,60±0,03	2,803±0,023	2,820±0,023
3,70±0,03	2,790±0,0I9	2,806±0,0I9
5,58±0,08	3,I5I±0,054	3,I70±0,054
5,89±0,07	3,2I9±0,022	3,238±0,022
[78], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,732		
I,36±0,I65	2,5I2±0,030	2,527±0,030
I,37±0,I50	2,556±0,030	2,572±0,030
2,33±0,I00	2,583±0,030	2,599±0,030
2,45±0,I25	2,600±0,030	2,6I6±0,030
2,98±0,I05	2,637±0,023	2,653±0,023
3,50±0,I00	2,756±0,029	2,773±0,029
3,93±0,075	2,84I±0,027	2,859±0,027
4,03±0,090	2,840±0,023	2,858±0,023
4,43±0,090	2,909±0,030	2,927±0,030
4,54±0,080	2,9I6±0,027	2,934±0,027
4,94±0,085	3,0I6±0,030	3,035±0,030
5,06±0,070	3,035±0,024	3,054±0,024
5,57±0,070	3,094±0,035	3,II3±0,035
5,98±0,075	3,2II±0,039	3,23I±0,039
6,08±0,065	3,I87±0,034	3,207±0,034
6,97±0,I70	3,355±0,025	3,376±0,025
7,09±0,065	3,353±0,032	3,374±0,032
7,48±0,I65	3,392±0,022	3,4I3±0,022
7,93±0,I45	3,476±0,02I	3,497±0,02I
8,49±0,I30	3,547±0,022	3,569±0,022
9,00±0,I20	3,645±0,022	3,667±0,022
9,49±0,II0	3,698±0,024	3,72I±0,024
9,74±0,II0	3,742±0,026	3,765±0,026
9,98±0,I00	3,8I4±0,020	3,838±0,020
I0,47±0,095	3,83I±0,024	3,855±0,024
I0,96±0,090	3,927±0,022	3,95I±0,022
II,44±0,085	4,000±0,025	4,025±0,025
II,93±0,080	4,094±0,024	4,II9±0,024
I2,4I±0,080	4,I48±0,024	4,I74±0,024
I2,88±0,080	4,205±0,026	4,23I±0,026
I3,36±0,075	4,29I±0,027	4.3I7±0,027
I3,84±0,075	4,393±0,025	4,420±0,025
I4,3I±0,070	4,443±0,026	4,470±0,026
I4.79±0,070	4,445±0,025	4,472±0,025
[70], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,782		
22,79±0,I40	5,5I3±0,043	5,474±0,043
23,94±0,II5	5,702±0,045	5,66I±0,045
25,05±0,I05	5,755±0,046	5,7I4±0,046
26,I5±0,090	5,823±0,038	5,78I±0,038
27,22±0,080	6,099±0,05I	6,055±0,05I
28,28±0,075	6,I37±0,067	6,093±0,067

Table 12.
Results of measurements of $\bar{\nu}_p$ for ^{237}Np

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[37], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,733$		
I,000±0,II0	2,7I8±0,063	2,734±0,063
2,000±0,080	2,934±0,064	2,95I±0,064
3,000±0,060	3,037±0,064	3,055±0,064
6,000±0,I30	3,495±0,063	3,5I6±0,063
7,500±0,090	3,856±0,067	3,879±0,067
I4,700±0,I50	4,785±0,085	4,8I3±0,085
[85], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,732$		
I,I43±0,240	2,706±0,02I	2,723±0,02I
I,734±0,I94	2,759±0,020	2,776±0,020
2,299±0,I63	2,842±0,022	2,860±0,022
2,846±0,I43	2,932±0,022	2,950±0,022
3,382±0,I28	3,0I5±0,025	3,034±0,025
3,9I2±0,II5	3,084±0,024	3,I03±0,024
4,435±0,I06	3,I93±0,025	3,2I3±0,025
4,952±0,I02	3,272±0,025	3,293±0,025
5,472±0,093	3,368±0,025	3,389±0,025
5,990±0,085	3,437±0,025	3,458±0,025
6,502±0,080	3,536±0,028	3,558±0,028
6,030±0,335	3,45I±0,023	3,472±0,023
6,6I2±0,285	3,560±0,022	3,582±0,022
7,I67±0,250	3,62I±0,02I	3,643±0,02I
7,706±0,225	3,708±0,022	3,73I±0,02I
8,233±0,205	3,785±0,023	3,808±0,023
8,750±0,I85	3,882±0,025	3,906±0,025
9,259±0,I70	3,988±0,025	4,0I3±0,025
9,766±0,I60	4,029±0,032	4,054±0,032
I0,265±0,I50	4,I2I±0,029	4,I46±0,029
I0,762±0,I40	4,I79±0,028	4,205±0,028
II,257±0,I35	4,287±0,032	4,3I3±0,032
II,748±0,I25	4,364±0,039	4,39I±0,039
I2,237±0,I20	4,4I8±0,032	4,446±0,032
I2,724±0,II5	4,469±0,034	4,497±0,034
I3,208±0,II0	4,524±0,03I	4,552±0,03I
I3,692±0,I05	4,586±0,033	4,6I4±0,033
I4,I75±0,I00	4,655±0,037	4,684±0,037
I4,656±0,095	4,702±0,047	4,73I±0,047

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[49,84], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,733$		
0,980±0,040	2,795±0,0I2	2,8II±0,0I2
I,I70±0,040	2,8I5±0,0I9	2,832±0,0I9
I,280±0,040	2,774±0,0I4	2,790±0,0I4
I,380±0,040	2,772±0,022	2,788±0,022
I,460±0,040	2,824±0,0I6	2,84I±0,0I6
I,620±0,040	2,8I7±0,0I7	2,834±0,0I7
I,660±0,060	2,907±0,033*	2,924±0,033
I,680±0,040	2,882±0,0I5	2,899±0,0I5
I,770±0,040	2,84I±0,0I3	2,857±0,0I3
I,890±0,040	2,887±0,0I8	2,904±0,0I8
I,920±0,040	2,886±0,0I0	2,903±0,0I0
2,000±0,040	2,853±0,0I3	2,870±0,0I3
2,000±0,050	2,893±0,034**	2,9I0±0,034
2,090±0,040	2,880±0,0I7	2,897±0,0I7
2,I30±0,040	2,878±0,0I0	2,895±0,0I0
2,230±0,030	2,944±0,0I2	2,96I±0,0I2
2,3I0±0,030	2,944±0,0I8	2,96I±0,0I8
2,430±0,030	2,960±0,0I7	2,977±0,0I7
2,620±0,040	2,98I±0,0I4	2,999±0,0I4
2,640±0,050	3,0II±0,022*	3,029±0,022
2,7I0±0,030	2,990±0,0I7	3,008±0,0I7
2,790±0,050	3,003±0,0I8*	3,02I±0,0I8
2,920±0,030	3,006±0,0I7	3,024±0,0I7
3,070±0,050	3,05I±0,020*	3,069±0,020
3,090±0,030	3,065±0,0I4	3,083±0,0I4
3,2I0±0,030	3,040±0,0I6	3,058±0,0I6
3,450±0,030	3,II0±0,0I7	3,I28±0,0I7
3,520±0,030	3,084±0,022	3,I02±0,022
3,7I0±0,020	3,I66±0,0I8	3,I85±0,0I8
5,580±0,080	3,445±0,025	3,465±0,025
5,900±0,080	3,493±0,024	3,5I4±0,024

* Measurement results using a fission chamber containing one layer of neptunium.
** Measurements made using a spiral fission chamber.

Table 13.
Results of measurements of $\bar{\nu}_p$ for ^{239}Pu

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[89], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,724		
0,200±0,025	2,849±0,0I3	2,897±0,0I3
0,350±0,052	2,869±0,0I7	2,9I8±0,0I7
0,550±0,036	2,893±0,0I7	2,942±0,0I7
0,700±0,036	2,9I5±0,0I7	2,965±0,0I7
0,900±0,048	2,938±0,0I4	2,988±0,0I4
I,300±0,050	2,976±0,020	3,026±0,020
I,600±0,050	3,029±0,02I	3,080±0,02I
I,900±0,050	3,I02±0,0I9	3,I55±0,0I9
[87], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
0,000	2,884±0,0I5	2,883±0,0I5
0,080	2,888±0,026	2,887±0,026
0,400±0,057	2,9I4±0,0I7	2,9I3±0,0I7
0,550±0,058	2,955±0,029	2,954±0,029
0,700±0,058	2,96I±0,023	2,960±0,023
0,800±0,049	2,99I±0,024	2,990±0,024
0,900±0,045	2,977±0,020	2,976±0,020
I,000±0,043	3,0I5±0,029	3,0I4±0,029
I,I00±0,035	3,04I±0,0I9	3,040±0,0I9
I,I50±0,035	3,0I8±0,023	3,0I7±0,023
I,200±0,035	3,00I±0,020	3,000±0,020
I,250±0,035	3,I20±0,020	3,II9±0,020
I,300±0,043	3,085±0,029	3,084±0,029
I,400±0,042	3,II6±0,028	3,II5±0,028
I,500±0,042	3,II6±0,029	3,II5±0,029
I,600±0,042	3,II8±0,033	3,II7±0,033
[55], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
0,000	2,884±0,007	2,883±0,007
0,700±0,055	2,969±0,034	2,968±0,034
0,900±0,059	2,963±0,023	2,962±0,023
I,000±0,064	2,970±0,027	2,969±0,027
I,200±0,060	3,006±0,023	3,005±0,023
I,300±0,056	3,048±0,0I5	3,047±0,0I5
I,400±0,06I	3,065±0,0I4	3,064±0,0I4
I,500±0,059	3,058±0,0I7	3,057±0,0I7
I,600±0,060	3,085±0,0I5	3,084±0,0I5
I,700±0,057	3,I23±0,0I5	3,I22±0,0I5
I,800±0,060	3,I65±0,024	3,I64±0,024
I,900±0,054	3,I46±0,0I6	3,I45±0,0I6
2,000±0,053	3,I69±0,025	3,I68±0,025
2,I00±0,053	3,I65±0,0I7	3,I64±0,0I7
2,200±0,055	3,I74±0,025	3,I73±0,025
2,300±0,050	3,I88±0,020	3,I87±0,020
2,400±0,05I	3,I70±0,023	3,I69±0,023
2,500±0,048	3,234±0,0I5	3,233±0,0I5
2,600±0,046	3,287±0,02I	3,286±0,02I
2,700±0,047	3,302±0,0I7	3,30I±0,0I7
2,900±0,059	3,308±0,025	3,307±0,025
3,I00±0,057	3,342±0,026	3,34I±0,026
3,300±0,055	3,330±0,026	3,329±0,026
[55], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
3,780±0,250	3,432±0,0I8	3,43I±0,0I8
4,I70±0,200	3,498±0,0I8	3,497±0,0I8
4,6I0±0,I60	3,622±0,023	3,62I±0,023
4,890±0,I40	3,64I±0,023	3,640±0,023
[31], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,756		
I,06	3,030±0,046	3,029±0,046
I,8I	3,I77±0,048	3,I76±0,048
[41]*		
0,0005-0,00I	0,774±0,0I0	2,906±0,038
0,00I-0,003	0,767±0,007	2,880±0,026
0,003-0,005	0,76I±0,009	2,858±0,034
0,005-0,007	0,768±0,0I0	2,884±0,038
0,007-0,0I0	0,756±0,009	2,839±0,034
0,0I0-0,020	0,762±0,006	2,86I±0,023
0,020-0,030	0,782±0,008	2,936±0,030
0,030-0,040	0,769±0,009	2,888±0,034
0,040-0,050	0,779±0,0I0	2,925±0,038
0,050-0,060	0,76I±0,0I0	2,858±0,038
0,060-0,070	0,772±0,0II	2,899±0,04I
0,070-0,080	0,77I±0,0I2	2,895±0,045
0,080-0,090	0,76I±0,0I3	2,858±0,048
0,090-0,I00	0,755±0,0I3	2,835±0,049
0,I00-0,200	0,764±0,004	2,869±0,0I5
0,200-0,300	0,772±0,006	2,899±0,023
0,300-0,400	0,776±0,006	2,9I4±0,023
0,400-0,500	0,786±0,007	2,95I±0,026
0,500-0,600	0,782±0,007	2,936±0,026
0,600-0,700	0,787±0,007	2,955±0,026
0,700-0,800	0,806±0,008	3,027±0,030
0,800-0,900	0,796±0,009	2,989±0,034
0,900-I,000	0,796±0,009	2,989±0,034
I,000-2,000	0,8I2±0,005	3,049±0,0I9
2,000-3,000	0,856±0,008	3,2I4±0,030
3,000-4,I00	0,887±0,0I2	3,33I±0,045
4,I00-5,200	0,922±0,0I6	3,462±0,060
5,200-6,I00	0,968±0,020	3,635±0,075
6,I00-7,200	I,0II±0,02I	3,796±0,079
7,200-8,200	I,060±0,023	3,980±0,086
8,200-9,200	I,II2±0,027	4,I76±0,I0I
9,200-I0,00	I,I54±0,026	4,333±0,098
0,050-0,I00**	0,770I±0,002I	2,892±0,008
0,I00-0,200	0,7750±0,0038	2,9I0±0,0I4
0,200-0,300	0,77I6±0,0040	2,897±0,0I5
0,300-0,400	0,7650±0,0050	2,873±0,0I9
0,400-0,500	0,7668±0,0044	2,879±0,0I7
0,5I0-0,6I0	0,763I±0,0039	2,865±0,0I4
0,6I0-0,7I0	0,7585±0,0098	2,848±0,037
0,7I0-0,800	0,784I±0,0086	2,944±0,032
0,800-0,900	0,7734±0,0078	2,904±0,029

Table 13 (continued)

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
	[4I]*	
0,900-I,000	0,7662±0,007I	2,877±0,027
I,000-2,000	0,7690±0,0035	2,888±0,0I3
2,000-3,000	0,7848±0,0II0	2,947±0,04I
3,000-4,000	0,7676±0,0080	2,882±0,030
4,000-5,000	0,766I±0,0I09	2,877±0,04I
5,000-6,000	0,7577±0,0I3I	2,845±0,049
6,000-7,000	0,7490±0,0I08	2,8I3±0,04I
7,000-8,000	0,7669±0,0055	2,880±0,02I
8,000-9,000	0,7582±0,0I59	2,847±0,060
9,000-I0,00	0,7593±0,0I67	2,85I±0,063
I0,000-20,00	0,77II±0,0063	2,895±0,024
20,000-30,00	0,77I5±0,0082	2,897±0,03I
30,000-40,00	0,7598±0,0I38	2,853±0,052
40,000-50,00	0,7609±0,008I	2,857±0,030
50,000-60,00	0,7675±0,0069	2,882±0,026
60,000-74,00	0,7665±0,0070	2,878±0,026
74,000-85,00	0,7522±0,0092	2,825±0,035
85,000-94,00	0,7565±0,0I0I	2,84I±0,072
94,000-I00,0	0,7654±0,0I89	2,874±0,07I
I00,000-200,0	0,7793±0,0045	2,926±0,0I7
200,000-300,0	0,7746±0,0043	2,909±0,0I6
300,000-400,0	0,7764±0,0042	2,9I5±0,0I6
400,000-500,0	0,7870±0,0043	2,955±0,0I6
500,000-600,0	0,7892±0,0046	2,963±0,0I7
600,000-7I0,0	0,7903±0,0047	2,968±0,0I7
7I0,000-800,0	0,7936±0,0048	2,980±0,0I8
800,000-920,0	0,7944±0,0049	2,983±0,0I8
920,000-I000,0	0,80I2±0,005I	3,009±0,0I9
I000,000-2I00,0	0,8I79±0,0024	3,07I±0,009
2I00,0 - 3I00,0	0,8575±0,004I	3,220±0,0I5
3I00,0 - 4I00,0	0,8994±0,0054	3,377±0,020
4I00,0 - 5I00,0	0,9376±0,0070	3,52I±0,026
5I00,0 - 6400,0	0,98I2±0,0077	3,684±0,029
6400,0-7200,0	I,0226±0,0080	3,840±0,030
0,005-0,0I0***	0,7653±0,0009	2,874±0,003
0,0I0-0,02	0,7646±0,0006	2,87I±0,002
0,02- 0,03	0,7664±0,0006	2,893±0,002
0,03- 0,04	0,765I±0,0006	2,873±0,002
0,04- 0,05	0,7644±0,0006	2,870±0,002
0,05- 0,06	0,7628±0,0007	2,864±0,003
0,06- 0,07	0,7640±0,0008	2,869±0,003
0,07- 0,08	0,7644±0,0009	2,870±0,003
0,08- 0,09	0,76I2±0,0009	2,858±0,003
0,09- 0,I0	0,7633±0,00I0	2,866±0,004
0,I0- 0,I2	0,7604±0,0008	2,855±0,003
0,I2- 0,I4	0,76I5±0,0009	2,859±0,003
0,I4- 0,I6	0,7600±0,00I0	2,854±0,004
0,I6- 0,I8	0,759I±0,00I0	2,850±0,004
0,I8- 0,20	0,7606±0,00I0	2,856±0,004
0,20- 0,22	0,7598±0,0008	2,853±0,003
0,22- 0,24	0,7599±0,0008	2,853±0,003
0,24-0,26	0,760I±0,0008	2,854±0,003

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
	[4I]*	
0,26-0,28	0,7587±0,0006	2,849±0,002
0,28-0,30	0,7584±0,0006	2,848±0,002
0,30-0,35	0,7595±0,0005	2,852±0,002
0,35-0,40	0,7607±0,0008	2,856±0,003
0,40-0,50	0,7634±0,00II	2,867±0,004
0,50-0,70	0,76II±0,00I5	2,858±0,006
0,70-I,00	0,7676±0,0023	2,882±0,009
I,00-I,80	0,7685±0,0025	2,886±0,009
I,80÷7,40	0,764I±0,0024	2,869±0,009
7,40÷I0,0	0,757I±0,00I9	2,843±0,007
I0,0 -I5,0	0,76I0±0,00I2	2,858±0,005
I5,0 -20,5	0,7598±0,0024	2,853±0,009
20,5 -33,0	0,7609±0,0023	2,857±0,009
33,0 -4I,0	0,7604±0,0065	2,855±0,024
4I,0 -60,0	0,7632±0,002I	2,866±0,006
	[62,90], $\bar{\nu}_p^{sp}(^{252}Cf)$ = 3,782	
0,2I	2,89I±0,094	2,870±0,094
0,23	2,9I3±0,059	2,892±0,049
0,25	2,848±0,049	2,828±0,049
0,27	2,883±0,042	2,862±0,042
0,29	2,874±0,036	2,853±0,036
0,3I	2,925±0,032	2,904±0,032
0,33	2,952±0,03I	2,93I±0,03I
0,35	2,94I±0,030	2,920±0,030
0,37	2,93I±0,030	2,9I0±0,030
0,39	2,954±0,027	2,933±0,027
0,4I	2,929±0,028	2,908±0,028
0,43	2,959±0,025	2,938±0,025
0,45	2,93I±0,023	2,9I0±0,023
0,47	2,952±0,022	2,93I±0,022
0,49	2,9I5±0,0I9	2,894±0,0I9
0,5I	2,963±0,0I8	2,942±0,0I8
0,53	2,923±0,0I7	2,902±0,0I7
0,55	2,955±0,0I7	2,934±0,0I7
0,57	2,955±0,0I6	2,934±0,0I6
0,59	2,930±0,0I8	2,909±0,0I8
0,6I	2,965±0,0I6	2,944±0,0I6
0,63	2,963±0,0I8	2,942±0,0I8
0,65	2,95I±0,0I8	2,930±0,0I8
0,67	2,967±0,0I9	2,946±0,0I9
0,69	2,973±0,0I9	2,952±0,0I9
0,725	2,966±0,0I5	2,945±0,0I5
0,775	2,986±0,0I5	2,965±0,0I5
0,825	2,962±0,0I8	2,94I±0,0I8
0,875	2,998±0,0I8	2,977±0,0I8
0,925	2,98I±0,02I	2,960±0,02I
0,975	2,983±0,02I	2,962±0,02I
I,025	3,0I3±0,026	2,99I±0,026
I,075	3,04I±0,03I	3,0I9±0,03I
I,I25	3,057±0,029	3,035±0,029
I,I75	3,026±0,034	3,004±0,034

Table 13 (continued)

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
[62,90], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,782$		
I,225	3,079±0,04I	3,057±0,04I
I,275	3,098±0,038	3,076±0,038
I,325	3,I39±0,047	3,II6±0,047
I,360	3,066±0,0I0	3,044±0,0I0
I,375	3,040±0,042	3,0I8±0,042
[63,78], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,732$		
I,36±0,I65	3,026±0,0I8	3,045±0,0I8
I,37±0,I50	3,I06±0,02I	3,I25±0,02I
2,33±0,I00	3,I4I±0,027	3,I60±0,027
2,45±0,I25	3,I75±0,022	3,I95±0,022
2,98±0,I05	3,264±0,0I6	3,284±0,0I6
3,50±0,I00	3,324±0,022	3,344±0,022
3,93±0,075	3,383±0,025	3,404±0,025
4,03±0,090	3,4I9±0,0I7	3,440±0,0I7
4,43±0,090	3,453±0,029	3,474±0,029
4,54±0,060	3,5I3±0,022	3,535±0,022
4,94±0,085	3,536±0,028	3,558±0,028
5,06±0,070	3,579±0,0I7	3,60I±0,0I7
5,57±0,070	3,638±0,027	3,660±0,027
5,98±0,075	3,688±0,042	3,7II±0,042
6,08±0,065	3,74I±0,028	3,764±0,028
6,97±0,I70	3,886±0,022	3,9I0±0,022
7,09±0,065	3,9I9±0,029	3,943±0,029
7,48±0,I65	3,947±0,0I8	3,97I±0,0I8
7,99±0,I45	4,038±0,0I8	4,063±0,0I8
8,49±0,I30	4,I24±0,020	4,I49±0,020
9,00±0,I20	4,I97±0,020	4,223±0,020
9,49±0,II0	4,27I±0,023	4,297±0,023
9,74±0,II0	4,28I±0,02I	4,307±0,II0
9,98±0,I00	4,368±0,0I6	4,395±0,0I6
[63,78], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,732$		
I0,47±0,095	4,409±0,022	4,436±0,022
I0,96±0,090	4,488±0,02I	4,5I6±0,02I
II,44±0,085	4,566±0,023	4,594±0,023
II,93±0,080	4,629±0,023	4,658±0,023
I2,4I±0,080	4,643±0,024	4,672±0,024
I2,88±0,080	4,750±0,025	4,779±0,025
I3,36±0,075	4,804±0,026	4,834±0,026
I3,84±0,075	4,884±0,025	4,9I4±0,025
I4,3I±0,070	4,942±0,029	4,972±0,029
I4,79±0,070	4,993±0,027	5,024±0,027
[70], $\bar{\nu}_p^{sp}(^{252}Cf) = 3,782$		
22,79±0,I40	6,000±0,077	5,957±0,077
23,94±0,II5	6,099±0,064	6,055±0,064
25,05±0,I05	6,I4I±0,086	6,097±0,086
26,I5±0,090	6,266±0,056	6,22I±0,056
27,22±0,080	6,424±0,076	6,378±0,076
28,28±0,075	6,479±0,I04	6,433±0,I04
[26]		
0,I86±0,I0I	2,867±0,026	
0,258±0,087	2,872±0,024	
0,385±0,07I	2,942±0,024	
0,603±0,068	2,905±0,023	
0,766±0,06I	2,924±0,024	
I,029±0,055	2,966±0,024	
I,238±0,048	2,972±0,023	
I,440±0,048	3,0I2±0,023	

* The data given by Gwin et al. [41] contain the total error; the results are preliminary.

** The rest of the neutron energies are given in keV.

*** From here until the end of the data of Gwin et al. [41] the neutron energy is given in eV.

Table 14.
Results of measurements of $\bar{\nu}_p$ for ^{240}Pu
$[\bar{\nu}_p^{sp}(^{252}Cf) = 3,732]$ /22/

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized	Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
I,870±0,I50	3,074±0,055	3,093±0,055	8,490±0,I30	4,058±0,04I	4,083±0,04I
2,450±0,I25	3,I62±0,05I	3,I82±0,05I	9,000±0,I20	4,I53±0,035	4,I79±0,035
2,980±0,I05	3,28I±0,045	3,30I±0,045	9,490±0,II0	4,2I3±0,042	4,239±0,042
3,500±0,I00	3,28I±0,05I	3,30I±0,05I	9,980±0,I00	4,298±0,040	4,325±0,040
4,030±0,090	3,355±0,055	3,376±0,055	I0,470±0,095	4,396±0,053	4,423±0,053
4,540±0,080	3,528±0,075	3,550±0,075	I0,960±0,090	4,4I2±0,054	4,439±0,054
5,060±0,070	3,546±0,07I	3,568±0,07I	II,440±0,085	4,5I0±0,040	4,538±0,040
5,8I0±0,2I0	3,66I±0,059	3,684±0,059	II,930±0,080	4,594±0,067	4,622±0,067
6,970±0,I70	3,854±0,04I	3,878±0,04I	I2,880±0,080	4,75I±0,068	4,780±0,068
7,480±0,I60	3,9I4±0,05I	3,938±0,05I	I3,840±0,075	4,848±0,065	4,878±0,065
7,990±0,I45	4,029±0,045	4,054±0,045	I4,790±0,070	5,086±0,I22	5,II7±0,I22

Table 15.
Results of measurements of $\bar{\nu}_p$ for ^{241}Pu $[\bar{\nu}_p^{sp}(^{252}Cf) = 3,732]$ /22/

Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized	Neutron energy, MeV	$\bar{\nu}_p$ Experimental	$\bar{\nu}_p$ Normalized
I,870±0,I50	3,I60±0,053	3,I80±0,053	9,980±0,I00	4,372±0,030	4,399±0,030
2,450±0,I25	3,209±0,034	3,229±0,034	I0,470±0,095	4,449±0,030	4,476±0,030
2,980±0,I05	3,322±0,028	3,343±0,028	I0,960±0,090	4,528±0,08I	4,556±0,03I
3,500±0,I00	3,332±0,033	3,353±0,033	II,440±0,085	4,605±0,04I	4,633±0,04I
4,030±0,090	3,474±0,042	3,495±0,042	II,930±0,080	4,658±0,033	4,687±0,033
5,060±0,070	3,63I±0,073	3,653±0,073	I2,4I0±0,080	4,744±0,032	4,773±0,032
6,970±0,I70	3,95I±0,067	3,975±0,067	I2,880±0,080	4,827±0,040	4,857±0,040
7,480±0,I60	3,967±0,038	3,99I±0,038	I3,360±0,075	4,873±0,034	4,903±0,034
7,990±0,I45	4,055±0,030	4,080±0,030	I3,840±0,075	4,999±0,043	5,030±0,043
8,490±0,I30	4,I27±0,028	4,I52±0,028	I4,3I0±0,070	5,089±0,05I	5,I20±0,05I
9,000±0,I20	4,249±0,038	4,275±0,038	I4,790±0,070	5,II2±0,058	5,I44±0,058
9,490±0,II0	4,252±0,034	4,278±0,034			

Table 16.
Results of measurements of $\bar{\nu}_p$ for ^{242m}Am [standard $\bar{\nu}_p(^{235}U)$] /95/

Neutron energy, MeV	ΔE^*, MeV	$\bar{\nu}(^{242m}Am)/\bar{\nu}(^{235}U)$	Neutron energy, MeV	E^*, MeV	$\bar{\nu}(^{242m}Am)/\bar{\nu}(^{235}U)$
0,037	0,022	I,354±0,060	4,I00	0,5I0	I,384±0,077
0,I07	0,048	I,338±0,048	4,860	0,480	I,I44±0,082
0,200	0,047	I,3I7±0,046	5,650	0,600	I,404±0,090
0,329	0,086	I,3I0±0,033	6,660	0,770	I,342±0,079
0,476	0,068	I,349±0,037	7,970	0,990	I,I23±0,068
0,620	0,085	I,347±0,036	9,I40	0,790	I,280±0,II0
0,820	0,I30	I,374±0,035	I0,I30	0,920	I,I60±0,II0
I,050	0,I20	I,402±0,044	II,300	I,I00	0,940±0,II0
I,300	0,I60	I,326±0,04I	I2,600	I,300	I,200±0,I50
I,570	0,I50	I,404±0,05I	I4,300	I,500	I,I20±0,I50
I,860	0,200	I,383±0,05I	I6,200	I,900	I,I50±0,I80
2,I30	0,I40	I,499±0,079	I8,700	2,300	I,I70±0,220
2,420	0,230	I,267±0,06I	2I,600	2,900	I,070±0,230
2,840	0,290	I,364±0,07I	25,400	3,600	0,830±0,2I0
3,390	0,380	I,359±0,076	30,300	4,700	I,020±0,290

* Half-width at half-height of the neutron energy distribution.

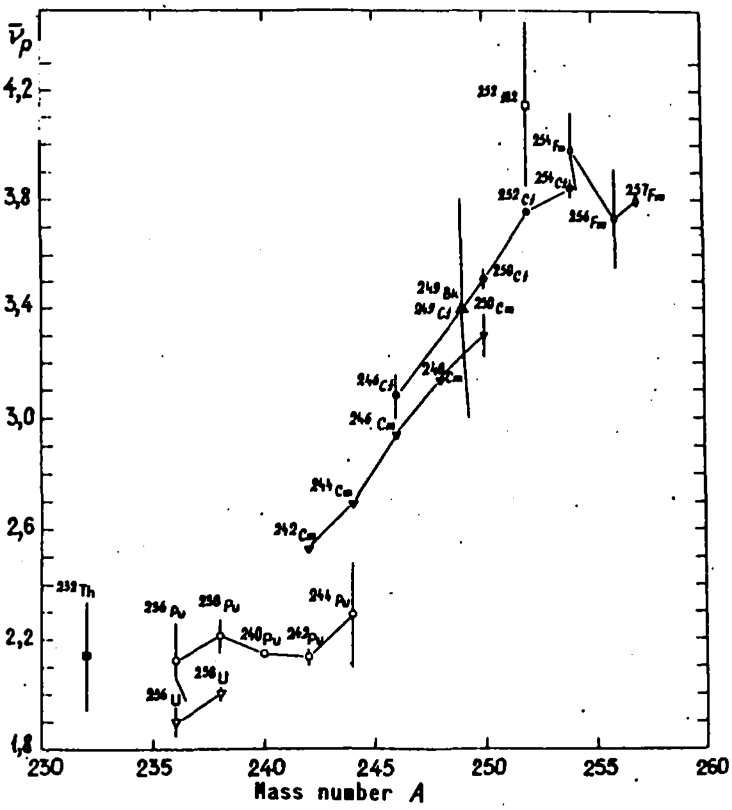


Fig. 1. Values of $\bar{\nu}_p$ for spontaneous fission as a function of the mass number A.

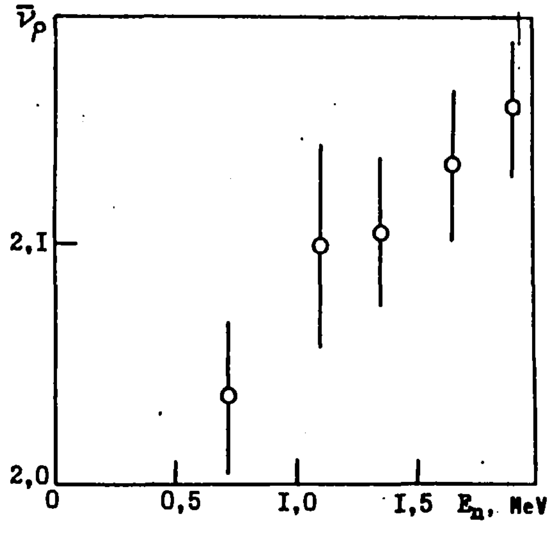


Fig. 2. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{230}Th [45].

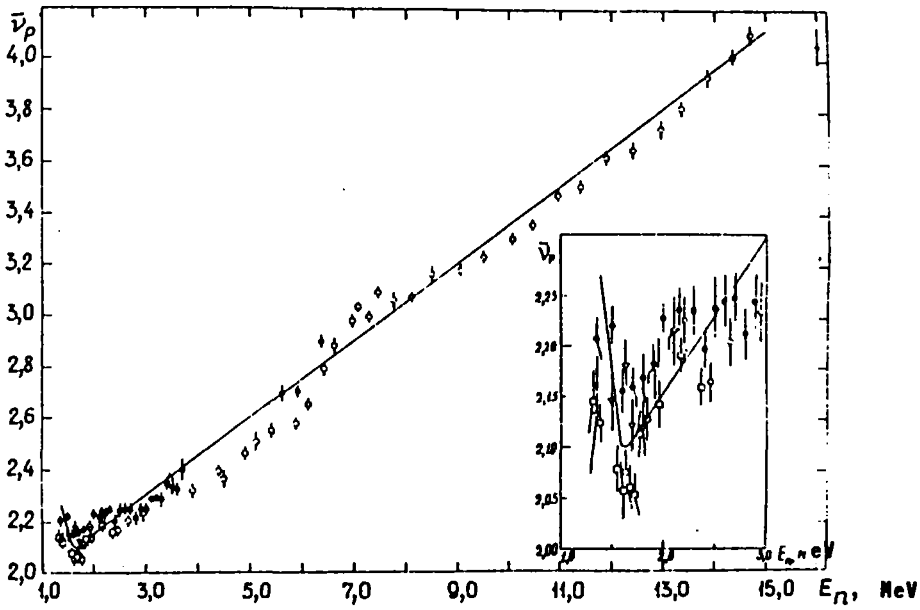


Fig. 3. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{232}Th: ∇ - [47]; • - [48]; □ - [53]; 0 - [52, 64]; —— - survey by Manero et al. [1].

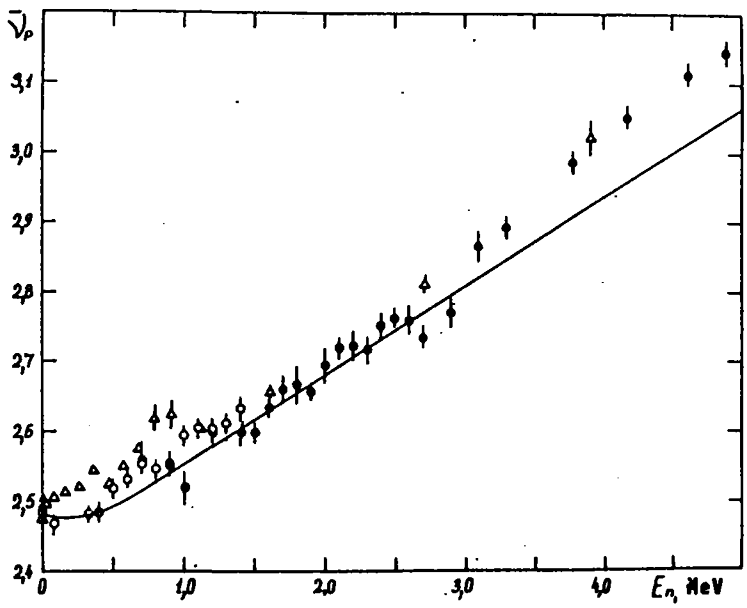


Fig. 4. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{233}U from the data of the following authors: 0 - [54]; • - [55]; Δ - [56]; —— - survey by Manero et al. [1].

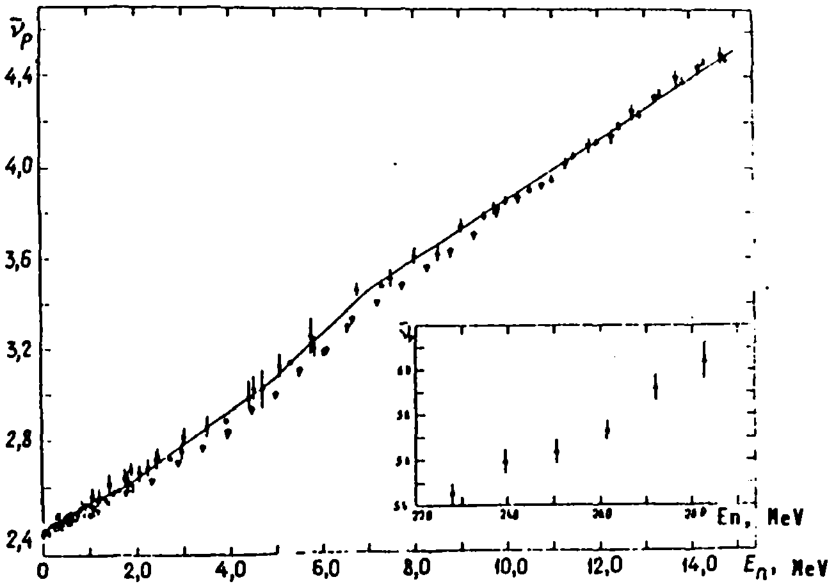


Fig. 5. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{235}U from the data of the following authors: x - [63]; Δ - [60, 63]; in the inset - [70]; □ - [62, 67]; ◐ - [68, 69 and 66]; ∇ - [65]; ◇ - [31]; O - [57]; ● - [71]; ▼ - [64]; —— - survey by Manero et al. [1].

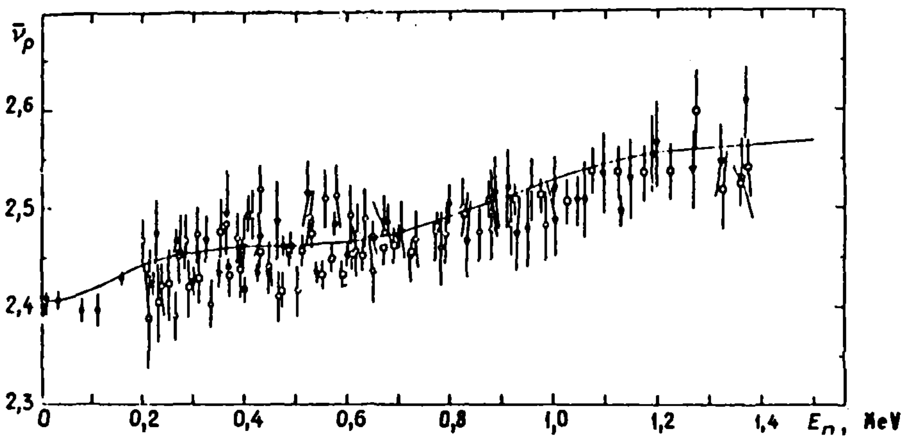


Fig. 6. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for ^{235}U fission between 0 and 1.4 MeV. The key is the same as in Fig. 5.

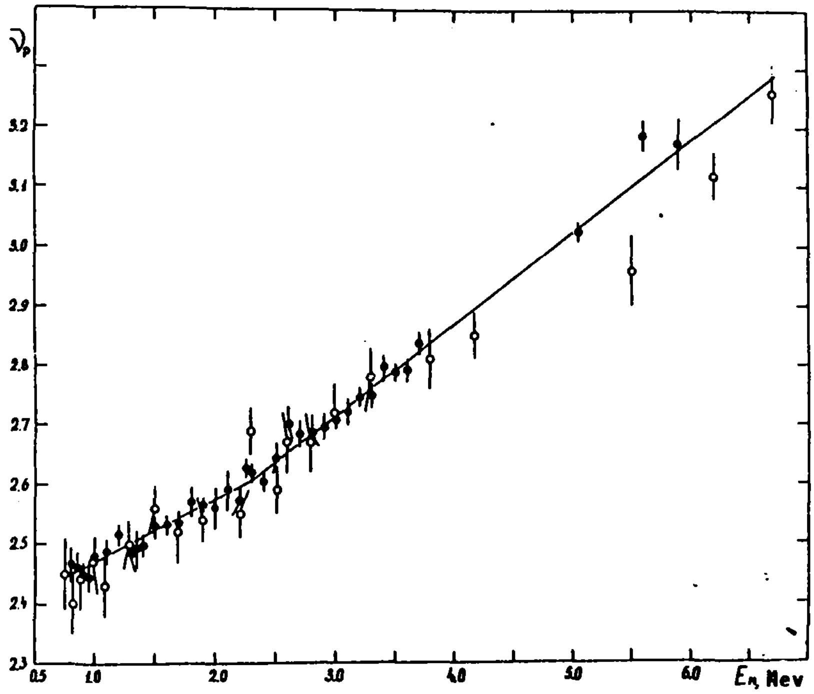


Fig. 7. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{236}U from the data of the following authors: O – [75]; ● – [50]; —— – dependence from Malinovsky et al. [50].

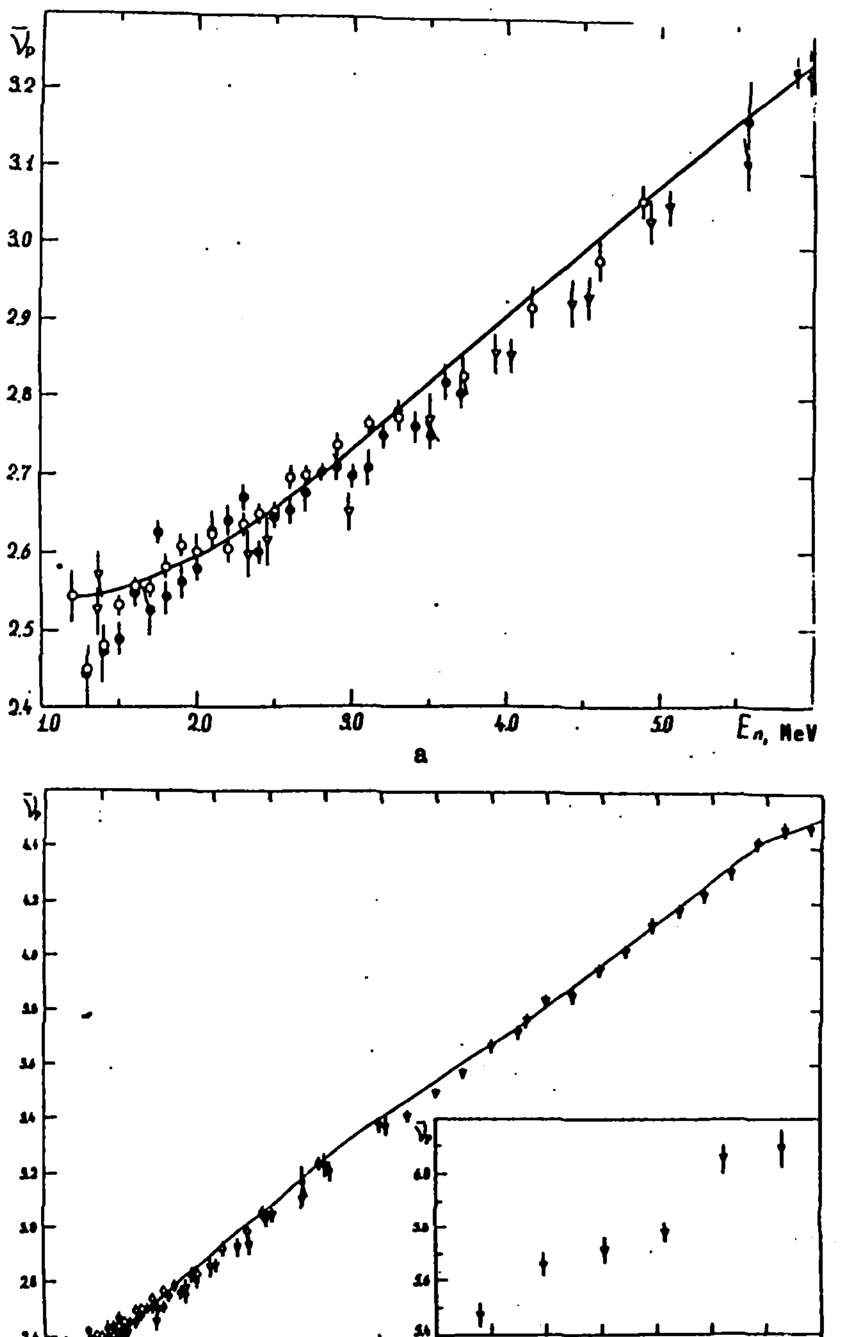
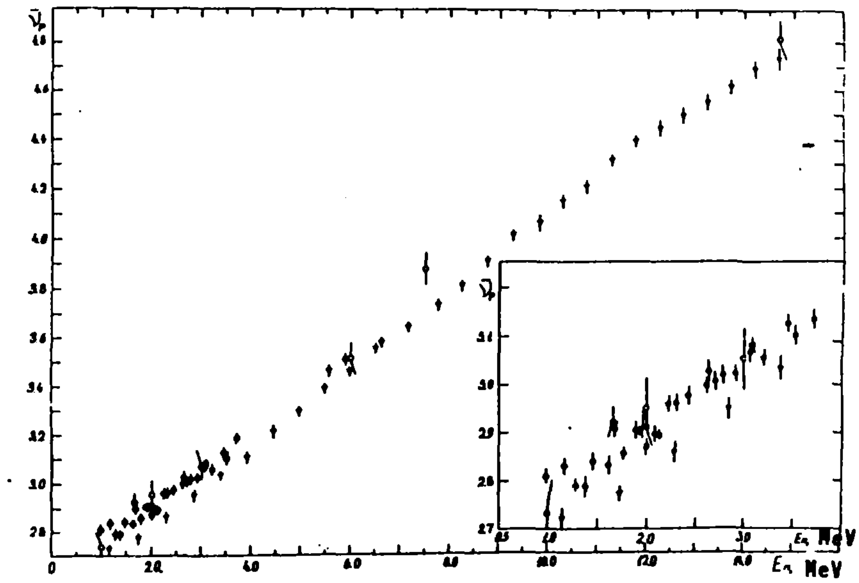
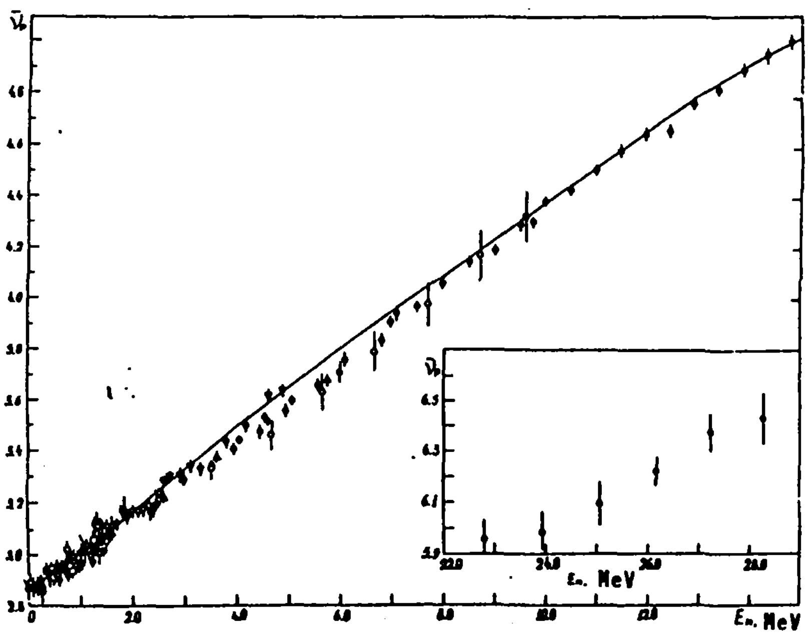


Fig. 8. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{238}U from the data of the following authors: O - [55]; ● - [77]; ∇ - [78]; —— - evaluation by Manero et al. [1] in the *1-5 MeV range (a), and 1-9 MeV range (b) (in the inset* ∇ is from [70]).



<u>Fig. 9.</u> Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{237}Np from the data of the following authors: O - [37]; ● - [49, 84]; ∇ - [85].



<u>Fig. 10.</u> Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{239}Pu in the 0-29 MeV range from the data of the following authors:
◇ - [87]; ▲ - [89]; ◆ - [31]; ∇ - [55]; □ - [90]; O - [41];
◐ - [78]; in the inset [70]; ● - [26]; Δ - [41]; (0.050-7200 keV range).
The data [90, 41] for energies below 1 MeV are grouped together
—— - evaluation by Manero et al. [1].

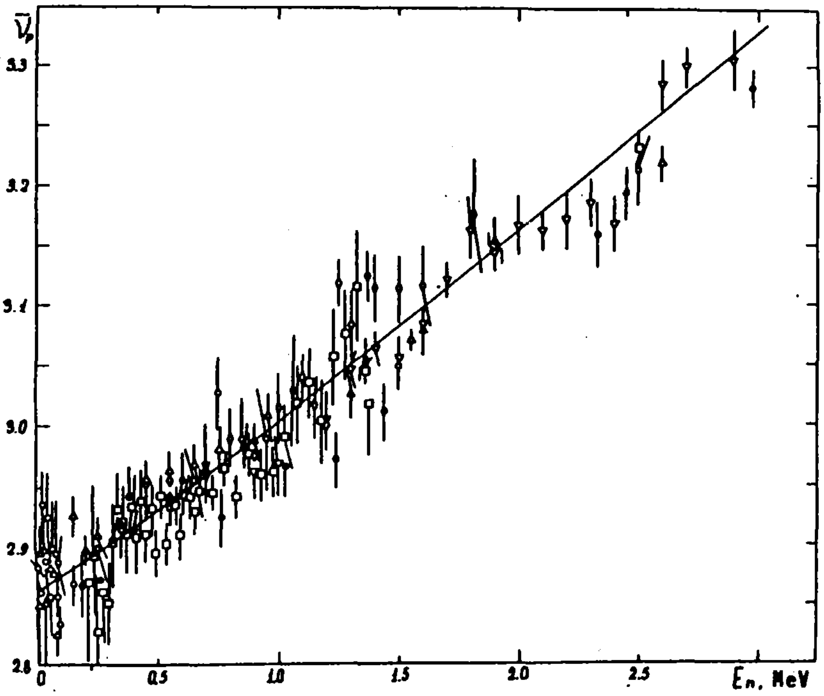


Fig. 11. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of the ^{239}Pu in the 0-3 MeV range. Key is the same as in Fig. 10.

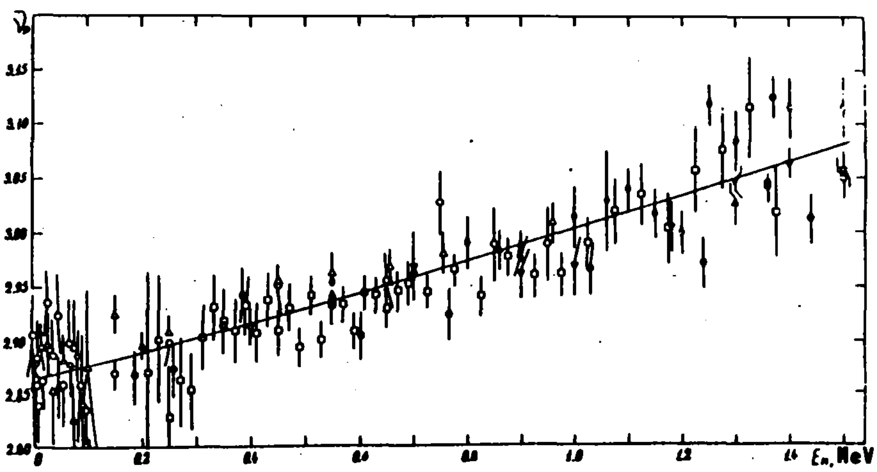


Fig. 12. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{239}Pu in the 0-1.5 MeV range. Key is the same as in Fig. 10.

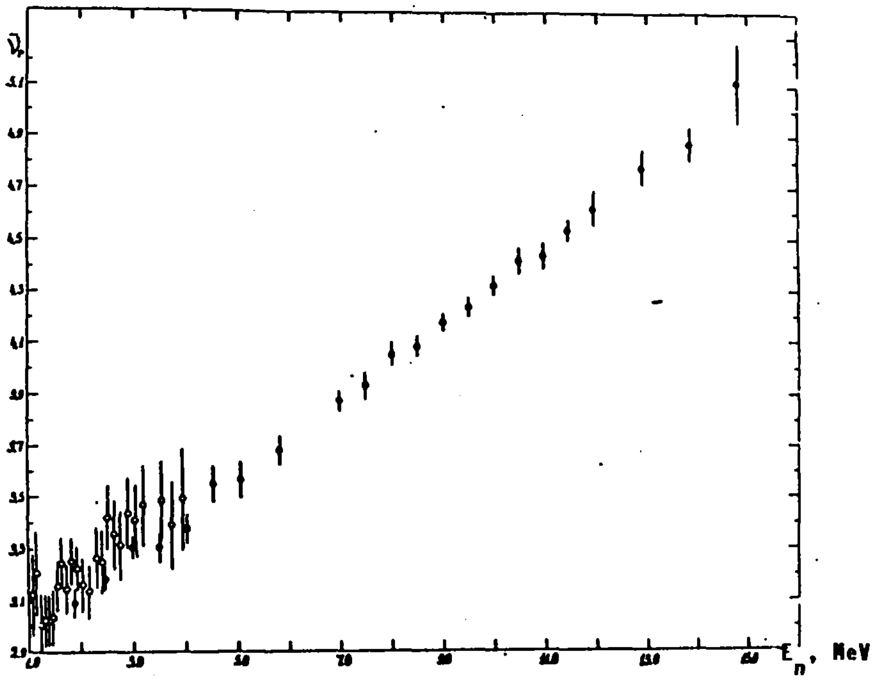


Fig. 13. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of ^{240}Pu from the data of the following authors: O – [92]; ● – [22].

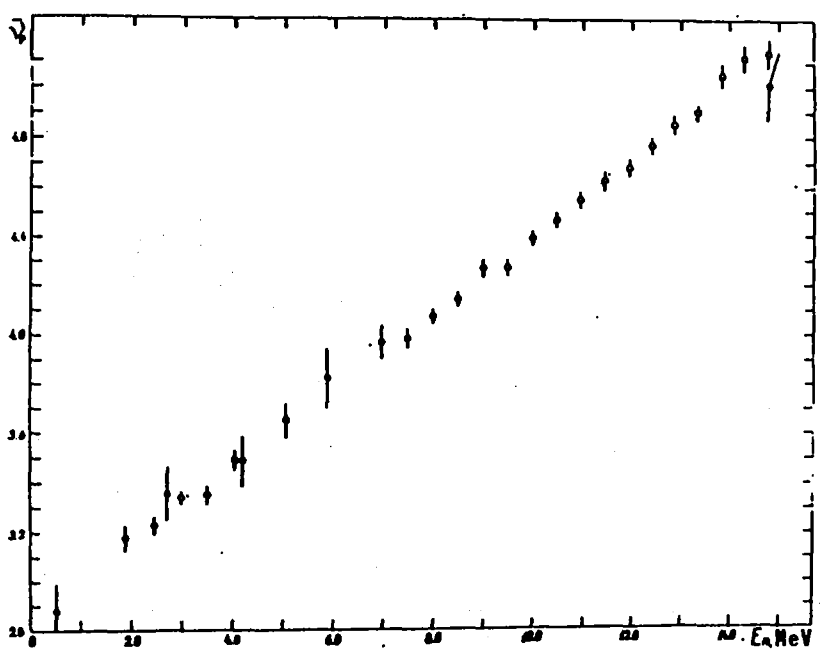


Fig. 14. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for the fission of ^{241}Pu from the data of the following authors:
● – [93]; O – [22].

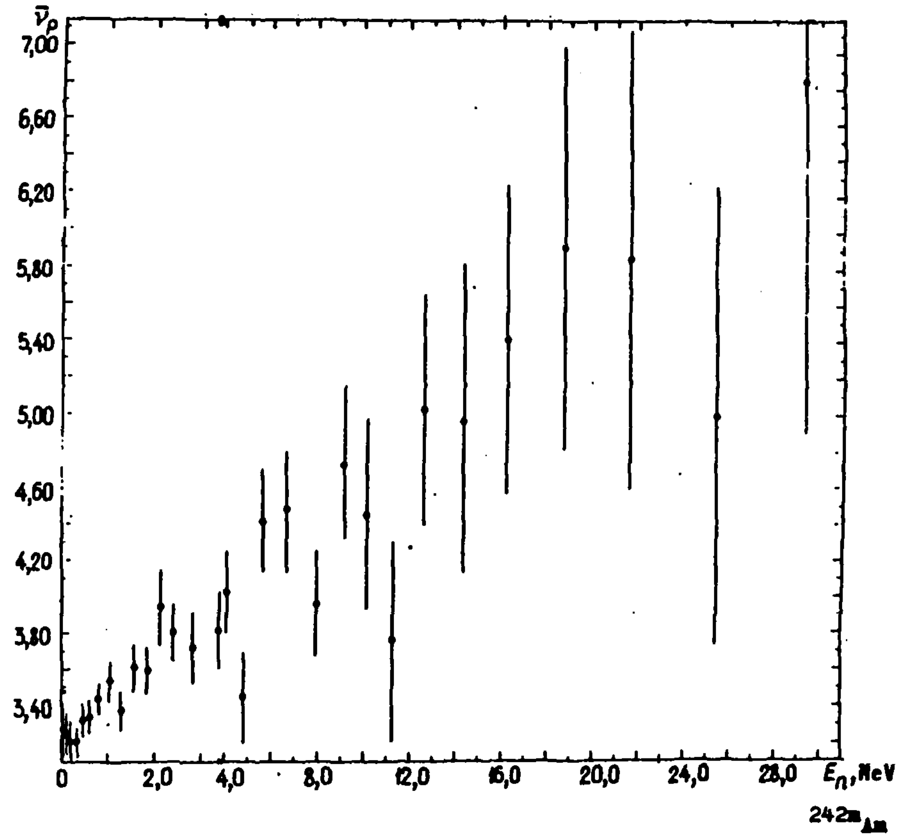


Fig. 15. Dependence of $\bar{\nu}_p$ on the neutron energy E_n for fission of $^{242}Am^m$ from the data of Howe et al. [95].