EUR 3053.e

EUROPEAN ATOMIC ENERGY COMMUNITY — EURATOM

INVESTIGATION OF PNC EFFECTS IN THE RADIATIVE CAPTURE OF POLARIZED NEUTRONS THE CASE OF H^2 (n,γ) AND Cd^{113} (n,γ)

by

M. FORTE and O. SAAVEDRA

1966

Joint Nuclear Research Center
Ispra Establishment - Italy

Reactor Physics Department
Experimental Neutron Physics

Paper presented at the
International Conference on Nuclear Structure
Antwerp, Belgium - July 19-23, 1965

LEGAL NOTICE

This report is on sale at the addresses listed on cover page 4

at the price of FF 4,—	FB 40	DM 3.20	Lit. 500	Fl. 3,—

When ordering, please quote the EUR number and the title, which are indicated on the cover of each report.

Printed by Smeets
Brussels, July 1966

EUR 3053.e

INVESTIGATION OF PNC EFFECTS IN THE RADIATIVE CAPTURE OF POLARIZED NEUTRONS — THE CASE OF H^2 (n, γ) AND Cd^{113} (n, γ)

by M. FORTE and O. SAAVEDRA

European Atomic Energy Community - EURATOM
Joint Nuclear Research Center - Ispra Establishment (Italy)
Reactor Physics Department - Experimental Neutron Physics
Paper presented at the International Conference on Nuclear Structure
Anwerp, Belgium - July 19-23, 1965
Brussels, July 1966 - 16 Pages - 2 Figures - FB 40

Parity non-conservation in nuclear electromagnetic interactions may produce interference effects with linear intensity in the F parameter. We have investigated them in the gamma transitions following the capture of polarized neutrons, respectively with H^2 and Cd^{113} targets. The (n, γ) target was exposed to a polarized neutron beam obtained from the magnetic mirror installed at the Ispra I reactor.

EUR 3053.e

INVESTIGATION OF PNC EFFECTS IN THE RADIATIVE CAPTURE OF POLARIZED NEUTRONS — THE CASE OF H^2 (n, γ) AND Cd^{113} (n, γ)
by M. FORTE and O. SAAVEDRA

European Atomic Energy Community - EURATOM
Joint Nuclear Research Center - Ispra Establishment (Italy)
Reactor Physics Department - Experimental Neutron Physics
Paper presented at the International Conference on Nuclear Structure
Anwerp, Belgium - July 19-23, 1965
Brussels, July 1966 - 16 Pages - 2 Figures - FB 40

Parity non-conservation in nuclear electromagnetic interactions may produce interference effects with linear intensity in the F parameter. We have investigated them in the gamma transitions following the capture of polarized neutrons, respectively with H^2 and Cd^{113} targets. The (n, γ) target was exposed to a polarized neutron beam obtained from the magnetic mirror installed at the Ispra I reactor.

The PNC effect to be investigated was a possible forward-backward asymmetry of gamma emission with respect to the direction of neutron polarization. The measuring apparatus and methods will be described in detail.

— In the case of H^2 (n, γ), the corrected asymmetry parameter, evaluated for the 7.25 MeV capture gamma-rays, was $\alpha = (0.45 \pm 2.5)\ 10^{-4}$. From this result we may simply assign an upper limit to the PNC parameter: $F \leqslant 3.10^{-6}$.

— In the case of Cd^{113} (n, γ), we considered both a range of the gamma spectrum containing mainly the transition to the 0^+ ground state of Cd^{111}, and a group of transitions of the first few excited levels of Cd^{114}, all having $+$ partities.

In both cases, the corrected α value was within the standard error, which had an order of magnitude of 10^{-4}.

Thus the present measurement does not confirm the existence of an asymmetry, which has been found by Abov *et al.*, in a similar experiment where the ground state transition was measured.

In any case, the order of magnitude of the PNC effect quoted by Abov *et al.*, and the upper limit assigned to it by our measurement, are comparable.

The PNC effect to be investigated was a possible forward-backward asymmetry of gamma emission with respect to the direction of neutron polarization. The measuring apparatus and methods will be described in detail.

— In the case of H^2 (n, γ), the corrected asymmetry parameter, evaluated for the 7.25 MeV capture gamma-rays, was $\alpha = (0.45 \pm 2.5)\ 10^{-4}$. From this result we may simply assign an upper limit to the PNC parameter: $F \leqslant 3.10^{-6}$.

— In the case of Cd^{113} (n, γ), we considered both a range of the gamma spectrum containing mainly the transition to the 0^+ ground state of Cd^{114}, and a group of transitions of the first few excited levels of Cd^{114}, all having $+$ partities.

In both cases, the corrected α value was within the standard error, which had an order of magnitude of 10^{-4}.

Thus the present measurement does not confirm the existence of an asymmetry, which has been found by Abov *et al.*, in a similar experiment where the ground state transition was measured.

In any case, the order of magnitude of the PNC effect quoted by Abov *et al.*, and the upper limit assigned to it by our measurement, are comparable.

EUR 3053.e

EUROPEAN ATOMIC ENERGY COMMUNITY — EURATOM

INVESTIGATION OF PNC EFFECTS IN THE RADIATIVE CAPTURE OF POLARIZED NEUTRONS
THE CASE OF H^2 (n, γ) AND Cd^{113} (n, γ)

by

M. FORTE and O. SAAVEDRA

1966

Joint Nuclear Research Center
Ispra Establishment - Italy

Reactor Physics Department
Experimental Neutron Physics

Paper presented at the
International Conference on Nuclear Structure
Antwerp, Belgium - July 19-23, 1965

SUMMARY

Parity non-conservation in nuclear electromagnetic interactions may produce interference effects with linear intensity in the F parameter. We have investigated them in the gamma transitions following the capture of polarized neutrons, respectively with H^2 and Cd^{113} targets. The (n, γ) target was exposed to a polarized neutron beam obtained from the magnetic mirror installed at the Ispra I reactor.

The PNC effect to be investigated was a possible forward-backward asymmetry of gamma emission with respect to the direction of neutron polarization. The measuring apparatus and methods will be described in detail.

— In the case of H^2 (n, γ), the corrected asymmetry parameter, evaluated for the 7.25 MeV capture gamma-rays, was $\alpha = (0.45 \pm 2.5)10^{-4}$. From this result we may simply assign an upper limit to the PNC parameter: $F \leqslant 3.10^{-6}$.

— In the case of Cd^{113} (n, γ), we considered both a range of the gamma spectrum containing mainly the transition to the 0^+ ground state of Cd^{114} and a group of transitions to the first few excited levels of Cd^{114}, all having+parities.

In both cases, the corrected α value was within the standard error, which had an order of magnitude of 10^{-4}.

Thus the present measurement does not confirm the existence of an asymmetry, which has been found by Abov *et al.*, in a similar experiment where the ground state transition was measured.

In any case, the order of magnitude of the PNC effect quoted by Abov *et al.*, and the upper limit assigned to it by our measurement, are comparable.

INVESTIGATION OF PNC EFFECTS IN THE RADIATIVE CAPTURE OF POLARIZED NEUTRONS - THE CASE OF H^2 (n,γ) AND Cd^{113}(n,γ)

Introduction

We have investigated the PNC in the electromagnetic transitions following the capture of slow polarized neutrons by H^2 and Cd^{113} nuclei, respectively.

In experiments of this kind one can attempt to find PNC effects, due to interference of a regular PC transition with PNC admixed transitions. The magnitude of these effects is linear in the relative amplitude η of irregular parity admixtures in the nuclear wave functions:

$$\Psi_i = \Psi_i + \eta \varphi_i$$

and therefore in the F parameter (1).

In each of the cases we have considered experimentally, the situation is the following:

A main PC transition, having M1 character, connects the initial capture state to the final state.

Due to the existence of PNC admixtures in the nuclear wave functions, also the opposite-parity multipole of the same order, E1, may be non-vanishing between the same states.

M1 - E1 interference might then be revealed by the asymmetry in the angular distribution of gamma radiation

Manuscript received on June 18, 1965.

$$W(\Theta) = 1 + \alpha P_n \cos\Theta$$

where Θ is the angle between the momentum of the gamma quantum and the neutron polarization axis, and P_n the degree of neutron polarization.

According to a more general form quoted by Blin-Stoyle(2) the asymmetry factor is

$$\alpha = 2A \frac{m^{*}1\ e1}{|m1|^{2} + |e1|^{2}} \qquad (1)$$

A is given in terms of a nuclear orientation parameter and of an angular distribution factor,

$$A = B_1(j_c)\, F_1(11, j_f j_c),$$ depending on

j_i, j_c, j_f, that are, respectively, the nuclear spins before the capture, in the compound state, and in the final state reached after the gamma transition.

$$h = \frac{m^{*}1\ e1}{|m1|^{2} + |e1|^{2}}$$

represents the ratio of the transition probability of the PNC admixed transition, which is proportional to F , to the transition probability of the main PC transition.

In both the experiments we have considered a large enhancement of PNC effects is expected, due to large amplification factors in the h ratio.

- PNC effects in $H^2(n,\gamma)$

The existence of largely enhanced PNC effects in the s-wave n-D capture has been suggested by Blin-Stoyle and Feshbach (3), who quote an order of magnitude of the PNC effect

$$\alpha \simeq \frac{\langle E1 \rangle}{\langle M1 \rangle} \simeq 100\, F$$

This figure is obtained by considering, at a very low neutron energy, the main PC M1 transition in comparison with the spurious E1 transition resulting from s-wave capture into irregular-parity components in the H^3 wave-functions.

In the wave-function of a well spaced level, the parity admixture parameter is $|\eta| \simeq F$, therefore, the effective E1 strength will be F times the single particle E1 value.

On the other hand M1 is inhibited with respect to E1 by two different factors.

A first factor ~ 10 is estimated for the ratio of M1 and E1 single particle values.

Furthermore, due to the fact that M1 is identically vanishing for the space-symmetric part of H^3 wave-function(4), only the non-symmetric part, which is ~ 0.1 in relative amplitude will contribute to M1.

An overall enhancement factor of ~ 100 is thus obtained.

A further enhancement, which was not included, arises from the opposite parity admixture in the wave function of the initial n-D system.

- The case of $Cd^{113}(n,\gamma)$.

In the case of intermediate nuclei, due to the large density of levels at high excitation energy, a large admixture of opposite parities is induced in the wave-function of the capture state, because of the interaction with states having the same angular momentum, but the opposite parity.

The parity admixture parameter, obtained from a perturbation calculation with the assumption of uniformly distributed oscillator levels, is

$$|\eta'| = \frac{1}{12} N^{\frac{1}{2}} F$$

where N is a parameter representing the number of states belonging to the same oscillator level.

In the formula (1) we may put $h = 5.10^2$ F, allowing a factor 10 for the ratio of single particle E1 and M1 values and a parity admixture parameter $|\eta| \simeq 50$ F , in agreement with an estimation of N adopted by Abov et.al. (5)

For the $1^+ \rightarrow 0^+$ ground-state transitions, A = 1 and therefore,

$$|\alpha| = 10^3 \text{ F}$$

A result of the same order of magnitude applies to each of the transitions from the capture state to one of the first few excited states 2^+ (A = 0.5)

Experimental methods and set up

The principle of the experiment is the following.
The (n,γ) target is exposed to a beam of polarized neutrons.

Two opposite scintillation counters A and B detect, respectively, capture gamma rays emitted forward and backward with respect to the neutron polarization axis. The neutron polarization is periodically reversed.

Let us call a_I, a_{II} and b_I, b_{II} the counts registered from counters A and B respectively, during periods of opposite polarization I and II.

As a measurement of the forward-backward asymmetry we have taken

$$\alpha_m = \frac{1}{2}\left(\frac{a_I - a_{II}}{a_I + a_{II}} - \frac{b_I - b_{II}}{b_I + b_{II}}\right)$$

The asymmetry factor was then calculated by

$$\alpha = \alpha_m / (\Omega \, P_n \, r \, f)$$

where Ω is a function of the target-detector geometry, P_n the degree of neutron polarization, r the depolarization factor of neutrons, due to multiple target scattering, f is the fraction of gamma counts pertaining to the transition being studied present in the overall number of counted pulses, including background and pile-up pulses.

The experimental disposition is shown in fig. (1)

A polarized neutron beam of $\sim 3.10^7$ n sec^{-1} is obtained by reflection from a magnetized Co-Fe mirror [6].

Along the path from the mirror to the target the neutron spins are guided in a magnetic field. The latter is vertical at the output of the polarizer and is turned by $\pi/2$ to the left or to the right, throughout the first section of the guide field device, sketched in fig. (1). Here a vertical field component is maintained between two iron strips magnetically coupled to the poles of the polarizer magnet, and a horizontal component is applied between the side walls of an Armco iron tunnel, magnetized by a current.

The intensity of the vertical component is decreasing and that of the horizontal component is increasing along the direction of the neutron flight, in such a way that the resultant field, seen in the neutron c.m. system is about constant ($\sim$ 30 gauss) and turns at uniform angular speed.

The neutron spins are adiabatically turned with the field so that, at the target, the polarization axis will point to the left or to the right according to the direction of the current exciting the guide field device.

The loss in the polarization degree, due to spin flip, should be less than 0.5 % , according to a calculation.

The field is $\sim$ 8 gauss inside the target chamber. The outside of the latter is lined with mumetal sheet to prevent that reversing the field may sistematically affect the gain of the scintillation counters.

Each scintillation counter is made of a 3'' x 3'' NaI (Tl) crystal, directly coupled to a 6363 Dumont photomultiplier, which is provided with a standard magnetic shield. The whole counter is enclosed in a 1 mm thick mumetal box.

A lead shield and an outer shield of borated paraffin protect the counters from external radiation.

In the high energy range, the background was almost entirely due to stray radiation associated with the polarized neutron beam, and to radiative capture of scattered neutrons. To reduce the latter contribution, the target chamber was provided with sufficiently thick walls of polyethylene loaded with high purity $Li_2\ CO_3$, and of B_4C - paraffin admixture

Electronic apparatus

A schematic diagram is shown in fig. (2).
The output of each counter is connected to an amplification chain, followed by a threshold discriminator.

The amplified outputs are mixed and sent to the common p.h. converter input of a LABEN 45.A. 256 channel analyzer, operated in the 4 x 64 - channel mode.

The discriminators, and a binary counter, which is driven by a timer and controls the orientation of the guide field, deliver gate signals which are combined and fed to the analyzer, according to the logic indicated in the diagram, in order to address the discriminated counter pulses a_I, b_I and a_{II}, b_{II} to the respective memory quadrants I, II, and III, IV.

The working conditions of the whole apparatus were carefully stabilized. The reliability of the p.h. analyzer and of the electronic chains, which are fully transistorized, had been severely tested during a long time before starting the main experiments.

Circuit details and characteristics have been described previously (7).

Measurement of neutron polarization

The neutron polarization was measured in a double reflection experiment, using the depolarizing shim method, as described in (6).

Before hitting the analyzing mirror, the neutrons were made to pass through a second turning field device, where the spins were turned back to a vertical orientation.

The measured polarization degree was practically the same, whether the guide field was steady, or alternating with a period of 2 sec., as during the γ measurements.

The values we have found, before and after each PNC experiment were always around 75% , and therefore we will use this figure in treating the results.

- Symmetry control experiments

In the PNC experiments false asymmetry effects might appear, due to instrumental asymmetries, such as a systematic dependence of the photomultiplier gain on the magnetic guide field orientation.

Therefore, in connection with each PNC experiment, a control experiment has been done, with the same experimental disposition and operating conditions, but, instead of a (n, γ) target, a Co^{60} gamma source was counted.

In order to have a very sensitive test of the gain stability between alternate polarization periods, the asymmetry was measured taking, in the Co^{60} spectrum, energy intervals ranging from the center of a peak to the next valley.

According to the control experiments, in none of which instrumental defects were found, we estimated the following standard error limits of the instrumental asymmetry α_0 , for the various PNC experiments

$H^2 (n, \gamma)$ - $(5.4 \div 6.6)$ MeV $\qquad \alpha_0 = \pm 1. \quad 10^{-5}$

$Cd (n, \gamma)$ - $(7.3 \div 7.9)$ MeV $\qquad \alpha_0 = \pm 1.2 \quad 10^{-5}$

$Cd (n, \gamma)$ - $(8 \div 9.4)$ MeV $\qquad \alpha_0 = \pm 2.5 \quad 10^{-5}$

- $H^2 (n,\gamma)$ measurements and results

A D_2O target was used in a container having the following inner dimensions: width 0,6 cm, height 8 cm, thickness 4 cm.

The container walls were made of methylmetacrylate resin, loaded with $Li_2 CO_3$, and the neutron entrance window was a very thin film of the same resin.

Preliminary measurements have been done, in order to analyze the various componenents of the total gamma spectrum, and to evaluate the relative contribution of the $H^2 (n,\gamma)$ and of the background.

The background spectrum was measured with the empty container. Besides, a measurement taken with a $Li_2 CO_3$ - paraffin target permitted to estimate that the contribution of fast neutrons scattered by the D_2O was almost negligible.

According to the preliminary measurements, it was found convenient, in the main experiment, to consider an energy interval containing only the 6.25 MeV total peak and the first escape peak of the H^2 capture gamma, avoiding to involve the $C^{12} (n,\gamma)$ 4.95 MeV peak, which was rather prominent.

In the chosen interval (5,4 - 6,6) MeV, the $H^2 (n,\gamma)$ counts were about 50% of the total. Since pulse pile-up effects were quite negligible, we can assume $f = 0.50$.

The neutron depolarization due to spin-incoherent scattering on H^2, has been evaluated taking as a depolarization factor in a single scattering event $r_I = 0,56$, according to (8). With the simplifying assumption that the angular distribution of scattered neutrons is isotropic, the average depolarization factor for the neutrons which undergo the capture inside the D_2O target, was estimated to be better than $r = 0,9$.

The geometry factor was better than $\Omega = 0,93$.

The PNC experiment was running according to an automatic cycle.

Each measurement lasted 16.384 sec (useful time) during which the spectra were accumulated in the 4 analyzer memories. Then, the data were printed, and soon after, the next measurement started.

Care was taken to control that, during each measuring period, the working conditions were stable enough to permit an experimental accuracy of the order of the one estimated from the control experiments.

The energy calibration of the spectra was adjusted, when necessary, to maintain it within 1%.

The drift, during a night, did not, in general exceed this value, with a steady neutron flux. All the times wide variations of the reactor power, or of the background level, measured by the area monitors, were registered, the spectra under measurement were discarded.

During an useful measuring time of about 500 hr, about 300 measurements were taken, with an overall number of counts $\sim 4.10^{8}$.

Preliminary results have been reported in (7) and (9)

The result, evaluated from the total of the counts, is reported in Tab. I, where, also, the same measurements have been grouped into partial series, for comparison purpose. A standard statistical test resulted in agreement with a gaussian error distribution.

According to the previous theoretical considerations, the present result is consistent with our upper limit assignment of the PNC parameter

$$F \lesssim 2.10^{-6} ,$$

that is an order of magnitude higher with respect to the results of different experiments (Cd^{113} (n,γ), f.i.) in which the actual order of magnitude of F was reached.

In any case there would be a particular interest in improving, by an order of magnitude, at least, the accuracy of an experiment of this kind, where a very simple nucleon system is dealt with, and a more direct relation between the measured effects and the PNC potential may be established.

In this connection we note that, in spite of the extremely low capture cross section of H^2, and the consequent experimental limitations (bad geometry, thick target effects, etc.) the quoted result could be reached after a relatively short measuring time.
On the other hand it was observed that, in the case a stronger beam of polarized neutron was available, the counting channels could safely work at a much higher counting rate.

- Cd (n,γ) measurements and results

This experiment was started in July 1964, some time before we were informed about the results obtained at Moscow, by Abov et al , and reported in (5).

The experimental set up was essentially the same used in the previous experiment, but some modification was introduced, which permitted to have a geometry factor close to unity. The counters were shifted at a larger distance from the target, and a lead collimator was introduced in front of each counter.

The Cd target was 0,8 cm high (1cm wide and 0,05 cm thick), so that only about 10% of the available neutron intensity was used.

Indeed, a limitation in the counting rate was set by the pulse pile-up, in spite of the very short RC constants (0,2 and 0,5 μs) used for double differentiating the counter pulses.

Two series of measurements, with different counting rates have been performed.

In series I, the counting rate on each counter was about 30 counts/sec, referring to the (8-9,4) MeV interval, for instance.

In series II, the collimation was arranged to have a 2 times higher counting rate.

Two different energy intervals have been considered. In the interval (8-9,4) MeV of the spectrum a main component belongs to the 9,04 MeV $1^+ \rightarrow 0^+$ ground state transition and a minor contribution is due to the 8.48 MeV $1^+ \rightarrow 2^+$. The interval (7,3 - 7,9) MeV, in addition to components belonging to the quoted transitions, contains the peaks of transitions from the capture to a 0^+ and to two 2^+ (probable assignement) excited levels (10).

In order to evaluate the contribution of spurious pile-up pulses, in each of the specified energy intervals, the pile-up distortion of the spectrum was determined following an experimental method, the basic principle of which will be referred here.

Artificial pulses, of the same shape as the scintillation pulses, were fed to the input of a counter amplification chain, and registered by the p.h. analyzer, gated in coincidence by the pulse generator.

By sending the correct number of pulses on each channel, the true spectrum could be simulated, in the wanted interval.

When the same operation was done in presence of the actual rate of gamma pulses from both counters, which disturbed the analyzer input, the pile-up distorted spectrum shape was obtained.

The various correction factors f , reported in Tab II and III, have been obtained from measurements of this kind, after taking into account, to a safe extent, some experimental uncertainities. The contribution of background was quite negligible. The experimental methods and the procedure followed in the present experiment were essentially the same as in the previous one.

The final results of series I and II for each of the energy intervals considered, are reported, respectively, in Tab II and III, together with related partial results. A statistical test applied to each case, was consistent with a gaussian error distribution.

As an overall result, the weighted average of the series I and II is taken.

For the various transitions considered in the present experiment, no asymmetry in the angular distribution was put into evidence.

In particular, for the (8 - 9,4) MeV interval our general average is

$$\alpha = (0,216 \pm 1,13) \cdot 10^{-4}$$

and does not confirm the evidence, found by Abov et.al. [5], of an effect (measured on the interval (8,1 - 9,4) MeV definitely larger than the statistical error:

$$\alpha = (-3,7 \pm 0,9) \quad 10^{-4}.$$

Certain different experimental conditions do not allow a too direct comparison of the two results.

For instance, the smaller detector size used in our case, should result in a different admixture ratio of the $1^+ \rightarrow 2^+$ transition in the measured part of the spectrum.

Moreover, the determination of the neutron polarization degree was affected, in both the experiments, by a wide uncertainity, that is inherent in the used measuring method of double reflection.

On the other hand, a large part of the shift between the average values of the two measurements may possibly result from a combination of the statistical errors which affect the experiments (taking into account the errors in the control experiments, too).

In any case, the order of magnitude of the PNC effect found by Abov et.al., and the upper limit assigned to it by our experiment, are comparable.

An upper limit assignement of F, consistent with our results, and with the theoretical calculations previously quoted, is

$$F \lesssim 1,5 \; 10^{-7}.$$

The negative result found for the group of transitions involved in the interval (7,3 - 7,9) MeV, may lead to two different conclusions.

Either the PNC effect was too small in each of the transitions, or the asymmetry factors of individual transitions balanced each other in such a way that no sufficiently large effect could be observed.

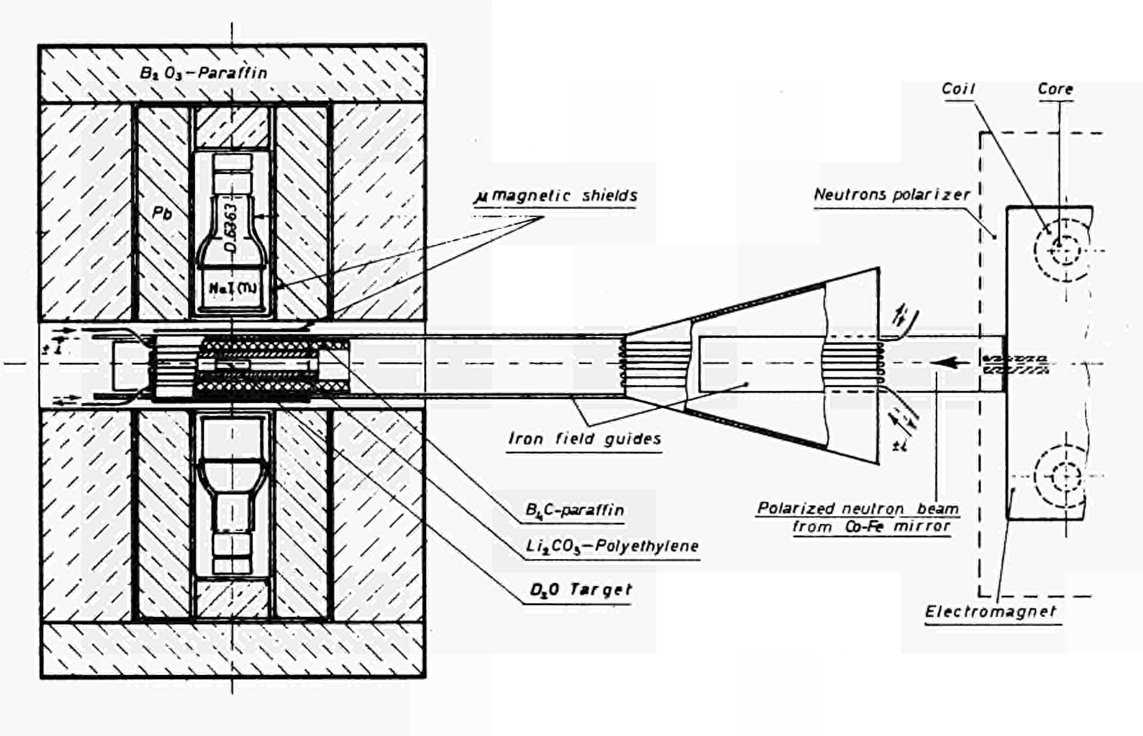
References

1. D.H. Wilkinson, Phys.Rev. 109 1603 (1958)
2. R.J. Blin-Stoyle, Phys.Rev. 120 181 (1956)
3. R.J. Blin-Stoyle and H. Feshbach, Nuclear Phys. 27 395 (1961)
4. M. Verde, Helv.Phys. Acta 23 453 (1950)
5. Y.C. Abov, P.A. Krupchitsky and Y.A. Oratovsky, Phys.Letters 12 25 (1964), and private communication.
6. M. Forte, Int.Conf. on Nuclear Physics with Reactor Neutrons ANL 6797 (1963)
7. M. Forte and C. Maranzana, XI Congresso Scientifico Internazionale per l'Elettronica. Roma (1964)
8. W.E. Meyerhoff and D.B. Nicodemus, Phys.Rev. 82 5 (1951)
9. M. Forte, in EUR 1643.e (July 1964)
10. L.V. Groshev, V.N. Lutsenko, A.M. Demidov, V.I. Pelikov, Atlas of -Ray Spectra from Radiative Capture of Thermal Neutrons, Engl.transl. Pergamon Press 1959

Captions of figures

Fig. 1 Experimental disposition for measuring the asymmetry of polarized neutron capture gamma rays.

Fig. 2 Schematic diagram of the electronic apparatus.


B2 O3-Paraffin
Pb
D-6363
NaI (Tl)
μ magnetic shields
Neutrons polarizer
Coil
Core
Iron field guides
B4C-paraffin
Li2CO3-Polyethylene
D2O Target
Polarized neutron beam
from Co-Fe mirror
Electromagnet

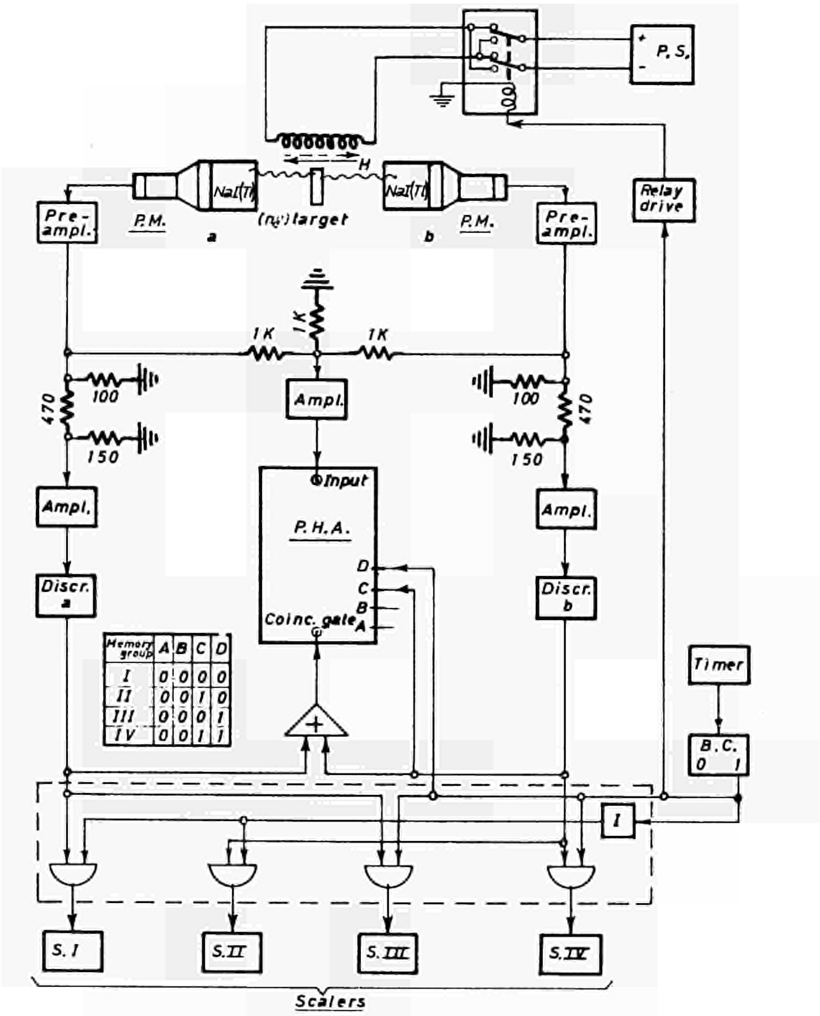

P. S.
H
NaI(Tl)
(n,γ) target
P.M.
a
b
Pre-ampl.
Relay drive
1K
1K
1K
470
100
150
Ampl.
Input
P. H. A.
D
C
B
A
Coinc. gate
Discr. a
Discr. b
Memory group
A B C D
I 0 0 0 0
II 0 0 1 0
III 0 0 0 1
IV 0 0 1 1
Timer
B.C.
0 1
I
S. I
S. II
S. III
S. IV
Scalers

TABLE I — $H^2(n,\gamma)$ experiment

	α_m $\times 10^{-4}$	σ $\times 10^{-4}$
	+ 0,35	1,12
	+ 0,17	0,91
	- 0,36	0,96
	+ 0,45	0,98
Total	+ 0,09	0,49

Ω	P_n	r	f
0,93	0,75	0,90	0,50

$$\alpha = \alpha_m/0.315 = (0{,}28 \pm 1{,}55) \cdot 10^{-4}$$

TABLE II — Cd (n,γ) experiment . (8 – 9,4) Mev

Series I

	α_{mI} $\times 10^{-4}$	σ $\times 10^{-4}$
	- 0,02	1,67
	+ 0,83	2,10
	+ 0,83	2,36
	- 0,11	2,21
Total	+ 0,62	1

Ω	P_n	r	f
0,99	0,75	1	0,92

Series II

	α_{mII} $\times 10^{-4}$	σ $\times 10^{-4}$
	- 0,55	2
	- 0,43	1,8
	+ 0,82	1,83
	- 0,80	1,22
Total	- 0,28	0,81

Ω	P_n	r	f
0,99	0,75	1	0,68

$$\alpha_I = \alpha_{mI}/0{,}68 = (0{,}91 \pm 1{,}47) \cdot 10^{-4} \qquad \alpha_{II} = \alpha_{mII}/0{,}505 = (-0{,}55 \pm 1{,}59) \cdot 10^{-4}$$

Weighted average :

$$\alpha = (0{,}216 \pm 1{,}13) \cdot 10^{-4}$$

TABLE III Cd (n,γ) experiment. (7,3 – 7,9) Mev

Series I

α_{mI} 10^{-4}	σ 10^{-4}
- 1,18	1,30
+ 0,51	1,57
- 0,37	1,40
Total -0,33	0,815

Ω	P_n	r	f
0,99	0,75	1	0,96

Series II

α_{mII} 10^{-4}	σ 10^{-4}
+ 0,35	1,93
+ 0,15	1,30
- 0,41	1,36
Total - 0,02	0,85

Ω	P_n	r	f
0,99	0,75	1	0,85

$\alpha_I = \alpha_{mI}/0{,}71 = (-0{,}47 \pm 1{,}15) \cdot 10^{-4}$ $\alpha_{II} = \alpha_{mII}/0{,}63 = (-0{,}03 \pm 1{,}35) \cdot 10^{-4}$

Weighted average:

$$\alpha = (0{,}296 \pm 0{,}86) \cdot 10^{-4}$$

NOTICE TO THE READER

All Euratom reports are announced, as and when they are issued, in the monthly periodical **EURATOM INFORMATION,** edited by the Centre for Information and Documentation (CID). For subscription (1 year : US$ 15, £ 5.7) or free specimen copies please write to :

Handelsblatt GmbH
"Euratom Information"
Postfach 1102
D-4 Düsseldorf (Germany)

or

Office central de vente des publications
des Communautés européennes
2, Place de Metz
Luxembourg

To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

SALES OFFICES

All Euratom reports are on sale at the offices listed below, at the prices given on the back of the front cover (when ordering, specify clearly the EUR number and the title of the report, which are shown on the front cover).

PRESSES ACADEMIQUES EUROPEENNES
98, Chaussée de Charleroi, Bruxelles 6

Banque de la Société Générale - Bruxelles
compte N° 964.558,

Banque Belgo Congolaise - Bruxelles
compte N° 2444.141,

Compte chèque postal - Bruxelles - N° 167.37,

Belgian American Bank and Trust Company - New York
compte No. 22.186,

Lloyds Bank (Europe) Ltd. - 10 Moorgate, London E.C.2,

Postcheckkonto - Köln - Nr. 160.861.

OFFICE CENTRAL DE VENTE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
2, place de Metz, Luxembourg (Compte chèque postal N° 191-90)

BELGIQUE — BELGIË
MONITEUR BELGE
40-42, rue de Louvain - Bruxelles
BELGISCH STAATSBLAD
Leuvenseweg 40-42 - Brussel

DEUTSCHLAND
BUNDESANZEIGER
Postfach - Köln 1

FRANCE
SERVICE DE VENTE EN FRANCE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
26, rue Desaix - Paris 15e

ITALIA
LIBRERIA DELLO STATO
Piazza G. Verdi, 10 - Roma

LUXEMBOURG
OFFICE CENTRAL DE VENTE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
9, rue Goethe - Luxembourg

NEDERLAND
STAATSDRUKKERIJ
Christoffel Plantijnstraat - Den Haag

UNITED KINGDOM
H. M. STATIONARY OFFICE
P. O. Box 569 - London S.E.1

EURATOM — C.I.D.
51-53, rue Belliard
Bruxelles (Belgique)