



**HAL**  
open science

# MEASUREMENT OF n-p AND p-p ASYMMETRY WITH ACCELERATED POLARIZED DEUTERON BEAM

J. Bystricky, J. Deregél, F. Lehar, A. de Lesquen, L. van Rossum, J. M. Fontaine, F. Perrot, J. Arvieux, T. Hasegawa, C. Newsom, et al.

► **To cite this version:**

J. Bystricky, J. Deregél, F. Lehar, A. de Lesquen, L. van Rossum, et al.. MEASUREMENT OF n-p AND p-p ASYMMETRY WITH ACCELERATED POLARIZED DEUTERON BEAM. Journal de Physique Colloques, 1985, 46 (C2), pp.C2-463-C2-466. 10.1051/jphyscol:1985256 . jpa-00224571

**HAL Id: jpa-00224571**

**<https://hal.science/jpa-00224571>**

Submitted on 4 Feb 2008

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## MEASUREMENT OF n-p AND p-p ASYMMETRY WITH ACCELERATED POLARIZED DEUTERON BEAM

J. Bystricky, J. Deregel, F. Lehar, A. de Lesquen, L. Van Rossum, J.M. Fontaine<sup>+</sup>, F. Perrot<sup>+</sup>, J. Arvieux<sup>++</sup>, T. Hasegawa<sup>++</sup>, C.R. Newsom<sup>++</sup>, H. Azaiez\* and A. Penzo\*\*

*DPhPE, CEN-Saclay, France*

*+DPhN/ME, CEN-Saclay, France*

*++LNS, CEN-Saclay, France*

*\*LAPP, Annecy, France*

*\*\*INFN, Trieste, Italy*

**Résumé** - Le pouvoir d'analyse pour la diffusion n-p élastique à 725 MeV a été déterminé d'après la mesure du rapport des pouvoirs d'analyse n-p et p-p avec un faisceau de 1450 MeV de deutons polarisés extrait de SATURNE II et en utilisant le pouvoir d'analyse p-p comme base. La polarisation des nucléons dans les deutons déterminée à partir de l'asymétrie p-p est en bon accord avec la valeur obtenue d'après la mesure directe de la polarisation vectorielle du faisceau de deutons .

**Abstract** - The analyzing power for n-p elastic scattering at 725 MeV was determined by measuring the ratio of n-p to p-p analyzing powers with 1450 MeV polarized deuterons from SATURNE II and using the p-p analyzing power as reference. The nucleon polarization in deuterons determined from the asymmetry  $\epsilon_{pp}$  agrees well with the value expected from direct measurement of the deuteron beam vector polarization.

We have determined the analyzing power for n-p elastic scattering by measuring simultaneously p-p and n-p scattering with quasi-free neutrons and protons in the SATURNE II polarized deuteron beam incident on the NN beam line polarimeter. The analyzing power  $A_{00n0}(n-p)$  is obtained directly by multiplying the measured ratio  $\epsilon_{np}^d / \epsilon_{pp}^d$  by the known analyzing power  $A_{00n0}(p-p)$ . The method takes advantage of the fact that protons and neutrons in polarized deuterons have the same polarizations. The resulting systematic uncertainties of  $A_{00n0}(n-p)$  are essentially only those due to the uncertainty on  $A_{00n0}(p-p)$ .

The measurements presented here were carried out with the 1450 MeV polarized deuteron beam and are compared with those obtained with the 725 MeV polarized proton beam. First we have studied the counting rates (Fig. 1) and asymmetries (Fig. 2) as function of  $\Delta\theta_{rec} = \theta - \theta_{conj}$ . Here  $\theta$  is the angular position of the recoil arm and  $\theta_{conj}$  is the conjugate angle for p-p elastic scattering with respect to the forward arm position at  $20.9^\circ$ .

Elastic p-p (n-p) scattering of quasi free protons (neutrons) are shown in Fig.1b(c). We observe practically no difference in the width of the peaks corresponding to scattering on hydrogen. The counting rates from the carbon target are essentially the same for free and quasi-free incident protons but the hydrogen effect for quasi-free protons is only about 2/3 of that for free proton beam. The relative rates of hydrogen and carbon events for quasi-free protons and quasi-free neutrons reflect the efficiency of 4 to 5 per cent of the neutron detectors.

The measured asymmetries for two opposite beam polarizations are shown in Fig. 2 . The Figure shows also the asymmetries  $\epsilon_{pp}$ ,  $\epsilon_{pp}^d$  and  $\epsilon_{np}^d$  for scattering on free target protons, calculated from the normalized  $CH_2 - C$  difference. In measurements

with incident proton beam, one expects  $\epsilon_{pp}$  to be a constant throughout the entire width of the hydrogen peak. This is in fact observed within errors (Fig. 2a). The data for both quasi-free incident protons and neutrons are consistent with independence on  $\Delta\theta_{rec}$  only at  $\Delta\theta_{rec} > 0$ , whereas at  $\Delta\theta_{rec} < 0$ ,  $\epsilon_{pp}$  is strongly decreasing. For  $\epsilon_{np}^d$  the statistical errors in this region are large and do not allow to draw any conclusion.

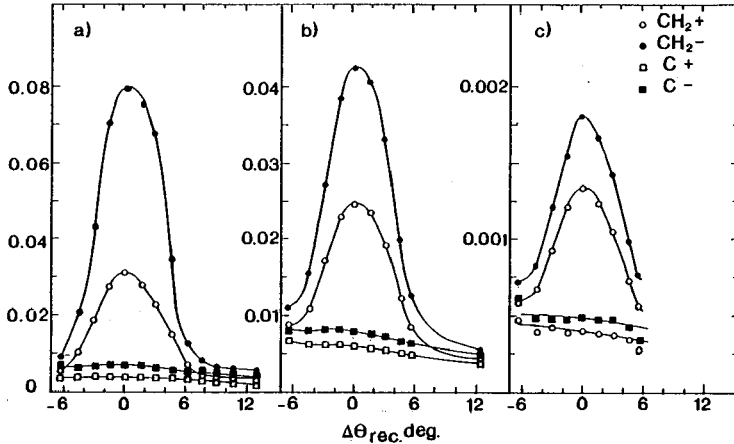


Fig. 1 - Counting rates from CH<sub>2</sub> and C target for + and - beam polarization state as a function of the backward arm position.  $\Delta\theta_{rec} = 0$  is the conjugate position for elastic p-p scattering. The forward arm is at 20.9° lab.

- a) proton beam  
 b) and c) deuteron beam  
 a) and b) two charged particles detected  
 c) forward neutron and backward charged particle

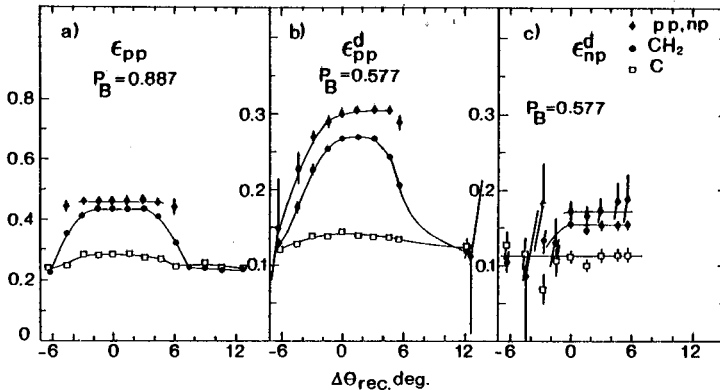


Fig. 2a,b,c - Asymmetries calculated from the data shown in Figures 1a, 1b and 1c, respectively.

The different behaviour of  $\epsilon_{pp}$  and  $\epsilon_{np}^d$  at  $\Delta\theta_{rec} < 0$  could be due to contributions to the hydrogen effect from reactions others than p-p elastic scattering (e.g.  $pp \rightarrow d\pi^+$ ).

The results of the measurements with deuteron beam of 1450 MeV at three different forward angles with the recoil protons at  $\Delta\theta_{rec} = 0$  are given in Table 1.

The column 6 gives the measured ratio  $\epsilon_{np}^d / \epsilon_{pp}^d$ . Using at each angle the known

values of the analyzing power  $A_{\text{oono}}(p-p)$  shown in column 7 we obtain the analyzing powers  $A_{\text{oono}}(n-p)$  - column 8 - shown in Fig. 3 together with the data from LAMPF (obtained with unpolarized neutron beam and polarized proton target). Our results agree well with the LAMPF measurements and confirm their absolute normalization.

From the measured asymmetries  $\epsilon_{pp}^d$  and the known analyzing power  $A_{\text{oono}}(p-p)$ , we calcu-

$\theta_{\text{lab.}}$ deg.	p or n $\theta_{\text{CM}}$ deg.	$\epsilon_{np}^d$	$\epsilon_{pp}^d$	$\frac{\epsilon_{np}^d}{\epsilon_{pp}^d}$	$A_{\text{oono}}$ p-p	$A_{\text{oono}}$ n-p	$P_B$
16.1	37.6	0.1999 $\pm 0.0038$	0.3056 $\pm 0.0012$	0.6541 $\pm 0.0259$	0.5293 $\pm 0.0012$	0.3462 $\pm 0.0137$	0.5774 $\pm 0.0026$
18.4	42.9	0.1859 $\pm 0.0041$	0.3097 $\pm 0.0012$	0.6003 $\pm 0.0293$	0.5345 $\pm 0.0014$	0.3208 $\pm 0.0157$	0.5794 $\pm 0.0029$
20.9	48.4	0.1715 $\pm 0.0050$	0.3002 $\pm 0.0015$	0.5713 $\pm 0.0367$	0.5232 $\pm 0.0019$	0.2988 $\pm 0.0193$	0.5738 $\pm 0.0036$

Table 1 - Results for the ratio  $\epsilon_{np}^d / \epsilon_{pp}^d$  and for the analyzing power  $A_{\text{oono}}(n-p)$ . The last column shows the beam nucleon polarization deduced from these measurements.

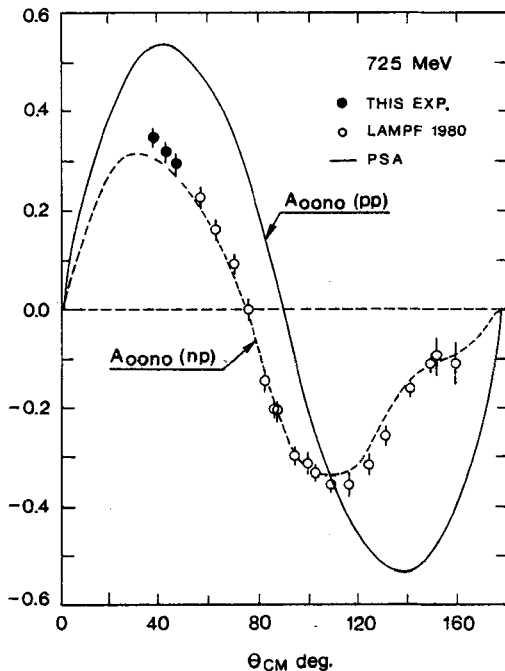


Fig. 3 - Results for the analyzing powers of 725 MeV elastic n-p scattering at three angles. Also shown are the LAMPF data at the same energy and the Saclay-Geneva phase shift analysis predictions for  $A_{\text{oono}}(n-p)$  and  $A_{\text{oono}}(p-p)$ .

late the beam nucleon polarization  $P_B$  in the polarized deuteron beam given in the last column of Table 1.

The weighted average ( $P_B = 0.5773 \pm 0.0017$ ) can be compared to the value expected from the independent measurement of the deuteron vector polarization  $P_d = 0.651 \pm 0.009$

(statistics)  $\pm 0.027$  (systematics) before injection. Assuming a D wave contribution of  $0.064 \pm 0.006$  and no Fermi momentum cut in the deuteron wave function one predicts a nucleon polarization of  $0.589 \pm 0.027$  in excellent agreement with our value of  $P_B$ . The result is consistent with no depolarization during deuteron acceleration. The agreement checks our assumption that the same analyzing power  $A_{0000}(p-p)$  describes the asymmetry for elastic scattering of free protons and of protons in deuterons.

The present experiment also yields "inclusive" asymmetries with only one charged or neutral particle detected.