THE NORMALIZATION OF N-N POLARIZATION OBSERVABLES NEAR 180 MeV

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As a byproduct of the CSB experiment (see report this volume[1]), very statistically precise measurements of the analyzing power and spin correlation parameter C_{nn} in n-p and p-p scattering have been made near 180 MeV. Low statistics preliminary n-p data have been published[2] and have constrained the $^3D_2$ phase shift and demonstrated deficiencies in the Paris potential's ability to describe free scattering observables. These conclusions were based on the shape of angular distributions and hence, as for the CSB results themselves, the precise absolute normalizations of the polarizations were not essential. While some other information can be extracted without knowing the polarizations, e.g. the energy dependence of the n-p analyzing power zero-crossing shown in Fig. 1, an independent polarization normalization is needed to get the full utility of the spin correlations and analyzing powers.

This report describes progress in a series of measurements devised to provide absolute normalizations for these N-N data taken in conjunction with the CSB experiment. The goal is to provide absolute normalizations accurate to $\pm 2\%$ or better for the n-p analyzing power. The scheme chosen has involved 3 separate approved experiments at IUCF. The first step was to obtain a precisely known absolute analyzing power near 180 MeV which could serve as a standard to be transferred to polarimeters and hence used to normalize other experiments. This was done in E290 (see report this volume[3]) by taking advantage of special relationships between the analyzing power and spin transfer parameters in spin 1/2 on spin 0 scattering when the analyzing power is close to 1. The results of this experiment make it possible to accurately determine the polarization of the high energy proton beams from the cyclotron by cross calibration to suitable polarimeters.

The second step of the scheme involved precise measurements of the p-p analyzing power in E273. This experiment (described previously[4]) was performed in the 64″ scattering chamber using left-right symmetric NaI detectors and a gas cell. Measurements were made from 15° to 90° in the center of mass. This experiment was completed in 1987 and analysis is well under way. The polarization of the beam was monitored online with high energy polarimeters based on p-^{12}C scattering. At various times during the run p-^{4}He elastic scattering data was taken with the 64″ chamber setup. This data was taken

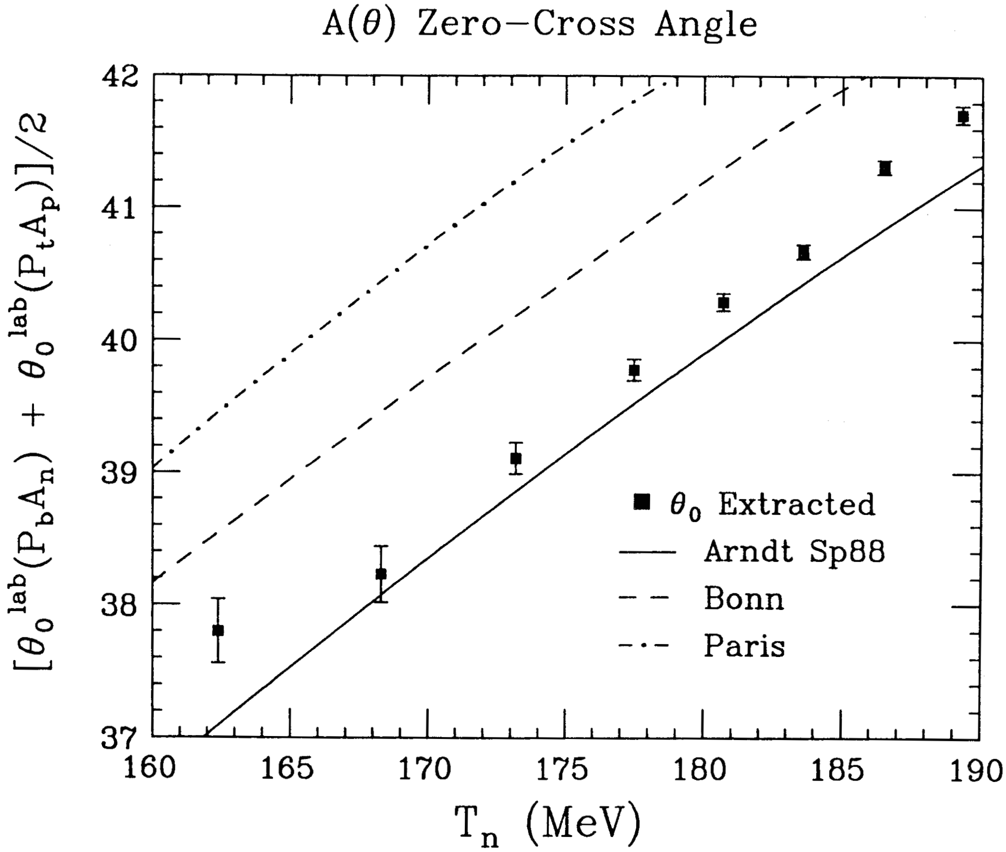

Figure 1. Zero crossing of the n-p analyzing power determined in the CSB experiment as a function of laboratory bombarding energy. The neutron beam energy is determined from the neutron time of flight versus the rf. The lab zero-crossing angle plotted is the average for the analyzing power measured with the neutron beam polarized (A_n) and the proton target polarized (A_p). The error bars shown represent statistical uncertainties only. There is an overall absolute energy uncertainty of about ± 2 MeV. The $^3S_1$ phase shift is particularly sensitive to the zero crossing.

near where the p-^{4}He analyzing power approaches a value of 1. Data from E290 taken on ^{4}He should provide a very precise determination of this analyzing power and hence cross calibrate the high energy polarimeters and p-p analyzing power.

We see now that with an accurate p-p analyzing power the p-p spin correlation parameter data can be normalized. This is done by comparing the asymmetries measured with the secondary polarized proton beam in the PNF and the polarized target to the E273 p-p analyzing powers to determine the beam and target polarizations, respectively. These polarizations then fix the spin correlation normalization.

Normalizing the n-p data required one more experiment, E327. This experiment used the same setup as the CSB experiment with the only change being that a sweeper magnet normally energized to deflect protons from the neutron beam was turned off. This resulted in a mixed neutron and proton beam incident on the polarized target. In this way n-p and p-p events scattered from the polarized target were detected simultaneously. The result is that asymmetries for n-p and p-p scattering are measured with an identical target polarization. Since as above we know the p-p scattering analyzing power accurately from E273, the target polarization is determined and the n-p analyzing power is normalized. This analyzing power can then be compared to the high precision data from the CSB running to determine the neutron beam and target polarizations and hence fix the normalization of the n-p spin correlation data.

This last experiment, E327, was completed this past April. Analysis of the series of experiments will be going on through the rest of the year. We feel the experiments have been successful, but it will be necessary to get all the experiments completely analyzed and check internal consistency among the measurements before we will be sure we have attained our original goal of 2% absolute accuracy.

1. C. Bloch *et al.*, IUCF Scientific and Technical Report, May 1989–April 1990.
2. J. Sowinski *et al.*, Phys. Lett. **B199**, 341 (1987).
3. S.W. Wissink *et al.*, IUCF Scientific and Technical Report, May 1989–April 1990.
4. J. Sowinski *et al.*, IUCF Scientific and Technical Report, 1986.

PREPARATIONS FOR A PRECISE MEASUREMENT OF C_{NN} AND A_y FOR THE $\vec{p}(\vec{n},d)\gamma$ REACTION AT $T_n = 183$ MeV (EXPERIMENT E328)

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The first major 'post-CSB' experiment to be mounted in the polarized neutron facility (PNF) should be ready to begin production running this summer. The primary motivation for this radiative capture experiment is to provide a quantitative test for theoretical treatments that incorporate meson-exchange currents and baryon resonance excitation at an energy where these effects are expected to be significant, while consideration of only a small number of relatively light mesons and baryons should be a good approximation. Calculations by Jaus and Woolcock[1,2] and by Arenhövel[3] for $d(\gamma,\vec{n})\vec{p}$ at $E_\gamma = 100$ MeV (nearly equivalent in c.m. energy to $T_n = 183$ MeV for $p(n,d)\gamma$) show that the spin correlation coefficient C_{NN} should be considerably more sensitive to the inclusion of meson exchange and isobar current effects than are the (previously measured) differential cross section and neutron analyzing power. We plan to measure C_{NN}, for the first time for