MEASUREMENT OF POLARIZATION TRANSFER IN THE ^{28}Si$(p,n)^{28}$P(6^-) REACTION AT 295 MeV

K. Yako, H. Sakai, H. Okamura, T. Wakasa,[a] H. Otsu,[a] T. Nonaka,
T.Ohnishi, S. Fukusaka, K. Sekiguchi, and K. Hatanaka[b]

Department of Physics, University of Tokyo, Bunkyo, Tokyo 113, Japan
[a] *Institute for Chemical and Physical Research (RIKEN), Wako, Saitama 351-01, Japan*
[b] *Research Center for Nuclear Physics (RCNP), Ibaraki, Osaka 567, Japan*

The study of stretched states through measurements of polarization transfer (PT) observables is suitable for getting information on the effective nucleon-nucleon (NN) interaction in nuclei. It is because (1) a stretched state can be described as an excitation with a simple 1p-1h configuration, and (2) PT observables are less sensitive to distortion effects than other spin observables such as analyzing powers. Actually, some measurements of PT observables in (p,p') reactions to the stretched states suggest modifications of the effective NN interaction in nuclear medium [1, 2]. In the (p,p') reaction, however, we could not discriminate between the effect of medium modifications and that of isospin mixing. On the contrary, the (p,n) reaction excites exclusively the pure isovector modes.

In this article we report measurements of cross sections, analyzing powers, induced polarizations, and polarization transfer D_{NN} for the stretched 6^- state at 4.94 MeV via the ^{28}Si$(\vec{p},\vec{n})^{28}$P reaction at 295 MeV. The data presented here were obtained with the Neutron Time-of-Flight facility [3] at the Research Center for Nuclear Physics. We used natural silicon targets (92.2% ^{28}Si, 4.7% ^{29}Si, and 3.1% ^{30}Si) for the measurement. Figure 1 shows the double differential cross sections at $\theta_{\rm lab} = 27.8°$ as a function of excitation energy of ^{28}P. The overall energy resolution is about 1.6 MeV in full width of half maximum. Since this energy resolution is not sufficient to isolate the 6^- state at 4.94 MeV, we have fitted the spectra with three gaussians and a smooth background to extract the cross sections and spin observables of the stretched state (See Fig. 1). Depending on the way of background subtraction, the D_{NN} values vary by less than 0.04.

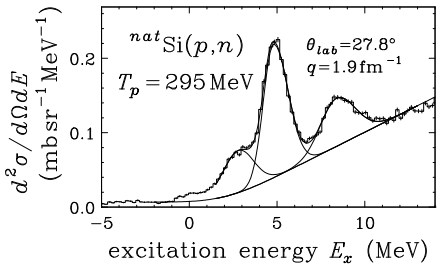

Figure 1: The double differential cross sections at 27.8°.

Figure 2 shows the preliminary results of cross sections, analyzing powers, induced polarizations, and polarization transfer D_{NN} as a function of momentum transfer. The solid curves in Fig. 2 are the results of DWIA calculations by using the computer code DW81 [4]. The effective NN interaction was the free NN t-matrix at 325 MeV parameterized by Franey and Love [5]. The configuration of the 6^- transition was assumed to be $(\pi f_{7/2}, \nu d^{-1}_{5/2})$. The optical-model parameters used were taken from Ref. 6. The single particle radial wave functions were assumed to have a harmonic oscillator shape with a range parameter $b = 1.743$ fm [6]. The cross section data are well reproduced by the calculations at $q \geq 1.7$ fm^{-1}, which indicates the predominance of the 6^- state in this region. The difference between the experimental and calculated cross sections at $q < 1.7$ fm^{-1} might be due to the contribution from excitations with small angular momenta. In the 6^- dominant region ($q \geq 1.7$ fm^{-1}), the calculations could not reproduce the polarization observables, especially the D_{NN} values. This discrepancy could be attributed to some medium modifications of the effective NN interaction.

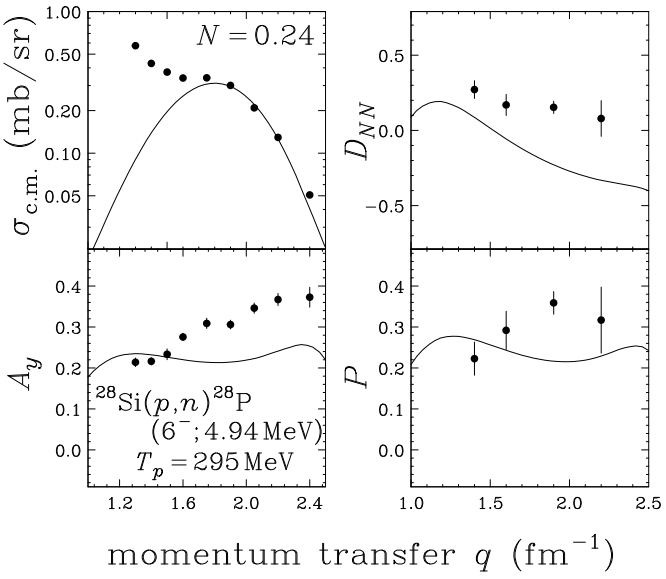

Figure 2: Cross sections, analyzing powers, induced polarizations, and polarization transfer D_{NN} for the ^{28}Si $(\vec{p},\vec{n})^{28}$P (6^-;4.94 MeV) reaction at 295 MeV. The solid curves are the results of DWIA calculations by using the free NN interaction of Franey and Love.

The comparison of the D_{NN} values between the $^{28}\mathrm{Si}(\vec{p},\vec{p'})^{28}\mathrm{Si}(6^-;T{=}1)$ [1, 2] and $^{28}\mathrm{Si}(\vec{p},\vec{n})^{28}\mathrm{P}(6^-)$ reactions should reveal the effect of isospin mixing. Figure 3 shows the D_{NN} data at $q \sim 1.9$ fm^{-1} as a function of incident proton energy. The solid line shows the results of DWIA calculations by using the free NN interaction. The calculated D_{NN} values for (p,p') and (p,n) reactions are almost identical. It should be noted that the D_{NN} value in the (p,p') reaction at 295 MeV is expected to be 0.23 ± 0.12 by interpolating the two (p,p') data. This value is consistent with our (p,n) value of $D_{NN} = 0.15 \pm 0.04$. On the other hand, the DWIA calculation predicts the $D_{NN} = -0.27$ at 295 MeV which is inconsistent with both (p,p') and (p,n) data. Therefore, the effect of isospin mixing in the (p,p') measurements seems to be small. The difference between the data and the calculations in D_{NN} should be explained mainly by medium effects.

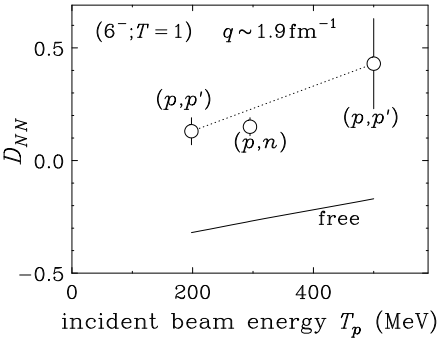

Figure 3: D_{NN} values at q=1.9 fm^{-1} in comparison with (p,p') measurement. The solid curve is the result of the DWIA calculation by using free NN interaction of Frany and Love.

References

1. E. J. Stephenson *et al.*, Phys. Rev. Lett. **78,** 1636 (1997).
2. E. Donoghue *et al.*, Phys. Rev. C **43,** 213 (1991).
3. T. Wakasa *et al.*, Nucl. Instrum. Methods A **404,** 355 (1998).
4. M. A. Schaeffer and F.Raynal, Program DW81.
5. M. A. Franey and W. G. Love, Phys. Rev. C **31,** 488 (1985).
6. K. Lin, M.Sc. thesis, Simon Fraser University, 1986.