Experimental study of proton-knockout reactions from s,p and d orbits

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Modification of nucleon and meson properties in nuclear medium is one of the most interesting topics in current nuclear physics. Such modification causes a density dependence of the nucleon-nucleon (NN) interaction and is expected to play an important role in nucleon induced reactions. Exclusive measurements of nucleon quasi-free scattering give a direct way to study the NN interaction in nuclei and thus to study meson and nucleon properties in nuclear medium.

In order to extract information on the NN interaction from quasi-free scattering data it is indispensable to check that nuclear distortion effect is well predicted theoretically. Here we report on our measurements of differential cross sections (d.c.s.) and analyzing powers (A_y) for (p,$2p$) reactions and on a comparison of these data with DWIA calculations. The measurements have been performed for several orbits of s, p and d-shells of ^{12}C and ^{40}Ca targets and four kinds of recoil momentum dependence are observed in order to check sensitivities of DWIA calculations to distorted wave, t-matrix and bound state wave function, separately.

The experiment was performed by using a 392MeV polarized beam and the two-arms spectrometer system, which consists of the Grand Raiden and LAS, at RCNP in July 1998. The defining slits, ± 20 mrad^W $\times$ ± 30 mrad^H for GR and ± 50 mrad^W $\times$ ± 45 mrad^H for LAS, were newly installed and utilized. The improved beam dump, which is presented elsewhere in this annual report, was used in this experiment.

A part of experimental data is plotted in Fig. 1. The error bars in the figure are only statistical ones. The ambiguity for the absolute value of d.c.s. is estimated to be 6% under assumptions that the efficiencies of plastic scintillators and charge collection of Faraday Cup are unity.

PWIA and DWIA calculations are also plotted in the same figure. As shown in the figure, recoil momentum dependence of d.c.s. is well reproduced by DWIA and peak values are reproduced within 20% by using the same normalization factor for all of kinematical conditions. For A_y, differences of experimental data and DWIA are less than 5% except regions where recoil momentum is large. These facts indicate that distortion effect is predicted in this such accuracy.

S-factors were deduced from the ratio of the experimental results to the DWIA calculations and listed in table 1. Ambiguities of these values are estimated to be 20% from the fit described above. S-factors from other reactions are also shown in the table. Present S-factors are consistent with those from (e,$e'p$) experiments within this ambiguity but S-factors from (d,^{3}He) reactions are 30 $\sim$ 40% smaller than the (p,$2p$) and (e,e'p) results. The (e,$e'p$) and (p,$2p$) reactions are geometrically similar reactions with two outgoing protons. Since the nuclear distortion effect is quite different between proton and electron, the consistency also shows that the distortion effect is well estimated by DWIA calculations.

Table 1: S-factors from this experiment and other experimental results.Two kinds of the present $(p,2p)$ results corespond to two kinds of DWIA calculations with different optical potential

		$(p,2p)$;this work		$(d,^3He)$[2],[3]	$(e,e'p)$[4],[5]
target	state	rel.Hartree	global	—	—
^{12}C	$1p_{3/2}$	1.4	1.3	2.98	1.72
^{12}C	$1p_{1/2}$	—	0.35	0.69	0.26
^{40}Ca	$1d_{3/2}$	1.8	2.1	3.76	2.58
^{40}Ca	$2s_{1/2}$	0.71	0.91	1.65	1.02

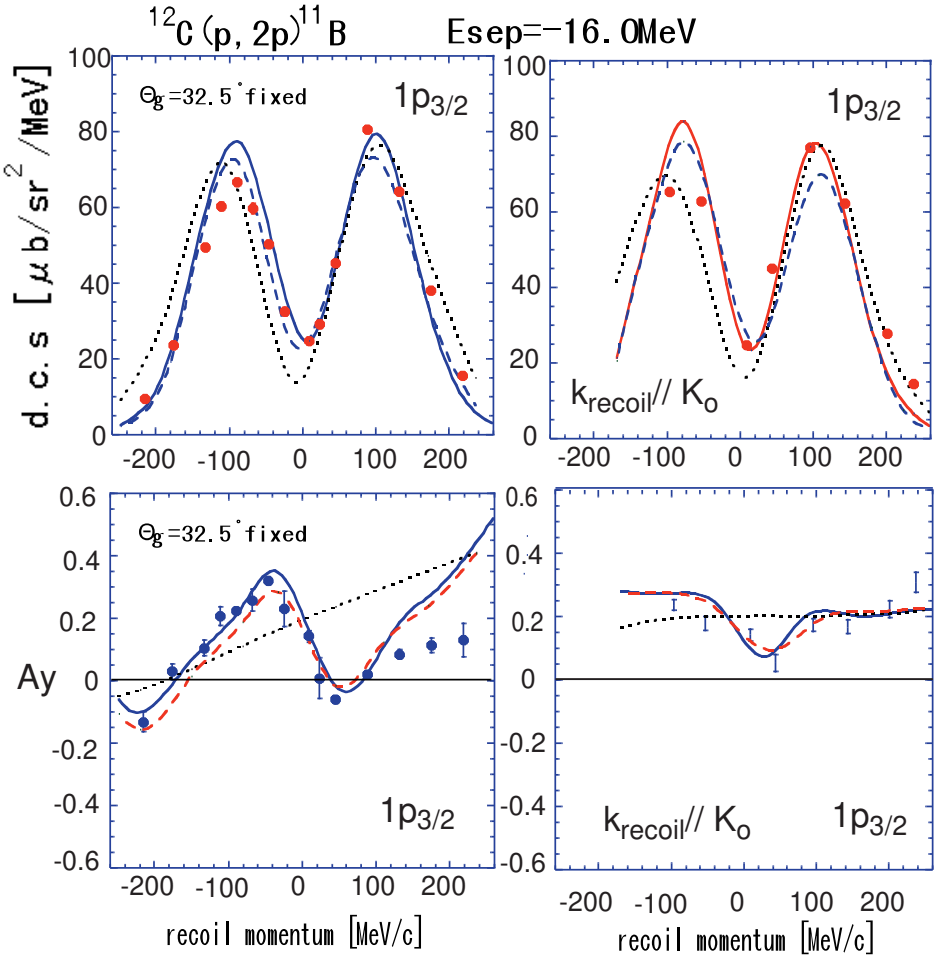

Figure 1: Two kinds of Recoil-momentum dependence (left,right) of the d.s.c and A_y. and an optical potential based on a relativistic Hartree calculation, respectively.

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