One and Two Neutron Transfer Reactions in Normal and Inverse Kinematics ◇

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1. Introduction

One- and two-nucleon transfer reactions with radioactive beams will enable unique insights into single-particle structure and nucleon pairing far off stability. Thus, these reactions are an ideal tool to study the evolution of shell structure in exotic nuclei.

We report here on first test experiments at the Munich Tandem accelerator, which aim to compare results from normal kinematics experiments with those of inverse kinematics reactions. The following reactions have been investigated so far: ^{58}Ni$(\vec{p},d)^{57}$Ni, ^{58}Ni$(\vec{p},t)^{56}$Ni, ^{62}Ni$(\vec{d},p)^{63}$Ni, d(^{62}Ni$,p)^{63}$Ni, and d(^{54}Fe$,p)^{55}$Fe. Future plans include the use of tritium loaded Ti foils for (t,p) reactions in inverse kinematics.

2. Experiments

For the normal kinematics reactions the Q3D spectrometer was used to measure excitation energies, angular distributions and analyzing powers. Fig. 1 shows differential cross-sections and analyzing powers for the ^{58}Ni$(\vec{p},d)^{57}$Ni reaction with 24.6 MeV polarized protons in comparison with DWBA calculations using the code FRESCO [1]. Optical model parameters were taken from Ref. [2]. The data has significantly better statistics than in the previous experiment [2] and will be used to test the wave functions calculated in modern shell model calculations [4], in which the ^{56}Ni core is severely broken.

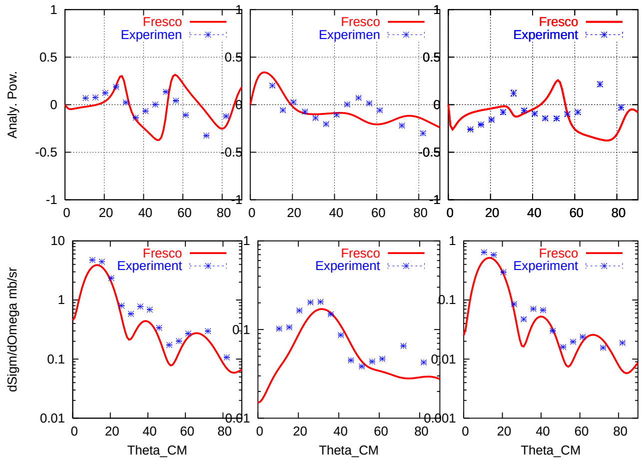

Fig. 1: Differential cross-sections and analyzing powers for the reaction ^{58}Ni$(\vec{p},d)^{57}$Ni $E_{\rm p}$=24.6 MeV for the 3/2$^-$ ground state (left), the 5/2$^-$ 0.768 MeV (middle) and 1/2$^-$ 1.112 MeV (right) excited states compared with DWBA calculations using the code FRESCO.

The inverse kinematics reactions d(^{62}Ni$,p)^{63}$Ni and d(^{54}Fe$,p)^{55}$Fe were performed in the Q3D target chamber at incident beam energies of 4.8 MeV/u using a deuterated Ti foil of 500 mg/cm^2 thickness and an annular DSSD detector for the detection of protons from the transfer reaction. The DSSD detector covered laboratory angles from 130° to 159° in the laboratory frame, which corresponds to 8° to 32° in the center of mass frame. Fig. 2 shows the differential cross section in the center of mass frame for the transfer into the ground state of ^{55}Fe in comparison to DWBA calculations using optical model parameters used for the description of the normal kinematics reaction [6]. The good agreement between data and calculation shows that the inverse kinematics reaction can be well understood.

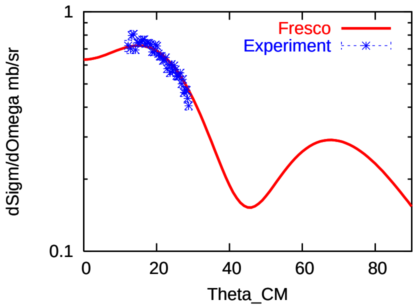

Fig. 2: Differential cross-sections in the center of mass frame for the ground state in ^{54}Fe populated in the reaction d(^{54}Fe$,p)^{55}$Fe at $E_{^{54}Fe}$ =140 MeV. The solid curve represents the DWBA calculations with FRESCO code using optical model parameters from [6].

A direct comparison of measured angular distributions and spectroscopic factors for the ^{62}Ni$(\vec{d},p)^{63}$Ni and d(^{62}Ni$,p)^{63}$Ni turned out to be difficult due to the limited excitation energy resolution in the DSSD detector of 75 keV, which was not sufficient to separate the low lying states at 0, 87, and 155 keV.

References

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