FINAL-STATE INTERACTIONS IN THE SYSTEM ^{8}He + n

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The neutron rich isotopes ^{6}He and ^{8}He are known to be halo nuclei with an extended valence neutron distribution. These even helium isotopes are particle stable. The odd isotopes ^{7}He and ^{9}He on the other hand are unstable against neutron emission. While the ground state of ^{7}He is known to be a $3/2^-$ state, the situation for ^{9}He is less clear. Some shell model calculations suggest that the ground state of ^{9}He should be $1/2^+$ instead of $1/2^-$ according to the normal shell order. This parity inversion is well established for ^{11}Be and there is mounting evidence that the same effect occurs for the lighter N=7 isotone ^{10}Li [1]. If the trend continues a $(1/2^+,1/2^-)$ pair should be separated by ~ 0.5-1 MeV for ^{9}He [2].

The nucleus ^{9}He has already been studied in a pion double charge exchange reaction on ^{9}Be [3]. The results were interpreted in terms of a number of sharp resonances of which the lowest was 1.1 MeV above the neutron emission threshold. This picture was confirmed by two-body reactions which were performed at the HMI [4]. Since an s state would not give the observed resonance-like structure we can assume that this state is the p state. A lower-lying s state can then be expected close to the particle threshold which should give a clear signal in an experiment measuring the final-state interaction between the neutron and the ^{8}He fragment.

We have studied the breakup of ^{10,11,12}Be on a light ^{9}Be target. The longitudinal and transverse momentum distributions of the outgoing neutron and fragment and the invariant mass spectra provide information on s and p state final-state interactions. To clarify the influence of the initial state, two projectiles ^{11,12}Be with very different sets of valence neutrons were used. The valence neutron in ^{11}Be is a relatively pure $s_{1/2}$ state while ^{12}Be in spite of its magic neutron number has a complex structure involving s,p and d neutron orbits. The projectile ^{10}Be was included to provide information on the relative contributions of the core and valence neutrons.

The experiment was performed at the NSCL using 30 MeV/u beams of ^{10,11,12}Be impinging on a 200 mg/cm^2 ^{9}Be target. The ^{10,11}Be nuclei were produced by fragmentation of a 80 MeV/u ^{13}C beam, provided by the K1200 cyclotron, in a 1900 mg/cm^2 ^{9}Be target. For the case of ^{12}Be a primary beam of 80 MeV/u ^{18}O bombarded a 1455 mg/cm^2 ^{9}Be production target. The fragments were identified in the A1200 fragment separator and separated using an achromatic plastic wedge placed in the second dispersive image of the A1200. The intensity of the secondary beams on target varied between about 20-80·10^3 particles per second.

A kinematically complete experiment requires the measurement of the angle and energy of the incident beam particle hitting the target and the emission angles and energies of the products leaving the target. The trajectory of the projectile was measured by a set of two PPACS in front of the target. The neutrons in coincidence with ^{8}He and other charged fragments were detected by means of the MSU neutron walls [5]. Neutrons could be separated from the large background of γ-rays via pulse shape discrimination. The position in the neutron cells provided the angle and the time of flight the energy of the neutron. For the charged fragments a double sided silicon strip detector behind the target provided angle and energy loss information. The particles were then swept by a dipole magnet into a plastic scintillator array yielding the fragment energy while the neutrons leaving the target traveled straight and arrived at the neutron walls which were centered at zero degrees [6]. For the identification of the incident beam particle the time of flight between a thin plastic scintillator after the A1200 focal plane and the fragment array was measured. The combination of energy loss and total energy allowed us to select the reaction channel of interest.

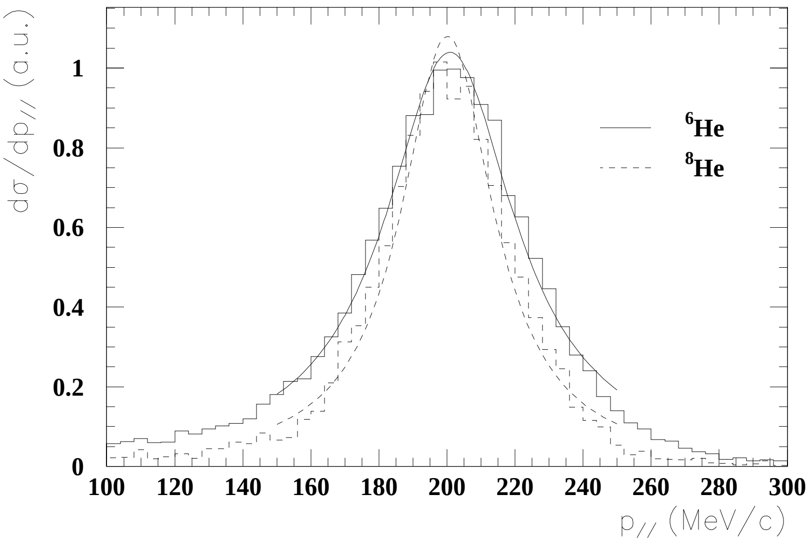

Fig. 1 Parallel momentum distribution of neutrons in coincidence with ^{6}He and ^{8}He fragments for the 30 MeV/u ^{11}Be beam. The histograms display the experimental data while the curves represent fits using a Lorentzian distribution with width parameter Γ = 51 MeV/c for ^{6}He and Γ = 39 MeV/c for ^{8}He.

The analysis of the data is underway. The ^{6}He and ^{8}He fragments could easily be separated. We have so far extracted total reaction cross sections and compared them to previous results obtained at about 40 MeV/u at Ganil [7]. For the He isotopes a total cross section of about 70 mb was measured for all three projectiles with about 10 mb for the interesting case of ^{8}He. At this moment the analysis of the neutron coincidence data is in progress. Investigation of the momentum distributions of the neutrons revealed a very narrow distribution for the ^{11}Be beam when selecting the ^{8}He+n exit channel. Fig. 1 shows the parallel momentum distribution of neutrons in coincidence with ^{6}He and ^{8}He fragments. The experimental data could be fitted with a Lorentzian distribution with width parameters of Γ = 51 MeV/c and Γ = 39 MeV/c respectively. The narrow distribution in the latter case can be interpreted as an indication of a stronger final-state interaction in the ^{8}He+n system. For the ^{12}Be projectile on the other hand, the distribution becomes broader and very similar to the ^{6}He+n case. Besides the parallel and transverse momentum distributions we also plan to extract the invariant mass spectrum which corresponds to the decay energy of the system.

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