MEASUREMENT OF THE REACTION CROSS SECTION OF d(^{7}Be,^{8}B)n

C. F. Powell, D. J. Morrissey, D. Anthony, B. Davids, M. Fauerbach[a],
P. F. Mantica, F. M. Nunes[b], B. M. Sherrill, M. Steiner

In order to study the structure of the ^{8}B nucleus, NSCL Experiment 96019 measured the reaction cross section of the d(^{7}Be,^{8}B)n reaction in inverse kinematics. In addition, we have measured the reaction cross section of d(^{12}C,^{13}N)n, and the scattering cross sections of d(^{7}Be,^{7}Be)d and d(^{12}C,^{12}C)d. The details of these measurements have been described previously in [1] and [2].

In an attempt to interpret the measured cross sections in a theoretical framework, finite-range DWBA calculations of the cross sections have been performed using the code FRESCO [3]. Figure 1 shows the measured cross sections of d(^{12}C,^{12}C)d and d(^{12}C,^{13}N)n along with several different calculations using Optical Model potentials from the literature. The potentials are given in Table 1.

Figure 2 shows the measured cross sections of d(^{7}Be,^{7}Be)d and d(^{7}Be,^{8}B)n, along with several calculations using Optical Model potentials from the literature. The potentials used are given in Table 2.

The limited energy resolution of the system prevents the resolution of inelastic scattering from the purely elastic processes. Therefore, the contribution of inelastic processes to the measured cross section must be quantified in order analyze the scattering data. DWBA calculations have shown inelastic scattering to excited states of ^{7}Be is unlikely compared to the elastic scattering, and that such contributions can be neglected. However, excitation of the deuteron has been shown to be a significant part of the measured d(^{7}Be,^{7}Be)d scattering cross section. In order to remove this contribution, the DWBA cross section for deuteron excitation has been subtracted from the measured d(^{7}Be,^{7}Be)d scattering cross section.

In Figure 3, this corrected cross section is shown, along with a DWBA calculation of the elastic scattering. This calculation uses an Optical Potential which has been adjusted to fit the data points. The parameters of this potential (*nunC*) are given in Table 2.

Figure 4 shows the measured d(^{7}Be,^{8}B)n transfer reaction cross section, along with the results of several DWBA calculations. These calculations use the *nunC* potential (which reproduces the corrected scattering data) for the ^{7}Be + d entrance channel, and several potentials from the literature for the ^{8}B + n exit channel. The curves shown have been scaled by the given spectroscopic factor in order to fit the data.

The measurement of the d(^{7}Be,^{7}Be)d scattering cross section was limited by the inability to clearly resolve inelastic scattering to excited states of ^{7}Be. In addition, scattering events leading to excitation of the deuteron have been shown to make a significant contribution to the measured cross section. These limitations, along with the limited angular range of the measurement, have led to uncertainty in the Optical Model analysis of the scattering cross section.

This study of d(^{7}Be,^{8}B)n was the first to make a kinematically-complete coincidence measurement of the reaction cross section. The coincidence technique was quite successful, with very good agreement between the cross section measured using the ^{8}B events and the cross section measured using the coincidence neutrons. We have shown that such a measurement is feasible, it reduces the statistical uncertainty, and it provides a good check for self-consistency.

The Optical Model analysis of the measured d(^{7}Be,^{8}B)n cross section was limited by uncertainty of the entrance channel potential, as discussed above, and also by uncertainty in the exit channel potential. The lack of available data for neutron scattering from ^{8}B has forced us to use exit channel potentials derived from studies of other nuclei. The preliminary estimate of the Spectroscopic Factor for d(^{7}Be,^{8}B)n determined from this work is 0.29 ± 0.09, which is in contrast to the value of 0.87 determined for the mirror reaction ^{7}Li(d,p)^{8}Li [11]. Further work to refine these calculations is underway.

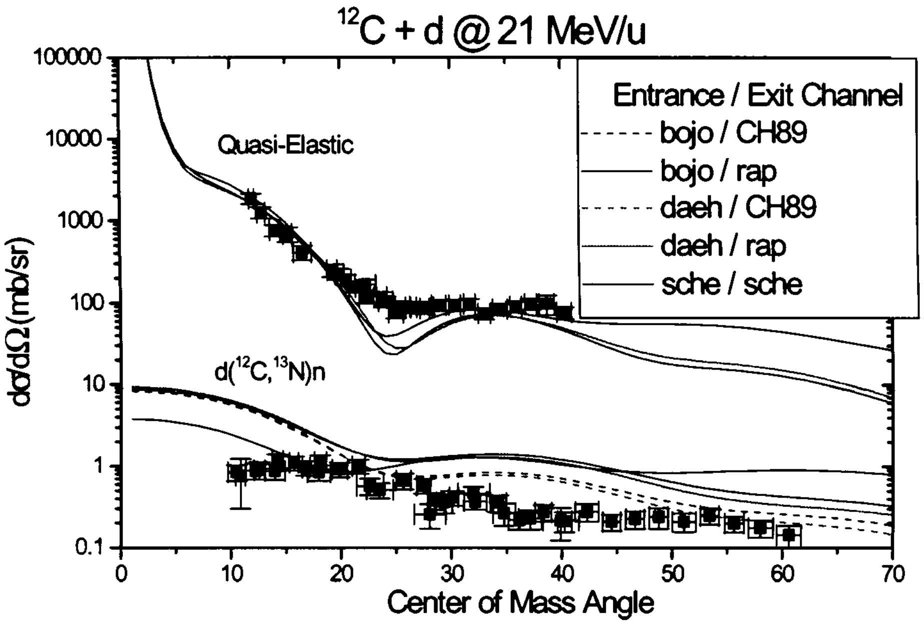

Figure 1: DWBA calculations of the d(^{12}C,^{12}C)d quasi-elastic and d(^{12}C,^{13}N)n transfer reactions at 21 MeV/u. Each line represents a different combination of entrance and exit channel parameters from the literature. The parameters of these potentials are listed in Table 1.

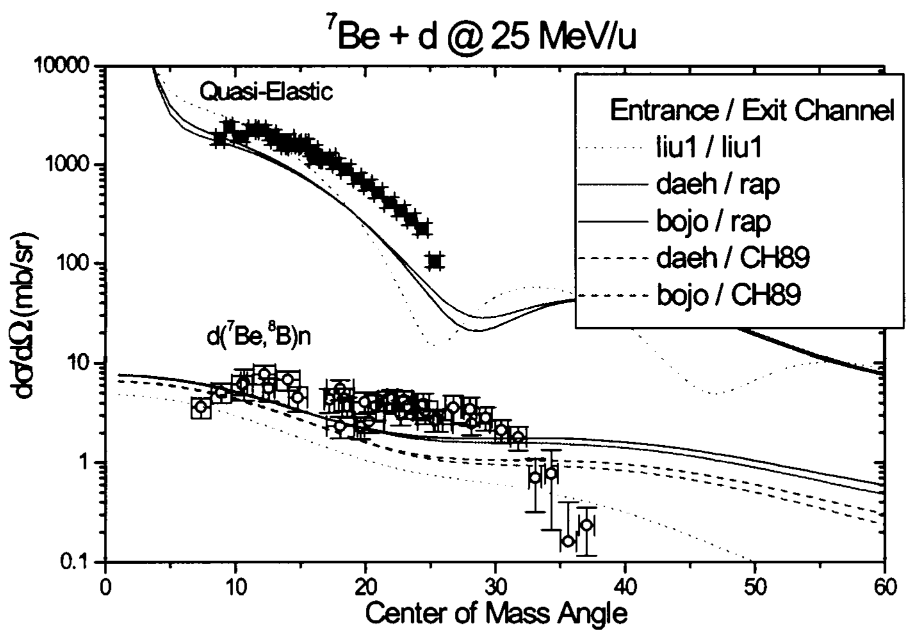

Figure 2: DWBA calculations of the d(^{7}Be,^{7}Be)d quasi-elastic and d(^{7}Be,^{8}B)n transfer reaction at 25 MeV/u. Each line represents a different combination of entrance and exit channel parameters taken from the literature. The parameters of these potentials are listed in Table 2.

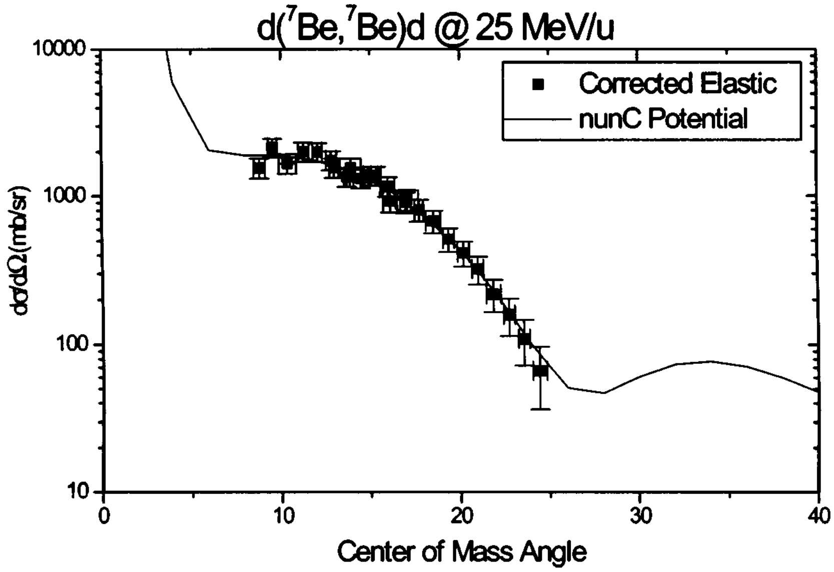

Figure 3: Scattering cross section of d(^{7}Be,^{7}Be)d which has been corrected for the effect of deuteron excitation. The points show the results of subtracting the calculated deuteron excitation cross section from the measured scattering cross section. The curve is a DWBA calculation using a potential which has been adjusted to fit this corrected data. The parameters of the *nunC* potential are given in Table 2.

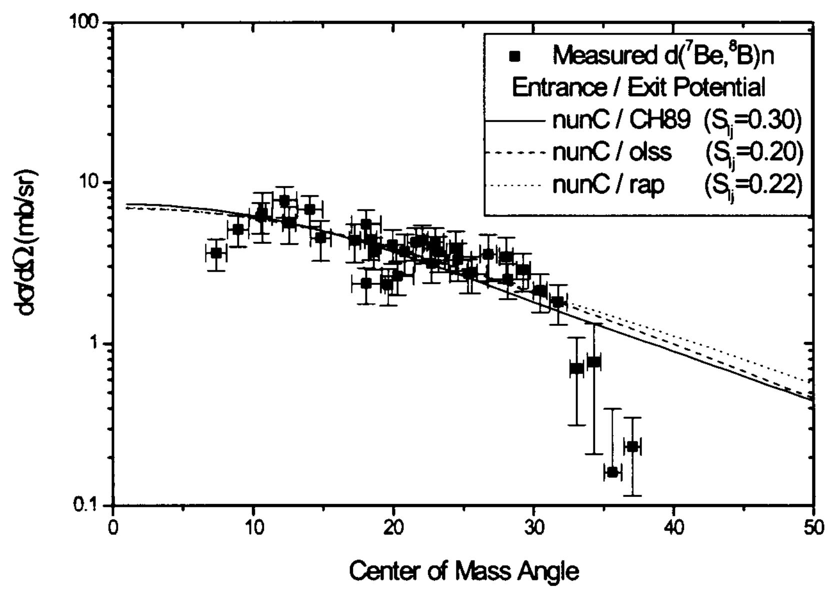

Figure 4: DWBA calculations of the d(^{7}Be,^{8}B)n transfer reaction which have been scaled by the given Spectroscopic Factor S_{lj}. The entrance channel potential is *nunC*, which was fit to the scattering data corrected by the calculated deuteron excitation cross section. The exit channel potentials were taken from the literature. The parameters of these potentials are given in Table 2.

Table 1 Optical Model Potential parameters used for the calculations of d(^{12}C,^{12}C)d and d(^{12}C,^{13}N)n.

Name	**Reference**	**Nuclei**	**V**	$\mathbf{r_V}$	$\mathbf{a_V}$	$\mathbf{W_{vol}}$	$\mathbf{r_{Wvol}}$	$\mathbf{a_{Wvol}}$	$\mathbf{W_{surf}}$	$\mathbf{r_{Wsurf}}$	$\mathbf{a_{Wsurf}}$	$\mathbf{V_{so}}$	$\mathbf{r_{so}}$	$\mathbf{a_{so}}$	$\mathbf{r_C}$
daeh	[4]	^{12}C + d	78.53	1.17	0.77	2.11	1.31	0.67	11.2	1.31	0.67	5.87	1.07	0.66	1.3
bojo	[5]	^{12}C + d	75.08	1.18	0.72	0	1.27	0.82	10.2	1.27	0.82	6	0.87	0.87	
rap	[6]	^{13}N + n	42.81	1.2	0.66	10.2	1.3	0.59	0	1.29	0.59	6.2	1.01	0.75	
CH89	[7]	^{12}C + d	42.39	1.15	0.69	15.5	1.15	0.69	5.06	1.15	0.69	5.9	0.82	0.63	
sche	[8]	^{12}C + d	118	0.89	0.93				6.11	1.52	0.79	5	0.89	0.93	1.3
sche	[8]	^{13}N + n	44.8	1.31	0.66				9.19	1.26	0.48	11	1.12	0.57	1.3

Table 2 Optical Model Potential parameters used for the calculations of d(^{7}Be,^{7}Be)d and d(^{7}Be,^{8}B)n.

Name	**Reference**	**Nuclei**	**V**	$\mathbf{r_V}$	$\mathbf{a_V}$	$\mathbf{W_{vol}}$	$\mathbf{r_{Wvol}}$	$\mathbf{a_{Wvol}}$	$\mathbf{W_{surf}}$	$\mathbf{r_{Wsurf}}$	$\mathbf{a_{Wsurf}}$	$\mathbf{V_{so}}$	$\mathbf{r_{so}}$	$\mathbf{a_{so}}$	$\mathbf{r_C}$
daeh	[4]	^{7}Be + d	75.75	1.17	0.78	2.97	1.31	0.65	10.57	1.31	0.65	5.61	1.07	0.66	1.3
bojo	[5]	^{7}Be + d	72.36	1.18	0.7	0.63	1.27	0.81	9.34	1.27	0.81	6	0.85	0.85	1.3
rap	[6]	^{8}B + n	44.31	1.2	0.66	11.36	1.29	0.59	0.53	1.29	0.59	6.2	1.01	0.75	1.3
liu1	[9]	^{7}Be + d	138.74	1.02	0.86	14.84	1.64	0.29	16.34	1.31	0.76	7	1.64	0.81	1.3
liu1	[9]	^{8}B + n	48.19	1.13	0.72				11.33	1.43	0.66	6.2	1.13	0.77	1.3
CH89	[7]	^{8}B + n	43.86	1.14	0.69	13.09	1.12	0.69	6.74	1.12	0.69	5.9	0.74	0.63	1.3
nunC		^{7}Be + d	37.44	1.04	0.81	15.9	1.43	0.56				1.82	4.28	0.65	1.97
olss	[10]	^{8}B + n	49.41	1.02	0.62				3.47	1.6	0.6	1.25	1.1	0.56	1.25

a. Present Address: Department of Physics, Florida State University, Tallahassee, FL 32306, USA
b. Permanent Address: CENTRA, Instituto Superior Técnico, Av. Rovisco Pais 1096 Lisboa, Portugal

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