# Measuring the $^{7}Be + p \rightarrow {}^{8}B$ ANC Through the $^{14}N(^{7}Be, {}^{8}B)^{13}C$ Reaction

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As part of an ongoing program to determine the astrophysical factor $S_{17}(0)$, we have extracted the asymptotic normalization coefficient, ANC, for $^{7}Be + p \rightarrow {}^{8}B$ using the reaction $^{14}N(^{7}Be, {}^{8}B)^{13}C$. The experiment was performed at the Cyclotron Institute using a radioactive beam of $^{7}Be$. Details of the experimental procedure and setup can be found in [1]. In this report we will focus on the analysis and results obtained.

A detailed Monte Carlo simulation code, written to simulate experimental conditions, was used to analyze the data. The parameters in the simulation were fine-tuned to reproduce the position, energy, and Q-value spectra obtained for the elastic $^{7}Be$ events. The experimental solid angles were then obtained by using a flat angular distribution as input to the simulation. This allowed us to reconstruct the differential cross section for the data shown in Figure 1.

The elastic scattering angular distributions were predicted using optical model parameters obtained from double folding model calculations convoluting Hartree-Fock density distributions with JLM effective nucleon-nucleon interactions. The folded potentials were then renormalized to match systematics in elastic scattering of eight *p*-shell nuclei at 9-16 MeV/u [2-4]. The calculated differential cross section, dotted line in Figure 1, was convoluted with the experimental resolutions using the simulation. The smoothed distribution was then overlaid in Figure 1 as the solid line. No arbitrary normalization factors were used to match the data and calculation in Figure 1. The quality of the agreement verifies that the beam integration is correct and that the simulation parameters match the experimental conditions quite well.

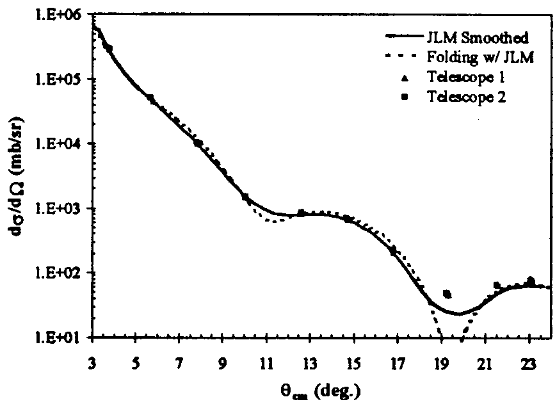


Fig. 1. Comparison of the elastic scattering differential cross section between data (circles and squares) and calculation (dotted). The solid line was obtained by convoluting the experimental resolutions with the theoretical calculations.

With the parameters in the simulation fixed to match the elastic scattering, the Q-value spectrum for the transfer reaction $^{14}N(^{7}Be, {}^{8}B)^{13}C$ was simulated and normalized to the data as shown in Figure 2. The two other peaks in Figure 2 were not included in the simulations since they do not contribute to the region of interest. The peak at -11 MeV is due to events populating the excited state of the $^{13}C$ target residue while the second peak at -15.5 MeV corresponds to $^{12}C(^{7}Be, {}^{8}B)^{11}B$ reactions on $^{12}C$ in the Melamine target.

The comparison to the Q-value fit was used to normalize the differential cross section of the data to DWBA calculations. This comparison is shown in Figure 3 for data (points) and total DWBA contribution (solid line). Also indicated in the figure are the individual contributions to the calculation due to the initial and final proton shell configurations. Once again excellent agreement is obtained.

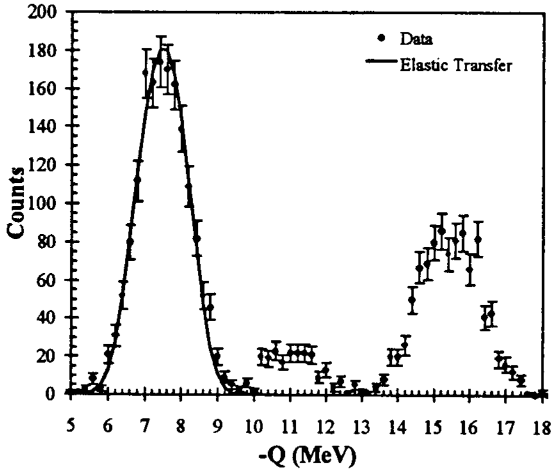


Fig. 2. Q-value spectrum for transfer reactions producing $^8B$ in the data (points). The solid line was obtained by fitting a simulation of the $^{14}N(^7Be, ^8B)^{13}C$ reaction to the data.

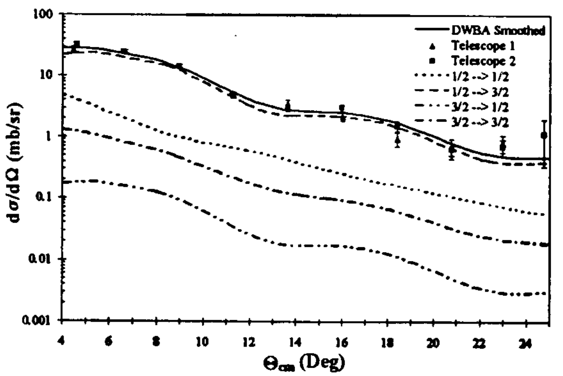


Fig. 3. Differential cross section measured for data (points with error bars) and the total DWBA calculation (solid line). Also shown are individual contributions from each proton shell configuration.

The normalization factor obtained from the Q-value fit and the ANC for $^{13}C + p \leftrightarrow {}^{14}N$ [3] allow us to calculate the ANC for the $^7Be(p,\gamma)^8B$ reaction. The ANC obtained for the $^7Be(p,\gamma)^8B$ reaction is $0.371 \pm 0.049\ fm^{-1}$. This ANC is then used to calculate the $S_{17}(0)$ from:

$$S_{17}(0) = \frac{38.6\ eV \cdot b}{fm^{-1}} C^2_{P_{3/2}} \left( 1 + \frac{C^2_{P_{1/2}}}{C^2_{P_{3/2}}} \right)$$

where the ratio $C^2_{P_{1/2}} / C^2_{P_{3/2}} = 0.157$ was obtained from microscopic calculations in $^8B$. The preliminary result is $S_{17}(0) = 16.6 \pm 2.2$ eV·b. This is in good agreement with the value of $17.8 \pm 2.8$ eV·b found from the $^{10}B(^7Be, ^8B)^9Be$ reaction [5]. All that is required to complete the present analysis is to confirm the uncertainty contribution from the DWBA calculation. The value quoted above contains a best guess value of 10% for the DWBA contribution which is shown in Table I along with other contributions to the uncertainty.

Table I. Error analysis.

| Source of Error | % Error |
|---|---|
| Simulation Parameters | 1.4 |
| Beam and Target | 5.0 |
| Normalization to Data | 2.6 |
| DWBA | 10.0 |
| $^{14}N$ ANC | 6.2 |
| Total | 13.3 |

## References


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[3] L. Trache *et al.*, Phys. Rev. **C58**, 2715 (1998).

[4] L. Trache *et al.*, this Progress Report.

[5] A. Azhari *et al.*, accepted for publication, Phys. Rev. Lett. (1999).



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