Comment on "Angular Distribution for the ^{7}Be$(d,n)^8$B Reaction at $E_{\mathrm{c.m.}} = 5.8$ MeV and the $S_{17}(0)$ Factor for the ^{7}Be$(p,\gamma)^8$B Reaction"

Recently, Liu *et al.* [1] reported a study of the ^{7}Be$(d,n)^8$B reaction at $E_{\mathrm{c.m.}} = 5.8$ MeV. They fit the forward-angle cross section, which they attribute to proton exchange, with zero-range distorted-wave Born approximation (DWBA) calculations to extract the asymptotic normalization coefficient (ANC) for the overlap of ^{7}Be + p in ^{8}B. Following our suggestion [2], they used this to infer the value of the $S_{17}(0)$ factor for the ^{7}Be$(p,\gamma)^8$B reaction at solar energies, concluding that $S_{17}(0) = 27.4 \pm 4.4$ eV b. This result is important since Liu *et al.* used a new independent technique to determine $S_{17}(0)$ from the ^{8}B ANC measured in a proton transfer reaction [2]. It is also significantly higher than the current adopted value used in solar models [3]. However, ambiguities in the choice of optical model parameters can lead to uncertainties in the ANC's extracted from transfer reactions [4] when the nuclear interior may make a non-negligible contribution or there exist few measured optical model potentials in the mass and energy range of interest. In this Comment, we show that such ambiguities make it difficult to draw precise conclusions regarding the ^{8}B ANC from the ^{7}Be$(d,n)^8$B reaction at this energy.

We fit the ^{7}Be$(d,n)^8$B angular distribution measured by Liu *et al.* with DWBA calculations from the code PTOLEMY [5], using the full transition operator. We assumed the same compound nuclear contribution as utilized by Liu *et al.* Our results were normalized to the known ANC, $C_d^2 = 0.76$ fm^{-1}, for $d \to p + n$ [6]. The single-proton orbital in ^{8}B was calculated in a Wood-Saxon potential with $r_0 = 1.25$ fm, $a = 0.65$ fm. Additional calculations varying this single-particle potential gave ^{8}B ANC's that were stable to $\pm 3\%$. Fits over the regions $\theta_{\mathrm{c.m.}}$ from 0° to 30°, 40°, and 60° all gave similar results.

In [1], the DWBA calculations used two different optical model parameter sets. Set 1 came from their own extrapolation of deuteron and neutron potentials to the energies and masses of interest. Set 2 came from 11.8 MeV d + ^{7}Li and 14 MeV n + B scattering [7]. We performed our DWBA calculations with these potentials, plus several others from [7]. One deuteron potential was derived from the same 11.8 MeV d + ^{7}Li data, but with a volume imaginary potential that fit the d + ^{7}Li elastic scattering better. Five additional potentials came from d + ^{9}Be scattering at 6.3–7.8 MeV. Three neutron potentials arose from n + B scattering at 14 or 9.72 MeV, including two that are similar to a global neutron potential [8] constructed for low-energy neutron scattering and one that corrected an error in neutron set 2 of Liu *et al.*, which used a surface Wood-Saxon rather than Gaussian imaginary potential [7]. Eight additional potentials came from p + ^{9}Be scattering at 5–9 MeV, which should be similar to n + ^{8}B. Four optical potentials (one d, three n) yielded total cross sections that deviated from the respective means by over 29%. They were discarded from consideration even when they provided good fits to the ^{7}Be$(d,n)^8$B data. The remaining potentials had total cross sections that varied by less than $\pm 15\%$.

Our results for the ^{8}B ANC when utilizing Liu *et al.* potential sets 1 and 2 are only 6 and 12% lower than their values. We investigated enough combinations of potentials to determine the range of ^{8}B ANC's that we obtain with each deuteron or neutron potential. We obtained fits to the experimental data comparable to those in Liu *et al.* with values of the ^{8}B ANC in the range $C^2 = 0.45$–0.77 fm^{-1}. The "extreme" fits were not isolated cases. Five deuteron potentials and six neutron potentials yielded ANC's of 0.50 fm^{-1} or below, and two deuteron potentials and three neutron potentials yielded ANC's of 0.70 fm^{-1} or above. It is useful to note that the corrected version of neutron set 2 gave excellent fits with ANC's as small as 0.46 fm^{-1} and yet is not included as one of the six neutron potentials with ANC's below 0.50 fm^{-1}. It implied an anomalously low n + ^{8}B total cross section and, thus, was one of the dicarded potentials. For each pair of potentials, C^2 was determined from the fit with a statistical accuracy of $\approx 11\%$. Thus, we obtain $S_{17}(0) = 23.5 \pm 6.7$ eV b.

In conclusion, we find that the theoretical uncertainty associated with the ^{8}B ANC determined from the ^{7}Be$(d,n)^8$B reaction is substantially larger than indicated in [1]. This arises from the ambiguities that exist at present in the appropriate low-energy optical model parameters to use for the d + ^{7}Be and n + ^{8}B systems.

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