Reply to “Comment on ‘Properties of ^{26}Mg and ^{26}Si in the sd shell model and the determination of the ^{25}Al(p,γ)^{26}Si reaction rate' ”

W. A. Richter, B. Alex Brown, A. Signoracci, and M. Wiescher

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Reply to the Comment by Chipps et al.

W. A. Richter[1,2] B. Alex Brown[3], A. Signoracci[3] and M. Wiescher[4]
[1] *iThemba LABS, P.O.Box 722, Somerset West 7129, South Africa*
[2] *Department of Physics, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa*
[3] *Department of Physics and Astronomy, and National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824-1321, USA and*
[4] *Department of Physics and Joint Institute for Nuclear Astrophysics, University of Notre Dame, Notre Dame, IN 46556, USA*

We discuss the implications for the ^{25}Al(p,γ)^{26}Si resonance-capture rate that result from the updates on the experimental data given in the Comment.

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The Comment by Chipps et al. [1] starts with a reminder of the astrophysical importance of this reaction. They present arguments for revised experimental values for the Q value and resonance energy of a final state. Our original paper [2] was not meant to update the experimental situation beyond that given in the paper by Matic et al. [3]. We appreciate the updated averages and have used them to recalculate the rate. We change the Q values from 5.5123 MeV to 5.5137 MeV and the energy of the 3^+ state from 5.9152(18) to their average of 5.923(2). The resonance energy for the 3^+ state changes from 403 keV to 409 keV. The ratio of the new rate (B) to our old rate (A) is shown in the top of Fig. 1. The bottom of Fig. 1 shows the ratio of the new rate (B) to that given in the 2010 evaluation [4]. The energy changes improve the agreement with the 2010 evaluation in the region of $\log_{10}$(T9) $= -0.7$.

The observation [5] of a 5.888 MeV resonance in the ^{24}Mg(^{3}He,n)^{26}Si reaction that gamma decays to three low-lying 2^+ states in ^{26}Si is an indication that the experimental situation is not yet final. The gamma decay looks like that expected for the 0^+_4 state. The gamma branchings for the mirror state in ^{26}Mg obtained with the USDB Hamiltonian are; 94% (2^+_1), 2% (2^+_2)and 2% (2^+_3) similar to what is observed in ^{26}Mg. The calculated branchings in ^{26}Si of 59% (2^+_1), 35% (2^+_2)and 4% (2^+_3) have a large mirror asymmetry and appear to be in qualitative agreement with that observed in [5].

A puzzle is why the 5.888 MeV state does not appear in the older (^{3}He,n) experiment [6] where two states were observed in this energy region at 5.912 and 5.946 MeV. In the mirror reaction ^{24}Mg(t,p)^{26}Mg [7] one observes a relatively strong 0^+_4 state (state number 14 in Fig. 2 of [7]) and a very weak 3^+_3 state (state number 13 in this figure). Based on this mirror reaction one might expect the relatively strong state observed in [6] at 5.912 MeV to be the 0^+_4, and the weaker one at 5.946 MeV to be the 3^+_3.

The 3^+_3 state is well established from the ^{26}P beta-delayed proton decay [8], [9] to have a resonance energy of 0.412 MeV consistent with the average energy of 5.923(2) MeV given in Table I of of the comment [1]. A large absolute proton branch of $b = 0.91(10)$ for this 3^+_3 state

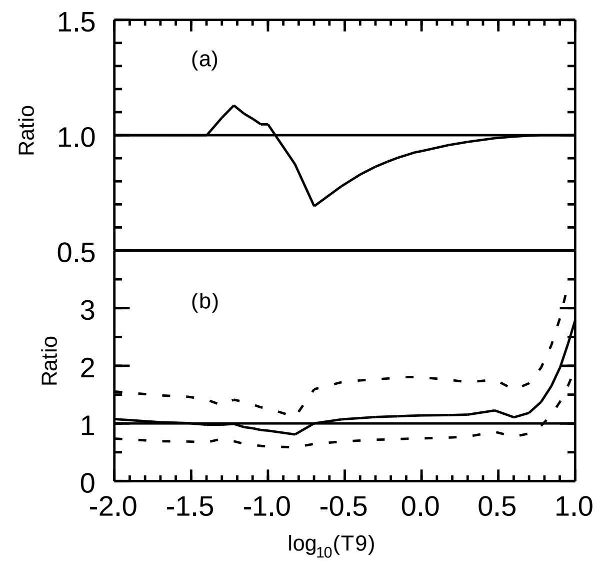

FIG. 1: (a) The new rate (B) divided by the old rate (A) of [2]. (b) The new rate (B) divided by the rate given in the 2010 evaluation (Table B.37 of [4]); solid line for the median rate and the dashed lines for the low and high rates.

has recently been measured [10]. This is in agreement with our (USDB) value [2] of $b = 0.967$. (Use of the experimental gamma-decay lifetime in ^{26}Mg in place of our USDB value would give $b = 0.991^{+0.002}_{-0.007}$). We also note from Table 3 of [11] that the experimental spectroscopic factors to the positive-parity levels obtained from the ^{25}Mg(d,p)^{26}Mg reaction are in good agreement with the USD theoretical values and to those we used in [2] including that for the 3^+_3 state. The 3^+_3 state is most important for the astrophysical rate since it is an ℓ=0 resonance. The position of the 0^+_4 state and its relationship to states populated in reaction experiments is not clear, but since it is an ℓ=2 resonance it is not very important for the astrophysical rate.

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