Comment on "From Coulomb excitation cross sections to nonresonant astrophysical rates in three-body systems: The ^{17}Ne case"

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Parfenova *et al.* state in [Phys. Rev. C **98**, 034608 (2018)] that the results presented by Casal *et al.* [Phys. Rev. C **94**, 054622 (2016)] concerning the radiative capture for ^{17}Ne formation are incorrect and their conclusions erroneous mainly because of two reasons: (1) it is "expressed" that the resonant rate is not important for $^{15}\mathrm{O}(2p,\gamma)^{17}\mathrm{Ne}$ since it is negligibly small compared with the nonresonant contribution to the rate, and (2) the electromagnetic dipole cross section predicted is dramatically different from the available experimental data for $^{17}\mathrm{Ne}+{}^{208}\mathrm{Pb}$ at 500 MeV/u [Phys. Lett. B **759**, 200 (2016)]. We demonstrate here that these conclusions are incorrectly extracted from our work.

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For nucleosynthesis studies, the determination of astrophysical reaction rates is an important subject. Among the relevant reactions, the two-proton capture on ^{15}O to produce ^{17}Ne, $^{15}\mathrm{O}(2p,\gamma)^{17}\mathrm{Ne}$, has been recently studied. In this context, in Ref. [1], Parfenova *et al.* state that the results for the reaction rate and the conclusions in Ref. [2] are wrong. However, they have incorrectly extracted two conclusions from our work, which we intend to refute here so as to maintain that the results in Ref. [2] are still relevant.

Point 1. In Ref. [1] it is said in the first page that "*an opinion was expressed in Ref. [2] that the resonance rate is not important for* $^{15}\mathrm{O}(2p,\gamma)^{17}\mathrm{Ne}$*, because it is negligibly small compared to the nonresonant contribution to the rate.*"

In our work [2], we only mention that our calculation contains resonant and nonresonant capture treated on the same footing. Therefore the statement by Parfenova *et al.* [1] about the resonant rate being not important while referring to our work seems to be an improper interpretation. On the contrary, what is demonstrated in Ref. [2] is that the resonant part may be relevant for the $^{15}\mathrm{O}(2p,\gamma)^{17}\mathrm{Ne}$ reaction rate. In Fig. 1 we reproduce Fig. 10 of Ref. [2] adapted for this comment. It shows two calculations of the relevant reaction rate: (i) one using a model with the $1/2^+$ resonance energy adjusted to the experimental value of 0.96 MeV [3] (solid black line), and (ii) a situation in which the $1/2^+$ resonance has been pushed up to higher energies (≈2.7 MeV above the threshold) by setting the three-body force to zero (dashed red line). The difference of these results shows clearly, within our model, a non-negligible contribution of the resonant part of the continuum to the reaction rate under study.

The $1/2^+$ resonance was first measured in a three-neutron pickup reaction [3]. We note that, while the structure of this state is under debate, its presence should produce a resonant contribution to Coulomb dissociation cross sections.

Point 2. In Ref. [1], Parfenova *et al.* also claim that the $B(E1)$ distribution from Ref. [2] does not reproduce the experimental data on $^{17}\mathrm{Ne}+{}^{208}\mathrm{Pb}$ dissociation at 500 MeV/u measured at GSI [4,5]. In Ref. [1], they show in Fig. 11 the comparison of the experimental data together with different $B(E1)$ theoretical distributions converted to Coulomb dissociation by Eq. (10) in that paper. The dotted line corresponds to, according to what they assert, our $B(E1)$ distribution from Ref. [2]. With this information they said on page 9 "*We have to state that the strength function from [2] and all the conclusions based on it are erroneous.*"

However, the dotted blue line in Fig. 11 of Ref. [1] presents our results in an incomplete, hence incorrect way. It corresponds to our $1/2^+$ component only. The authors of Ref. [1] omitted our $3/2^+$ contribution, without any mention to it. In Fig. 2 of this comment, we show the experimental data with the Coulomb dissociation cross section, calculated using the same formalism [Eq. (10) of Ref. [1]], for our total $B(E1)$

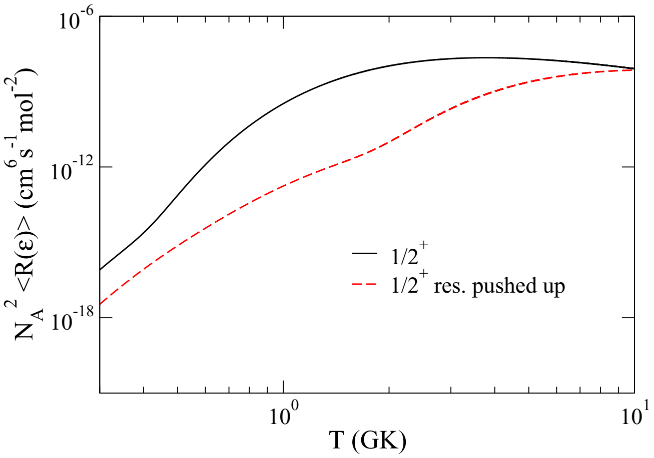

FIG. 1. Contribution to the $^{15}O(2p,\gamma)^{17}Ne$ reaction rate from $1/2^+$ states (black line). A calculation with the $1/2^+$ resonance pushed up to higher energies is also shown (red line). (Extracted from Fig. 10 of Ref. [2].)

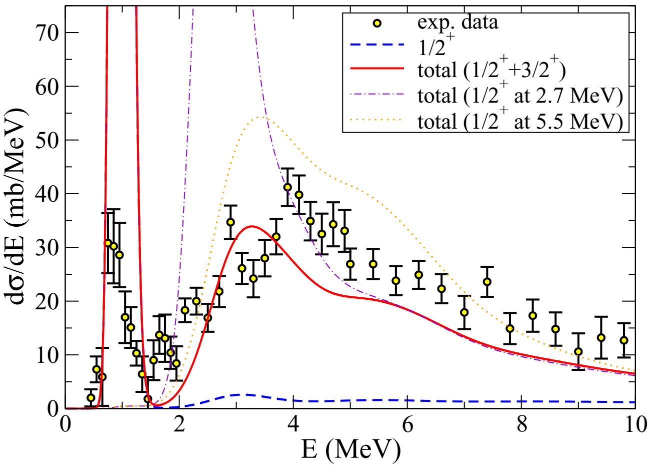

FIG. 2. Dissociation cross section for $^{17}Ne+^{208}Pb$ at 500 MeV/u. Experimental data from Ref. [4] is compared with theoretical results on Coulomb dissociation, for the $1/2^+$ $B(E1)$ distribution (dashed blue line) and for the total $(1/2^+ + 3/2^+)$ $B(E1)$ distribution (solid red line). We also present calculations by shifting the $1/2^+$ resonance position (see text).

distribution. This total $B(E1)$ distribution includes $1/2^+$ and $3/2^+$ states as was shown in Fig. 7 of Ref. [2]. We also include the Coulomb dissociation cross section corresponding only to the $1/2^+$ distribution to be compared with the dotted-blue line shown in Fig. 11 of Ref. [1]. From Fig. 2, we can see that the Coulomb dissociation cross section from our total $B(E1)$ follows the shape of the experimental data. Then, we conclude that our strength function, when including also the $3/2^+$ contribution, is reasonably close to the data at least in the energy region corresponding to the soft dipole mode above ≈2 MeV, and the omission by Parfenova *et al.* is unfortunate. Comparing our calculation with the data at that region, it shows minor differences, but two facts have to be considered: (1) Although Coulomb dissociation is the most relevant process in this reaction, a non-negligible nuclear contribution could exist as has been proposed for $^{11}Be + ^{208}Pb$ at 520 MeV/u [6]. This contribution, although small, could increase the cross section. (2) The theoretical distribution in Fig. 2 is a little bit displaced with respect to the experimental data, but the position of the maximum depends on the three-body force used for the $3/2^+$ states. For completeness we also show in Fig. 2 the Coulomb dissociation cross section obtained when the $1/2^+$ state obtained within our model is pushed up to 2.7 MeV (dot-dashed curve), and 5.5 MeV (dotted curve).

The authors of Ref. [1] provide arguments to explain the disagreement between our calculations and the data in the low-energy region, namely the nature of the $1/2^+$ resonance in our three-body model and its reliability based on the knowledge of its mirror state in ^{17}N and the available experimental information. It is not the purpose of this comment to refute any of these statements, nor to assert that the results by Parfenova *et al.* are wrong. We limit ourselves to the points raised above, giving our predictions the merit they deserve.

A longer discussion, aiming at a full understanding of the experimental data, may be subject for further investigations. In any case, it is worth noting that a model agreeing at higher relative energies cannot be guaranteed to be accurate for the low relative energies involved in astrophysics. This applies also to the results by Parfenova *et al.* [1]. These predictions do not imply that an accurate knowledge of the radiative capture rate has been achieved, since no data at such low energies are available.

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