Comment on "Fusion-fission dynamics of ^{188,190}Pt through fission fragment mass distribution measurements"

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Kavita *et al.* [Phys. Rev. C **100**, 024626 (2019)] analyze the width of the mass distributions of fission fragments from ^{28}Si + ^{160}Gd and ^{12}C + ^{178}Hf collisions. The authors report that the distributions "are reproducible with a single Gaussian at all studied energies". However, the fits presented in the figures show functions that do not correspond to single-Gaussian distributions. A critical analysis, presented here, sheds doubts on the characterization of the mass distributions.

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In the article [1], Figs. 3 and 4 are presented as Gaussian fits to the fragment-mass distributions, and the source of the analyzed width values. However, a close inspection reveals that all the fitted functions have their tails below zero, suggesting that the fitted function is the sum of a Gaussian distribution and a negative offset in the yield, resulting in truncated Gaussian functions.

Figure 1 of this comment shows the fragment-mass distributions presented in Ref. [1] with the Gaussian functions obtained from the article (green lines). An offset with respect to zero appears in all cases, reaching below −0.2 in some of them. The reasons for such negative offset are not explained in the paper, nor its use seems adequate in this case. The same figure shows new Gaussian functions, with no offset, fitted to the mass distributions for the purpose of this comment.

The widths reported in Fig. 5 and Table III of Ref. [1] are presented as the "variance of the fission fragment M_R distributions as a function of excitation energies"[1] and as "obtained from the fitting of mass ratio", which, according to the text, "are reproducible with a single Gaussian at all studied energies". However, it is not evident how these standard deviations are obtained from the functions shown in Figs. 3 and 4 of Ref. [1] since they are not *single*-Gaussian but truncated Gaussian functions.

The main goal of the mass-distribution fits in Ref. [1] seems to be the calculation of the standard deviation. The selection of any function to be fitted for this purpose introduces a certain bias that can be avoided if the standard deviation is computed directly from the contents of the mass-distribution histograms. In the case of addressing the symmetric and asymmetric contents, the fitted function should contain a realistic description of these components, such as Gaussian functions [2,3].

Assuming that statistical uncertainties are dominant, the residuals calculated in this way would be proportional to the actual ones. With actual single-Gaussian functions fitted to the data in this comment, the validity of the claim that the distributions "are reproducible with a single Gaussian at all studied energies" can be further addressed. Figure 1 of this comment shows histograms with the residuals from the newly fitted Gaussian functions, computed as a function of the mass ratio as $[Y(M_R) - f(M_R)]/\sqrt{Y(M_R)}$ with $Y(M_R)$ and $f(M_R)$ as the yield and the fitted function evaluated at M_R. Ideally, in order to obtain the residuals, the difference between both would be normalized to the data uncertainty; however, this is not given in Ref. [1]. Instead, the difference is here normalized to the square root of the yield.

The resulting distributions of residuals show a clear oscillating pattern in all the cases,[2] and with similar characteristics: positive residuals around $M_R \sim 0.4$ and 0.6, and negative ones around $M_R \sim 0.5$. The possibility of having such similar pattern in the residuals of all distributions by sheer chance is very unlikely; and remarkable, since the accumulated statistics of these distributions can vary in more than one order of magnitude, according to Figs. 1 and 2 in Ref. [1]. Such persistent pattern is a strong indication of contributions different from the single-Gaussian function used to reproduce the distributions.

The common pattern of the residuals suggests the presence of asymmetric fission components, similar to the case studied in [2]. Thus, a more accurate reproduction of the mass distributions should be done with multi-Gaussian functions [3]. This is evidenced in Fig. 2, where examples of two-

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[1]Incidentally, the concepts of variance and standard deviation seem to be mixed in the text.

[2]Maybe with the exception of the 120 MeV data from ^{28}Si + ^{160}Gd reactions, although the reduced histogram binning and statistics prevent any firm conclusion.

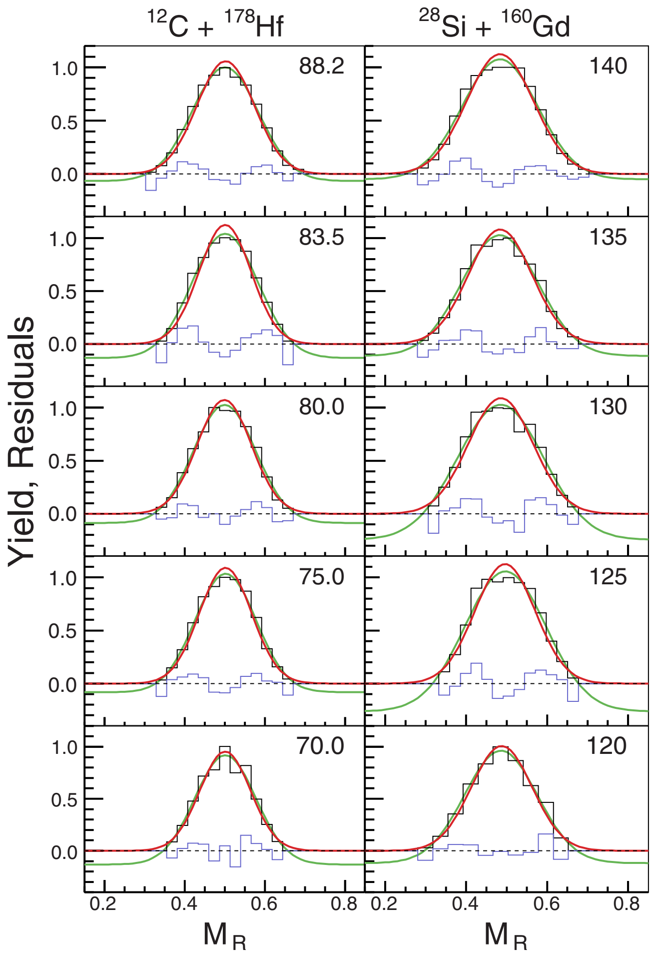

FIG. 1. Fragment-mass ratio distributions from $^{12}C + ^{178}Hf$ (left panels) and $^{28}Si + ^{160}Gd$ (right panels). Black-line histograms are the data from Ref. [1], while green lines show the complete functions fitted in the same article. Red lines show new, actual single-Gaussian fits; and blue-line histograms show the residuals between the data and the new fits.

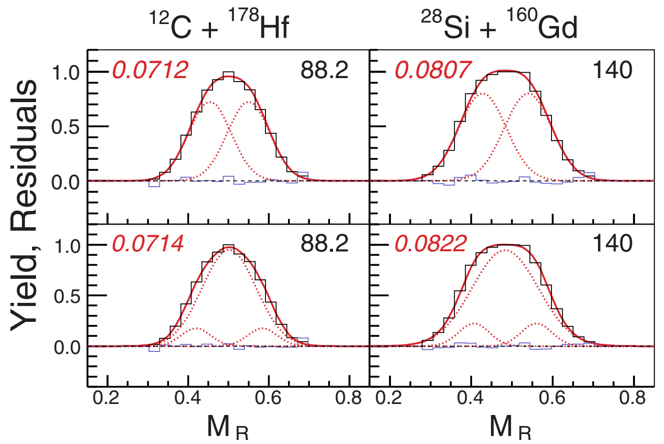

FIG. 2. Fragment-mass ratio distributions at 88.2 MeV from $^{12}C + ^{178}Hf$ (left panels) and 140 MeV from $^{28}Si + ^{160}Gd$ (right panels). Black-line histograms are the data from Ref. [1]; red lines show double- and triple-Gaussian functions fitted to the data (upper and bottom panels, respectively); blue-line histograms show the residuals between the data and the fitted functions. The standard deviation of the fitted functions is shown in red italic font.

and three-fits for the mass distribution of two energies from $^{12}C + ^{178}Hf$ and $^{28}Si + ^{160}Gd$ reactions show a clear reduction of the residuals when compared to Fig. 1. The chosen mass distributions, at 88.2 and 140 MeV, are the ones with the highest statistics, ensuring that this reduction is statistically significant. Figure 2 suggests that the mass distributions are sensitive to the single- or multi-Gaussian character of the fits, but not sensitive enough to distinguish between two- or three-Gaussian fits. Other observables might be needed for that. The figure also displays the standard deviation of the fitted functions. Their value changes slightly with the number of Gaussian components, but remains within the uncertainty calculated in [1].

In summary, this comment shows that, despite the claim made in Ref. [1] that the reported mass distributions are "reproducible with a single Gaussian at all studied energies", the functions shown in the corresponding figures are not *single*- but *truncated* Gaussian functions. Further, any attempt to reproduce the mass distributions with actual single-Gaussian functions reveals a clear need for more components in the fit procedure. These observations put in doubt the characterisation and analysis of the mass distributions measured in Ref. [1].

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