Reply to "Comment on 'Very weak γ transitions in the ϵ/β^+ decay of ^{68}Ga' "

D. T. Vo, W. H. Kelly, F. K. Wohn, J. C. Hill, and J. P. Vary
Iowa State University, Ames, Iowa 50011

M. A. Deleplanque, F. S. Stephens, R. M. Diamond, J. R. B. Oliveira, and A. O. Macchiavelli
Nuclear Science Division, Lawrence Berkeley Laboratory, Berkeley, California 94720

J. A. Becker, E. A. Henry, M. J. Brinkman, and M. A. Stoyer
Lawrence Livermore National Laboratory, Livermore, California 94550

J. E. Draper
University of California, Davis, California 95616

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Using the spectra in the article "Very weak γ transitions in the ϵ/β^+ decay of 68 Ga" [D. T. Vo *et al.*. Phys. Rev. C **50**, 1713 (1994)], Skalsey makes an interesting speculation in the accompanying article [M. Skalsey, Phys. Rev. C **54**, 439 (1996), the preceding paper] on the possible existence of a positron feeding with a kinetic endpoint energy of 16 keV in the decay of ^{68}Ga. Skalsey also points out the facts supporting the e^+ feeding to the 1656-keV level that were not mentioned by Vo *et al.* In this Reply to the Comment, we present information supporting the new e^+ decay to the 1656-keV level and further information on the statistical uncertainties that suggest an even greater skepticism than that shown by Skalsey about the possible existence of the 16-keV e^+ decay to the 1883-keV level upon which he commented. [S0556-2813(96)03207-4]

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In the accompanying article [1], from the 511-keV peak in coincidence with the 578-keV gate in Fig. 2 of Ref. [2], Skalsey notes the existence of the e^+ feed to the 1656-keV level. Also from the apparent 511-keV peak in coincidence with the 1883-keV γ rays, Skalsey speculates on the possible existence of the 16-keV e^+ decay to the 1883-keV level.

It is important to emphasize that the 511-keV peaks in coincidence with the 578-, 1261-, and 1884-keV peaks, as shown in Fig. 2 of Ref. [2], have very large uncertainties from two major sources: the statistics and the over/undersubtractions of the chance coincidences. These are quantified in the table below, which shows the counts of the coincident 511-keV peaks obtained from our data.

Table I shows the counts of the 511-keV peaks in coincidence with the 578-, 1261-, and 1884-keV peaks. Because of the narrowness of the timing window (88 channels) and the slope of the timing spectrum of the chance coincidence background (i.e., the number of counts per channel is larger for the channels close to the prompt than those farther away), the chance coincidence background is assumed to have an uncertainty of 1%. To justify the 1% uncertainty, it is assumed that if the timing window is increased or decreased by one channel, or if the timing window is shifted by few channels toward or away from the prompt, then the number of counts of the chance coincidence would increase or decrease by about 1%. The uncertainties Err2 in Table I come from the over/undersubtractions of the chance coincidences, i.e., the uncertainties due to the over/undercounting of the background within the timing window. The chance coincidences were assumed to have a 1% error from over/undercounting.

TABLE I. The counts of the 511-keV peaks in coincidence with the 1261- and 1884-keV peaks from this table were obtained by summing the counts above background. The uncertainties (Err1) are statistical, and the second (Err2) come from the over/undersubtractions of the chance coincidences.

Gate (Kev)	Peak (Kev)	Counts	Err1	Err2	%Err1	%Err2
578	511	2650	1040	450	39%	17%
1261	511	900	500	970	56%	108%
1884	511	710	490	1270	69%	179%

In Ref. [1], Skalsey suggests that the 511-keV peak intensity in coincidence with the 578-keV gate [see Fig. 2(a) of Ref. [2]], may be due to γ-ray scattering and the e^+ feed to the 1656-keV level. There is another major source that may also contribute to the intensity of this peak, and this is also given in Table I. This source is the possible over/undersubtraction of the chance background. However, even with this source of error included, the data support the speculation of the existence of the e^+ decay to the 1656-keV level. It is interesting to note that the ϵ/β^+ ratio for this new e^+ decay is (320±40%) compared to the theoretical ratio of about 120 [3]. Reference [1] also mentions the nonexistence of the 511-keV peak in coincidence with the 1261-keV peak [see Fig. 2(b) of Ref. [2]]. Even though the total counts in that (not well-defined) "peak" could be 900 greater than the background, the uncertainty of this "peak" is so large (see Table I) that the presence of this "peak" is, at best, inconclusive. As for the apparent 511-keV peak in coincidence with the 1884-keV gate [see Fig. 2(c) of Ref. [2]], Skalsey estimates, using the resolving time of 10 μs, that half of the total counts in the 511-keV peak come from the pileup mechanism. We agree that his estimate is quite conservative. From our data, using the actual counts in the 1589-keV peak (511+1077 keV) and the 1022-keV peak (511+511 keV) in coincidence with the 1077-keV gate, we calculated the number of the 1883-keV summing events in coincidence with the 511-keV γ rays, and it turned out to be small, only 10 counts. This is quite insignificant compared to the total counts in the 511-keV coincident peak, which appears to be about 700 counts.

The main sources of error of the 511-keV peak in Fig. 2(c) arise from the statistics and the uncertainty of the chance coincidences. The table above shows that the counts for the peak are $710 \pm 69\% \pm 179\%$. With such large uncertainties, one must be very skeptical in suggesting that the 1883-keV γ is or is not in coincidence with the 511-keV γ. Furthermore, close inspection of this ''peak'' shows that it has large fluctuations in counts, and that its width is about 5 keV, whereas the expected width for a true 511-keV peak is about 3 keV. Thus our data clearly do not provide any real evidence for the existence of the 16-keV positron branch that Skalsey proposes in Ref. [1].

In conclusion, our data support the existence of the 243-keV e^+ feeding to the 1656-keV level. However, the validity of the 511-keV peaks in coincidence with the 1883-keV γ rays and hence the existence of the possible 16-keV branch should be seriously questioned because of the large uncertainties.

[1] M. Skalsey, Phys. Rev. C **54**, 439 (1996), the preceding paper.
[2] D.T. Vo, W.H. Kelly, F.K. Wohn, J.C. Hill, J.P. Vary, M.A. Delephanque, F.S. Stephens, R.M. Diamond, J.R.B. Oliveira, A.O. Macchiavelli, J.A. Becker, E.A. Henry, M.J. Brinkman, M.A. Stoyer, and J.E. Draper, Phys. Rev. C **50**, 1713 (1994).
[3] *Table of Isotopes*, 7th ed., edited by C.M. Lederer and V.S. Shirley (Wiley, New York, 1978), pp. A21–A22.