# Reply to "Comment on '$\alpha$-decay properties of neutron-deficient polonium and radon nuclei' "

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We reply to the preceding Comment.

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The comment of Buck, Merchant, and Perez is predominantly based on the fact that we concentrated our discussion on statements in Refs. [1] and [2] while we ignored the discussions from a later publication [3]. Indeed this latter paper, from the May 1992 issue of Physical Review C, refines the discussion on nuclear structure effects in the alpha-decay half-lives but it came to our knowledge too late to be included in our manuscript [4].

Our experimental evidence on the alpha-decay half lives of even-even Po and Rn nuclei [4] led us to question the conclusion of Ref. [2] "At the level of a factor of approximately two, the alpha decay half lives of the heavy even-even nuclei are not sensitive to any more physics than that embedded in a large value of $G$ and an appropriately chosen radius capable of fitting the $Q$-value in each case." We mentioned this conclusion three times throughout the paper. We now realize that the last quotation "...the conclusion of Buck, Merchant, and Perez that no physical structural information can be extracted from $\alpha$-decay rates..." was somewhat misleading. We should have said "...no *further* physical information...".

The standard approach to extract nuclear structure effects out of the alpha-decay half-lives, introduced by Rasmussen [5], is to split the $\alpha$-decay process in two parts: first the formation of an alpha particle, described by the reduced $\alpha$ widths ($\delta^2$), followed by the tunneling of the alpha particle through the barrier. The reduced $\alpha$ widths contain most of the nuclear structure information and as can be seen, e.g., in Fig. 3(a) of our article [4], the reduced widths for the even-even Pt to No nuclei scatter by a factor of 30, although systematic trends are present. Crossing the $N = 126$ shell makes the biggest change in reduced $\alpha$ widths.

A possibility to look for remaining nuclear structure effects in the half-lives calculated by Buck, Merchant, and Perez is to plot the ratio of the theoretical to experimental partial alpha-decay half-lives as was done in Fig. 3(b) of our paper and independently in Fig. 4(a) of Ref. [6] by Brown. Indeed most of the nuclei have a theoretical to experimental partial alpha-decay half-life ratio between 0.5 and 2, and the dramatic effect of the $N = 126$ closure is severely reduced. Our criticism to the conclusions of Buck, Merchant, and Perez in Refs. [1] and [2] is that they do not consider the correlations in the ratios as a function of proton and neutron number [see Fig. 3(b) in Ref. [4]]. For example, the theoretical to experimental partial alpha-decay half-life ratios of the neutron-deficient radon nuclei drop steadily with decreasing neutron number: the difference in ratio between $^{198}$Rn and $^{212}$Rn is a factor 7. Almost identical correlations are present in the $\delta^2$ plot in Fig. 3(a) of Ref. [4]: the reduced widths drop regularly from $^{198}$Rn (200 keV) to $^{212}$Rn (17 keV).

The model of Buck, Merchant, and Perez provides an excellent reference frame for the comparison of experimental alpha-decay half lives where not only systematic mismatches between calculated and measured values, as mentioned in Ref. [3] and in the Comment, but also correlated deviations are essential tools to extract further nuclear structure information out of the alpha decay.

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