Sharma *et al.* Reply: In a Comment on our paper [1], Dobaczewski and Nazarewicz [2] argue that shell effects in their Skyrme approach and in our approach based upon the relativistic mean-field theory are similar. In the former, they claim [2] to represent pairing correctly by employing the Hartree-Fock-Bogoliubov (HFB) formalism *vis-à-vis* the BCS one that we have used in the latter. Before any conclusion on the similarity in the shell effects in the Skyrme and relativistic mean-field (RMF) theories could be drawn, it is appropriate to point out that no perceptible differences arise in the shell effects when applying HFB or BCS, at least within the Skyrme theory. In order to reinforce this statement, we present in Fig. 1 the binding energies using the force SkP in the BCS and HFB methods, the latter results [3] including a treatment of pairing as advocated in Ref. [2]. Clearly, within the Skyrme theory, there is no stagnation in the binding energies of Zr isotopes after the closed shell at $A = 122$, be it BCS or HFB. Thus, in this case *pairing neither creates nor destroys the shell effects.* On the other hand, HFB does alleviate the problem of the so-called neutron gas, as commented on by Dobaczewski and Nazarewicz [2]. It cannot, however, introduce the shell effects if they are intrinsically weaker in theory. In comparison, our RMF values from the force NL-SH [4] (Fig. 1) exhibit the kink conspicuously in the BCS, implying strong shell effects. It is expected that HFB treatment in the RMF theory would not alter this behavior as seen above in the Skyrme theory. Therefore, it is difficult to see similarities in the shell effect in the RMF and the Skyrme approaches. In addition, the strong shell effects seen in the binding energies in the RMF (NL-SH), characterized by the kink at the shell closure, are retained even if the pairing gap in the BCS is reduced by 50%, as shown in Fig. 1. We thus conclude in contrast with Ref. [2] that pairing does not have considerable influence on the shell effects.

Although HFB treatment is desirable in order to account for unbound states, a comparison of BCS and HFB for Skyrme theory as above shows that for nuclei close to the drip line the large excess of neutrons will inevitably create a giant neutron halo. On the comment by the authors [2] in regard to plausible increase of rms radii by using a large oscillator basis, we want to point out that the values for rms radii for the isotopes ^{122}Zr and ^{130}Zr given in our paper [1] have been calculated using a spherical coordinate space representation. These results differ only negligibly from those of the oscillator expansion method.

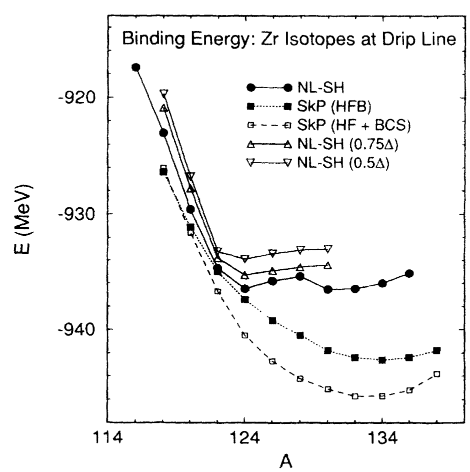

FIG. 1. Binding energies. See text for details.

We agree that Skyrme force SkM* may not be the last choice for discussing neutron-rich nuclei. However, the smooth behavior of the binding energies around shell closure, i.e., weak shell effects in the Skyrme theory, is exhibited both by SkM* and also by SkP, the force favored by the authors [2], as can be seen from Fig. 1. The smooth behavior of binding energies across shell closure in the SkM* as well as in SkP is the basis of our contention [1]. Moreover, the authors [2] incorrectly assume that the force NL-SH has been tuned to neutron-rich nuclei. On the contrary, NL-SH was obtained by fitting six nuclei at the stability line only, including ^{16}O and ^{208}Pb, as shown in Ref. [4]. It is the correct asymmetry energy and the correct treatment of neutron skin in NL-SH that render a successful description of nuclei both at the stability line as well as far away from it.

In conclusion, we believe that the different density and isospin dependence [5] of the spin-orbit term is responsible for differences in shell effects found in the RMF theory as compared to the Skyrme approach. The importance of the spin-orbit contribution in the RMF theory has been underlined in the successful description [6] of anomalous isotope shifts in Pb nuclei in the RMF theory as against the Skyrme theory which is unable to do so.

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