Boulay *et al.* Reply: In the preceding Comment [1] on our article [2], Garrett questions the IBFM-1 interpretation of the low-lying level structure of ^{99}Zr by pointing out possible drawbacks of the wave functions (w.f.) of the $1/2_1^+$ (ground) and $3/2_1^+$ states, and by stating that a similar reproduction of the experimental data could be achieved with a much different set of single-particle energies (SPE) [3,4].

The $1/2_1^+$, $3/2_1^+$ states of ^{99}Zr have similar B values and magnetic moments with those of ^{97}Zr and ^{97}Sr [2,5,6]. Based on this similarity and on the observation of the $1/2_1^+$ state in the ^{96}Zr$(d,p)^{97}$Zr study [7], it is claimed [1] that this state should be predominantly $\nu s_{1/2}$, as provided by the IBFM-1 calculations of [3,4]. However, the (d,p) reaction in this argument concerns a different isotope, and the extremely quick variation of the properties in this region (^{99}Zr is close to the critical point of the shape phase transition at $N \approx 59$ [2,5]) may invalidate this conclusion. Indeed, a recent (d,p) reaction investigation of the ^{95,96,97}Sr isotopes showed a weak population of the $1/2_1^+$ and $3/2_1^+$ states in ^{97}Sr [C^2S values of 0.07(5) and 0.25(5), respectively], compared to ^{95}Sr [C^2S values of 0.41(9) and 0.53(8)] [8]. This suggests differences between the w.f. of these states in ^{95}Sr and ^{97}Sr. As the Sr and Zr isotones in this region are very similar, one may expect that these states of ^{99}Zr are more weakly populated in the (d,p) reaction than their analogs in ^{97}Zr. There are also recent IBFM-2 calculations [5,6] where the $1/2^+$ g.s. of ^{99,97}Zr and ^{97}Sr has $\nu s_{1/2}$ components of 21%, 16%, and 12%, respectively, compared to 1.5% in [2,9]. The $3/2_1^+$ state in ^{99}Zr is $\nu d_{5/2}$ dominated and has a $\nu d_{3/2}$ component of 11% in [2,9], while in [5] it has 32% $\nu d_{3/2}$. Without experimental (d,p) data for ^{99}Zr one cannot decide now which s.p. composition is more realistic.

The second point in [1] concerns the SPE values used in [2,9]. Those values report an extreme solution with an exact reproduction of the $7/2_1^+$ state g factor [2]. For the present discussion we reviewed the old calculations and chose a different SPE set where the latter condition was relaxed. The initial calculations started from SPE close to the experimental systematics of Zr isotopes [10] and those of [3,4]. For each SPE set we sought parameters of the boson-fermion interaction that describe the available experimental data. Many trials indicated that the $s_{1/2}$ and $d_{3/2}$ SPE have to be lowered. Figure 1 shows the SPE values of the present calculations and those of Refs. [4,5] and [4,5]. The present SPE differ from those in [2,9] by an increase of 0.5 MeV for $s_{1/2}$ and of 0.2 MeV for $d_{3/2}$, but they still provide a description of the experimental data similar to that in [2,9], the predicted magnetic moment of the $7/2_1^+$ state being now lower (+1.48 nm). Increasing more the energy of any of the two orbitals accentuates the discrepancies for some of the magnetic moments and transition probabilities. These SPE values, although not uniquely

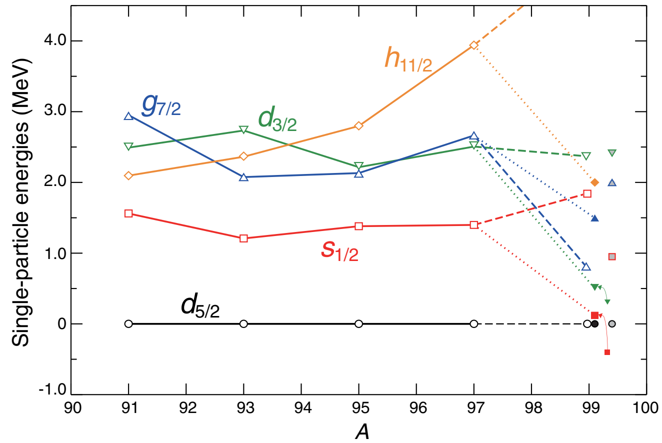

FIG. 1. Neutron SPE for $^{91-99}$Zr isotopes: experiment for $A = 91$ to 97 [10], and IBFM for ^{99}Zr: filled symbols, present calculations, arrows showing the modification of values from [2,9]; open symbols (left) [5]; gray-filled symbols (right) [3,4]. Note that the SPE of $\nu h_{11/2}$ in our calculations was chosen to reproduce the relative position of the positive- and negative-parity states calculated with the same Hamiltonian.

determined because of inherent ambiguities, still show deviations from the pattern of the experimental values. Some SPE used in the IBFM-2 calculations [5] also do not smoothly continue the experimental trend of the masses 91 to 97, and differ from those of [3,4] (Fig. 1). Thus, the parameterization of the IBFM Hamiltonian (core, SPE, and boson-fermion interaction) forms a whole for each case, that must be validated by comparison with experimental data. In our work this was achieved by empirically studying the influence of the various parameters. In the IBFM-2 calculations [5,6], the IBM-2 core Hamiltonian and the SPE were determined by microscopic calculations, leaving adjustable only the boson-fermion strengths. In the older calculations [3,4] the choice of the SPE and boson-fermion interaction parameters was made to reproduce the properties of the lowest three states of ^{97}Sr and ^{99}Zr, and was guided by zeroth order shell-model expectations for the quasiparticle structure of their w.f. (and notably, a $\nu s_{1/2}$-dominated g.s.). Overall, the relatively large number of model parameters was tuned to a rather small set of available experimental data. The calculations from [2,9] and [5,6] were tuned to a much larger set of experimental data [2,9], validating, within certain limits, the w.f. of the IBFM Hamiltonian. New experimental data on Zr isotopes around mass 99, especially on one-neutron transfer, are essential to better understand this special nuclear region.

F. Boulay,[1,2,3] G. S. Simpson,[4] Y. Ichikawa,[2]
S. Kisyov,[5] D. Bucurescu,[5] A. Takamine,[2] D. S. Ahn,[2]
K. Asahi,[2,6] H. Baba,[2] D. L. Balabanski,[2,7] T. Egami,[2,8]
T. Fujita,[2,9] N. Fukuda,[2] C. Funayama,[2,6] T. Furukawa,[2,10]
G. Georgiev,[11] A. Gladkov,[2,12] M. Hass,[13] K. Imamura,[2,14]
N. Inabe,[2] Y. Ishibashi,[2,15] T. Kawaguchi,[2,8] T. Kawamura,[9]

W. Kim,[12] Y. Kobayashi,[16] S. Kojima,[2,6] A. Kusoglu,[11,17]
R. Lozeva,[11] S. Momiyama,[18] I. Mukul,[13] M. Niikura,[18]
H. Nishibata,[2,9] T. Nishizaka,[2,8] A. Odahara,[9] Y. Ohtomo,[2,6]
D. Ralet,[11] T. Sato,[2,6] Y. Shimizu,[2] T. Sumikama,[2]
H. Suzuki,[2] H. Takeda,[2] L. C. Tao,[2,19] Y. Togano,[6]
D. Tominaga,[2,8] H. Ueno,[2] H. Yamazaki,[2]
X. F. Yang[20] and J. M. Daugas[1,2]

[1]CEA
DAM, DIF, 91297 Arpajon cedex, France
[2]RIKEN Nishina Center for Accelerator-Based Science
2-1 Hirosawa, Wako, Saitama 351-0198, Japan
[3]GANIL
CEA/DSM-CNRS/IN2P3, BP55027
14076 Caen cedex 5, France
[4]LPSC, CNRS/IN2P3
Université Joseph Fourier Grenoble 1, INPG, 38026
Grenoble Cedex, France
[5]Horia Hulubei National Institute for R&D in Physics and
Nuclear Engineering (IFIN-HH)
077125 Bucharest-Măgurele, Romania
[6]Department of Physics, Tokyo Institute of Technology
2-12-1 Oh-okayama, Meguro, Tokyo 152-8551, Japan
[7]Extreme Light Infrastructure—Nuclear Physics (ELI-NP)
Horia Hulubei National Institute for R&D in Physics and
Nuclear Engineering (IFIN-HH)
077125 Bucharest-Măgurele, Romania
[8]Department of Advanced Sciences, Hosei University
3-7-2 Kajino-cho, Koganei, Tokyo 184-8584, Japan
[9]Department of Physics, Osaka University
Machikaneyama 1-1 Toyonaka, Osaka 560-0034, Japan
[10]Department of Physics, Tokyo Metropolitan University
1-1 Minami-Ohsawa, Hachioji, Tokyo 192-0397, Japan
[11]CSNSM, Université Paris-Sud, CNRS/IN2P3
Université Paris-Saclay
91405 Orsay Campus, France
[12]Department of Physics, Kyungpook National University
80 Daehak-ro, Buk-gu, Daegu 702-701, South Korea
[13]Department of Particle Physics
Weizmann Institute of Science
Rehovot 76100, Israel
[14]Department of Physics, Meiji University
1-1-1 Higashi-Mita, Tama, Kawasaki
Kanagawa 214-8571, Japan
[15]Department of Physics, University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki 305-5877, Japan
[16]Department of Informatics and Engineering
University of Electro-Communication
1-5-1 Chofugaoka, Chohu, Tokyo 182-8585, Japan
[17]Department of Physics, Faculty of Science
Istanbul University
Vezneciler/Faith, 34134 Istanbul, Turkey
[18]Department of Physics, University of Tokyo
7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
[19]State Key Laboratory of Nuclear Physics and Technology
School of Physics, Peking University
Beijing 100871, China
[20]Instituut voor Kern-en Stralingsfysica
K.U. Leuven, Celestijnenlaan 200D
3001 Leuven, Belgium

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