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Mirror symmetry at mass $A = 54$: $E4$ effective charges near doubly magic ^{56}Ni

D. Rudolph[a,*], B. Blank[b], J. Giovinazzo[b], T. Roger[c], H. Alvarez-Pol[d], A. Arokia Raj[e], P. Ascher[b], M. Caamaño-Fresco[d], L. Caceres[c], D.M. Cox[a], B. Fernández-Domínguez[d], J. Lois-Fuentes[d], M. Gerbaux[b], S. Grévy[b], G.F. Grinyer[f], O. Kamalou[c], B. Mauss[g], A. Mentana[e], J. Pancin[c], J. Pibernat[b], J. Piot[c], O. Sorlin[c], C. Stodel[c], J.-C. Thomas[c], M. Versteegen[b]

[a]*Department of Physics, Lund University, SE-22100 Lund, Sweden*
[b]*Centre d'Etudes Nucléaires de Bordeaux Gradignan, UMR 5797 CNRS/IN2P3 – Université de Bordeaux, F-33175 Gradignan Cedex, France*
[c]*Grand Accélérateur National d'Ions Lourds, CEA/DRF-CNRS/IN2P3, F-14076 Caen Cedex, France*
[d]*IGFAE and Dpt. de Física de Partículas, Universidade de Santiago de Compostela, E-15758 Santiago de Compostela, Spain*
[e]*Instituut voor Kern- en Stralingsfysica, KU Leuven, B-3001 Leuven, Belgium*
[f]*Department of Physics, University of Regina, Regina, Saskatchewan S4S 0A2, Canada*
[g]*RIKEN Nishina Center, Wako, Saitama 351-0198, Japan*

Abstract

Supplemental Material

Reference numbers relate to the main article

End of June 2022 we realized that the convergence of a subset of KB3GR-based ANTOINE calculations for solely the yrast $I^\pi = 8^+$ state was incorrect. This implies that the following four modifications were implemented in this updated version of the Supplemental Material, which was made available online about July 10, 2022:

1. KB3GR-entry for the $B(E2; 10^+ \rightarrow 8^+)$ value in Table 1 changed from 0.001 to 1.92 W.u.
2. The level energy predicted for the $I^\pi = 8^+$ state in the KB3GR-column in Fig. 1 was changed from 6949 to 6715 keV.
3. In Fig. 2(b), the data point for the $I^\pi = 8^+$ state of the $V_{CM} + V_{C\ell s} + V_{C\ell\ell} + V_{B:J} + V_{Cp3}$ parametrization (dot dashed, red) changed from -182 to +117 keV.
4. In Fig. 2(b), the data point for the $I^\pi = 8^+$ state of the $V_{CM} + V_{C\ell s} + V_{C\ell\ell} + V_{B:4x0} + V_{Cp}$ parametrization (dot-dot dashed, green) changed from -191 to +116 keV.

Clearly, a more consistent picture arises when comparing the KB3GR predictions with those of the other interactions. We apologize for any inconvience or headache caused by the four faulty values presented earlier.

Note that neither text nor Fig. 2(e) of the main article are concerned.

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*Corresponding author.
E-mail address: Dirk.Rudolph@nuclear.lu.se

Table 1: Reduced transition strengths, $B(E2)$, in W.u., for decays of states in ^{54}Fe calculated with several fp-shell interactions and for various restricted numbers, t, of particles allowed to cross the shell gap at particle numbers $N, Z = 28$. The electric quadrupole and magnetic dipole moments of the $I^{\pi} = 10^{+}$ isomer are listed as well. For all calculations, $\varepsilon_{\pi} = 1.15$ and $\varepsilon_{\nu} = 0.80$ [11] and free g factors were used.

observable	exp [15]	GXPF1A [34]						FPD6 [40]	KB3G [35,36]	KB3 [37,38]	KB3GR [39]
		$t=2$	$t=4$	$t=8$	$t=10$	full	$t=6$	$t=6$	$t=6$	$t=6$	$t=6$
$B(E2; 2^+ \to 0^+)$	11.1(3)	5.13	7.56	9.49	9.75	9.56	9.14	11.8	7.57	6.76	9.29
$B(E2; 6^+ \to 4^+)$	3.25(5)	2.38	2.88	3.06	3.05	3.04	2.99	3.50	2.83	2.67	3.42
$B(E2; 10^+ \to 8^+)$	1.70(3)	1.99	2.05	2.05	2.01	2.00	1.98	2.31	2.05	2.16	1.92
$Q(10^+)$ (efm^2)	52(8)	45.9	56.6	59.3	59.6	59.6	59.3	59.9	54.5	54.8	56.6
$\mu(10^+)$ (μ_N^2)	7.281(10)	6.98	7.14	7.19	7.19	7.19	7.19	7.54	6.77	6.68	6.92

Table 2: Modifications of proton, π, and neutron, ν, single-particle energies, ε, due to isospin-symmetry breaking terms. See main text for definitions and Refs. [1,3,4] for further details. Values used in the KB3G (and KB3G56) shell-model calculations are provided for reference. All numbers are in keV.

term	$\Delta\varepsilon_{\nu}(f_{7/2})$	$\Delta\varepsilon_{\nu}(p_{3/2})$	$\Delta\varepsilon_{\nu}(p_{1/2})$	$\Delta\varepsilon_{\nu}(f_{5/2})$	$\Delta\varepsilon_{\pi}(f_{7/2})$	$\Delta\varepsilon_{\pi}(p_{3/2})$	$\Delta\varepsilon_{\pi}(p_{1/2})$	$\Delta\varepsilon_{\pi}(f_{5/2})$
$V_{C\ell s}$ [4]	+49	+16	−31	−65	−59	−19	+37	+78
V_{Cr} [4]	0	0	0	0	0	−300	−475	−210
V'_{Cr}	0	0	0	0	0	−400	−575	−210
$V_{C\ell\ell}$ [3]	0	0	0	0	−45	+105	+105	−45
interaction	$\varepsilon_{\nu}(f_{7/2})$	$\varepsilon_{\nu}(p_{3/2})$	$\varepsilon_{\nu}(p_{1/2})$	$\varepsilon_{\nu}(f_{5/2})$	$\varepsilon_{\pi}(f_{7/2})$	$\varepsilon_{\pi}(p_{3/2})$	$\varepsilon_{\pi}(p_{1/2})$	$\varepsilon_{\pi}(f_{5/2})$
KB3G	0	2000	4000	6500	0	2000	4000	6500
$+V_{C\ell s}$	49	2016	3969	6435	−59	1981	4037	6578
$+V_{C\ell s}+V_{Cr}$	49	2016	3969	6435	−59	1681	3562	6368
$+V_{C\ell s}+V_{C\ell\ell}$	49	2016	3969	6435	−104	2086	4142	6533
$+V_{C\ell s}+V_{C\ell\ell}+V'_{Cr}$	49	2016	3969	6435	−104	1686	3567	6323
KB3G56	300	2000	4000	6500	300	2000	4000	6500
$+V_{C\ell s}+V_{Cr}$	349	2016	3969	6435	241	1681	3562	6368

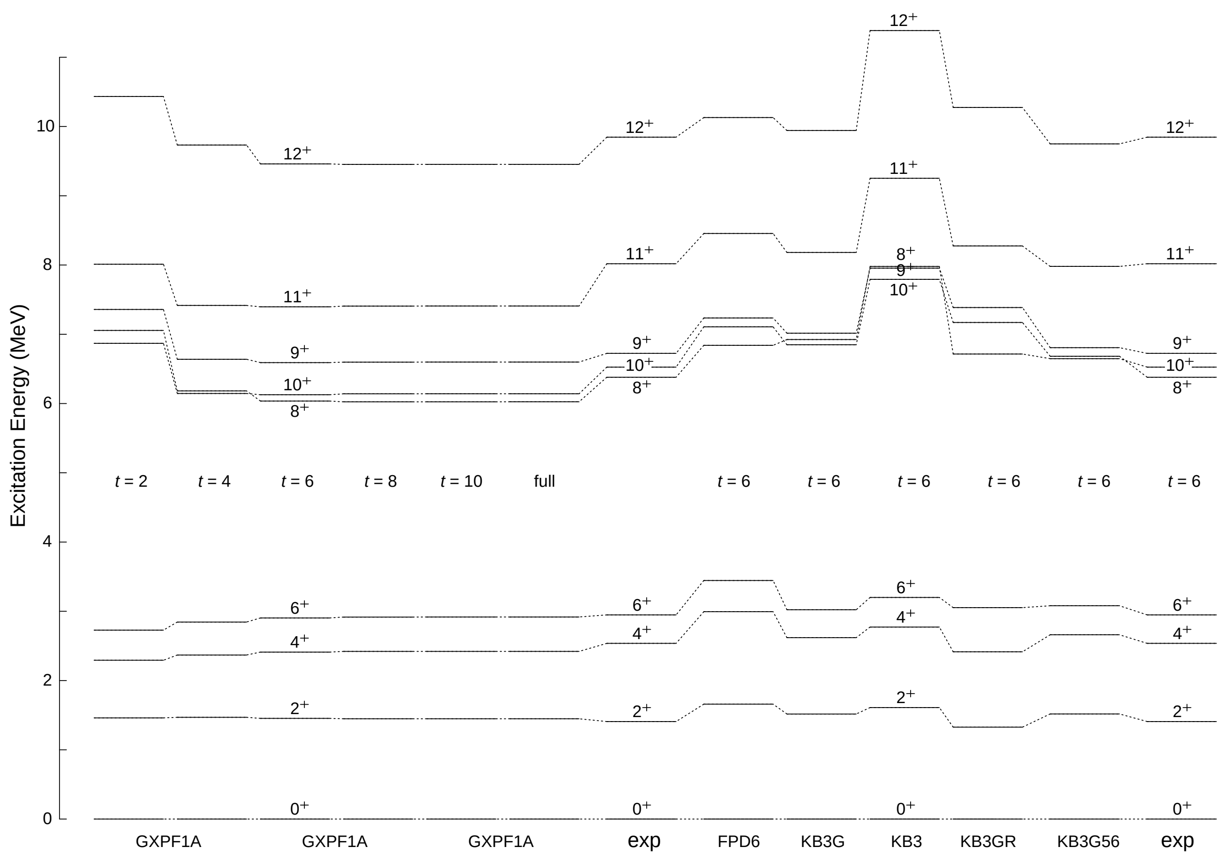

Figure 1: Calculated level energies of selected yrast states of ^{54}Fe for several common fp-space interactions. On the left, they are shown as a function of truncation of the full fp model space exemplified for GXPF1A [34]; t = 2, 4, 6, 8, 10 particles are allowed to cross the shell gap at particle number $N = Z = 28$, as well as an unrestricted calculation. Truncated at the t = 6 level, predictions of FPD6 [40], KB3G [35,36], KB3 [37,38], KB3GR [39], and the present KB3G56 are shown on the right.

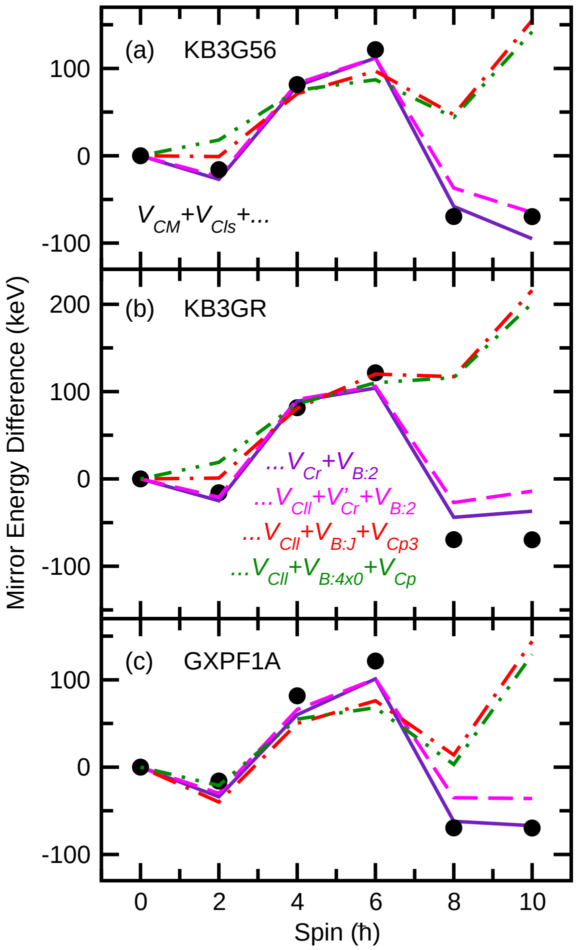

Figure 2: Mirror-energy differences (MED) between excited states in ^{54}Ni and ^{54}Fe. The selection of sums of isospin-breaking terms is identical to Fig. 2(d) (KB3G [35,36]) of the main article, but for three other underlying fp shell-model interactions: KB3G56 in panel (a), KB3GR [39] in panel (b), and GXPF1A [34] in panel (c), always compared with the experimental values (filled circles, cf. Fig. 1 main article). As pointed out in the main article, rather independent of the specific interaction, the sums $V_{CM} + V_{C\ell s} + V_{Cr} + V_{B:2}$ (solid, indigo) and $V_{CM} + V_{C\ell s} + V_{C\ell\ell} + V'_{Cr} + V_{B:2}$ (dashed, magenta) provide good to very good descriptions of the observed MED. At variance, attempts using ISB corrections based on $p-$-orbital occupation numbers fail; $V_{CM} + V_{C\ell s} + V_{C\ell\ell} + V_{B:4x0} + V_{Cp}$ (dot-dot dashed, green) or $V_{CM} + V_{C\ell s} + V_{C\ell\ell} + V_{B:J} + V_{Cp3}$ (dot dashed, red). See main article for details and definitions.