Comparison of shell model results for ^{86,87,88,89}Y isotopes

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The nuclei Sr, Y and Zr are close to subshell closure, thus they are expected to exhibit single-particle characteristics. The high-spin states in ^{86}Y using heavy-ion fusion-evaporation reactions have been studied in [1]. In view of recent experimental results for ^{86,87,88,89}Y isotopes. In the present work, we reported systematic study of shell-model results for ^{86,87,88,89}Y isotopes. The aim of present work to explain recently available experimental data for these isotopes. The projected shell model results for Y isotopes recently reported in [2]. In this work the need for comprehensive shell model calculations are also pointed out.

We performed shell model calculation in $f_{5/2}pg_{9/2}$ space, this will add more information in the previous study [1] where truncated shell model results have been carried out. For the $f_{5/2}\,p\,g_{9/2}$ valence space the calculations have been performed with the interactions JUN45 [3] and jj44b [4]. The JUN45 interaction is based on Bonn-C potential, the single-particle energies and two-body matrix elements was modified empirically so as to fit 400 experimental data out of 69 nuclei with A = 63∼69. In the fitting of JUN45 interaction the experimental data are taken around $N = 50$. The jj44b interaction was obtained from a fit to about 600 binding energies and excitation energies with 30 linear combinations of the good $J - T$ two-body matrix elements. For jj44b the energy data for the fit taken from nuclei with $Z = 28 - 30$ and $N = 48 - 50$. The single-particle energies for the $1p_{3/2}$, $0f_{5/2}$, $1p_{1/2}$ and $0g_{9/2}$ single-particle orbits employed in conjunction with the JUN45 interaction are -9.8280, -8.7087, -7.8388, and -6.2617 MeV respectively. In the case of the jj44b interaction they are -9.6566, -9.2859, -8.2695, and -5.8944 MeV, respectively. The core is ^{56}Ni, i.e. $N = Z = 28$, and the calculations are performed in this valence space without truncation. The calculations were performed with shell-model code ANTOINE [5]. Previously shell model calculation in $f_{5/2}pg_{9/2}$ space for this isotopes with truncation by allowing up to two particles excitation from $f_{5/2}$ and $p_{3/2}$ to $p_{1/2}$ and $g_{9/2}$ was reported in ref. [1]. The signature splitting and magnetic rotation of ^{86}Y using self-consistent tilted axis cranking calculations based on relativistic mean field theory to investigate the dipole structures have been studied by Li *et al.* [6]. In present shell model calculation performed in $f_{5/2}pg_{9/2}$ space, this will add more information in the previous study [1] where truncated shell model results reported. The shell model results for ^{86}Y with two different interaction is shown in Fig. 1. The results of JUN45 interaction showing very good agreement with experimental data.

TABLE I: Comparison of $B(E2)$ [W.u.] values with effective charges $e_p = 1.5$ $e_n = 0.5$.

	I_1^π	I_f^π	E_γ	Exp.	JUN45	jj44b
^{87}Y	$1/2^-$	$5/2^-$	793.7	≥ 0.0078	6.54	1.06
	$13/2^+$	$17/2^+$	1023.6	≥ 0.0022	7.53	18.30
	$17/2^+$	$21/2^+$	399	4.6 (3)	3.99	5.00
	$21/2^+$	$(23/2^+)$	159.8	≥ 4.1	7.51	9.90
	$21/2^+$	$(25/2^+)$	1782.4	4.9 (21)	5.67	6.76
^{89}Y	$9/2^+$	$5/2^+$	1313.2	4.3 (13)	2.99	3.22
	$9/2^+$	$13/2^+$	1984.1	4.3(8)	7.98	8.50
	$13/2^+$	$17/2^+$	1931.9	< 0.029	0.98	6.69
	$1/2^-$	$5/2^-$	1744.7	2.3	5.38	5.29
	$13/2^-$	$17/2^-$	1106.5	2.1(5)	2.24	0.12
	$15/2^-$	$19/2^-$	706.3	2.2(10)	1.55	3.09
	$17/2^-$	$(21/2^-)$	860.1	0.57(15)	0.93	2.27

JUN45 correctly reproduce negative-parity ground state as 4^- but for jj44b it is 75 keV higher than 2^- (g.s. with jj44b). The

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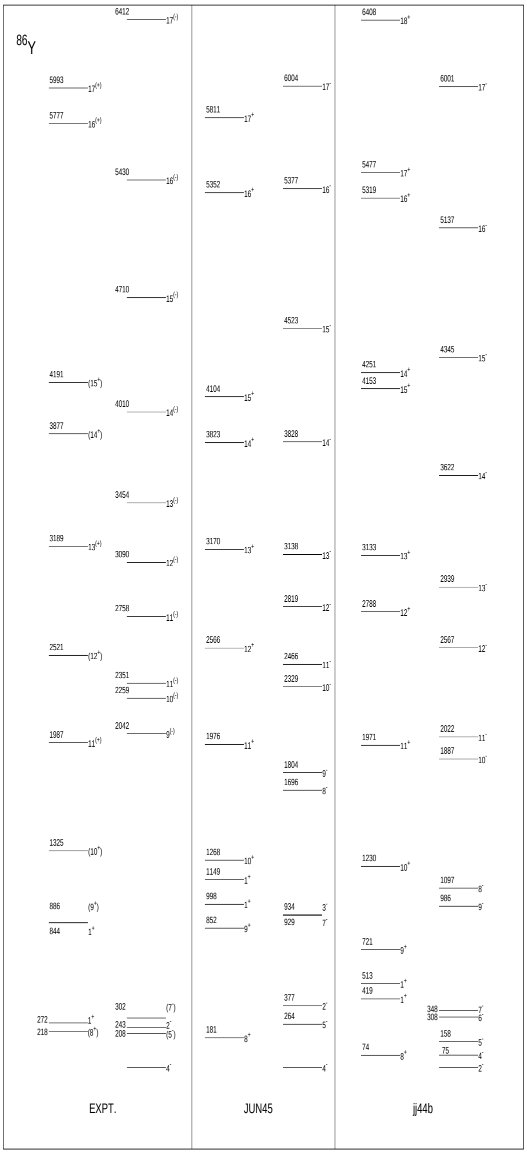

FIG. 1: Comparison of experimental and calculated excitation spectra of ^{86}Y with two different interactions.

JUN45 correctly reproduce order as 4^-- 5^-- 2^--7^-. The JUN45 interaction predicting $\pi(p^4_{3/2}f^6_{5/2}p^1_{1/2}) \otimes \pi(p^4_{3/2}f^6_{5/2}p^2_{1/2}g^7_{9/2})(\sim 30\%)$ configuration for 4^- while with jj44b it is $\pi(p^4_{3/2}f^4_{5/2}p^3_{1/2}) \otimes \pi(p^4_{3/2}f^5_{5/2}p^2_{1/2}g^8_{9/2})(\sim 16\%)$.

In case of ^{87}Y, the first $9/2^+$ predicted by JUN45 with only 23 keV higher with experimental data, while for jj44b it is 230 keV lower. Although the order $1/2^-$- $5/2^-$-$3/2^-$-$1/2^-$ -$9/2^-$ correctly reproduce with jj44b interaction. As we move from ^{87}Y to ^{89}Y, the predicted results for JUN45 become better this is due to JUN45 fitted for $N = 50$ region. In case of ^{88}Y, the jj44b interaction results are compressed in comparison to experimental data. The calculated $B(E2)$'s values for different transitions is shown in Table 1. The overall agreement with JUN45 interaction is more closer to the experimental data.

In conclusion, we have performed fullfleged shell model calculation for Y isotopes. The predicted results are in agreement with the experimental data. Further, it is important if we include $d_{5/2}$ orbital in the model space to study neutrons excitation across $N = 50$ shell. VK is thankful to CSIR for financial support.

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