Microscopic study of high spin states of $^{98\text{-}112}$Ru

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The neutron-rich Ru isotopes are in a region of the nuclear landscape where interesting shape related properties occur. The structures of these nuclei were the focal point of a very large number of experimental and theoretical studies. With the advent of latest experimental techniques, the experimental data on yrast bands, B(E2) transition probabilities and g-factors is available for $^{98\text{-}112}$Ru nuclei. Anharmonic features of the low-lying collective states in the $^{98\text{-}112}$Ru isotopes have been investigated systematically by Kotila et al. [1] by using the microscopic anharmonic vibrator approach. Deloncle et al. [2] have discussed both the low spin and high spin structures observed in neutron rich even- even Ru isotopes in the frame work of collective model and the rotating mean-field approach. Various theoretical groups have made different conclusions about the structure of the yrast states in neutron rich Ru isotopes. With a motivation to explain the structure of yrast states of these isotopes, projected shell model (PSM) approach [3] has been applied in the present piece of work.

The Hamiltonian employed in the present work is

$$H = H_0 - \frac{1}{2}\chi\sum_{\mu} Q_{\mu}^{+} Q_{\mu} - G_M P^{+} P - G_Q \sum_{\mu} P_{\mu}^{+} P_{\mu}$$

where H_0 is the spherical single-particle Hamiltonian. The second term in the Hamiltonian is the quadrupole-quadrupole interaction and the last two terms the monopole and quadrupole pairing interaction, respectively. The strength of the quadrupole force χ is adjusted such that the known quadrupole deformation parameter ε_2 is obtained. This condition results from the mean field approximation of quadrupole-quadrupole interaction of the Hamiltonian in above equation. The monopole pairing force constant G are adjusted to give known energy gaps. The strength parameter G_Q for quadrupole pairing is assumed to be proportional to G_M.

In the present work, the PSM results are obtained for Yrast bands, B(E2) transition probabilities and g-factors for $^{98\text{-}112}$Ru nuclei. In Fig. 1, the comparison of experimental and calculated yrast spectra is presented for $^{100\text{-}106}$Ru. It is evident from the graphs of these figures that the agreement between the experimental and theoretical low-lying yrast states is reasonably good. The PSM results obtained for yrast states of other isotopes are also in reasonable agreement with experimental data. The reduced transition probabilities B(E2) and g-factor values obtained from PSM calculations for $^{98\text{-}112}$Ru are presented in table 1. The experimental values for B(E2) and g-factors are in agreement with the available experimental data for $^{98\text{-}108}$Ru. However, for ^{110,112}Ru the theoretical values are not in good agreement with the experimental data.

Table 1. Comparison of experimental (Exp) and calculated (Th.) B(E2) transition probabilities (in units of e^2b^2), g factors in $^{98\text{-}112}$Ru.

	$B(E2;2_1^+ \rightarrow 0_1^+)$		g-factor $g(2_1^+)$	
	Exp.	Th.	Exp.	Th.
^{98}Ru	0.078(2)	0.113	0.4(3)	0.546
^{100}Ru	0.098(1)	0.116	0.51(6)	0.497
^{102}Ru	0.126(2)	0.126	0.37(3)	0.445
^{104}Ru	0.164(2)	0.145	0.41(5)	0.387
^{106}Ru	0.154(4)	0.188	0.3(1)	0.322
^{108}Ru	0.202(3)	0.177	0.23(4)	0.287
^{110}Ru	0.136(22)	0.173	0.44(7)	0.262
^{112}Ru	0.234(6)	0.132	0.45(10)	0.289

References

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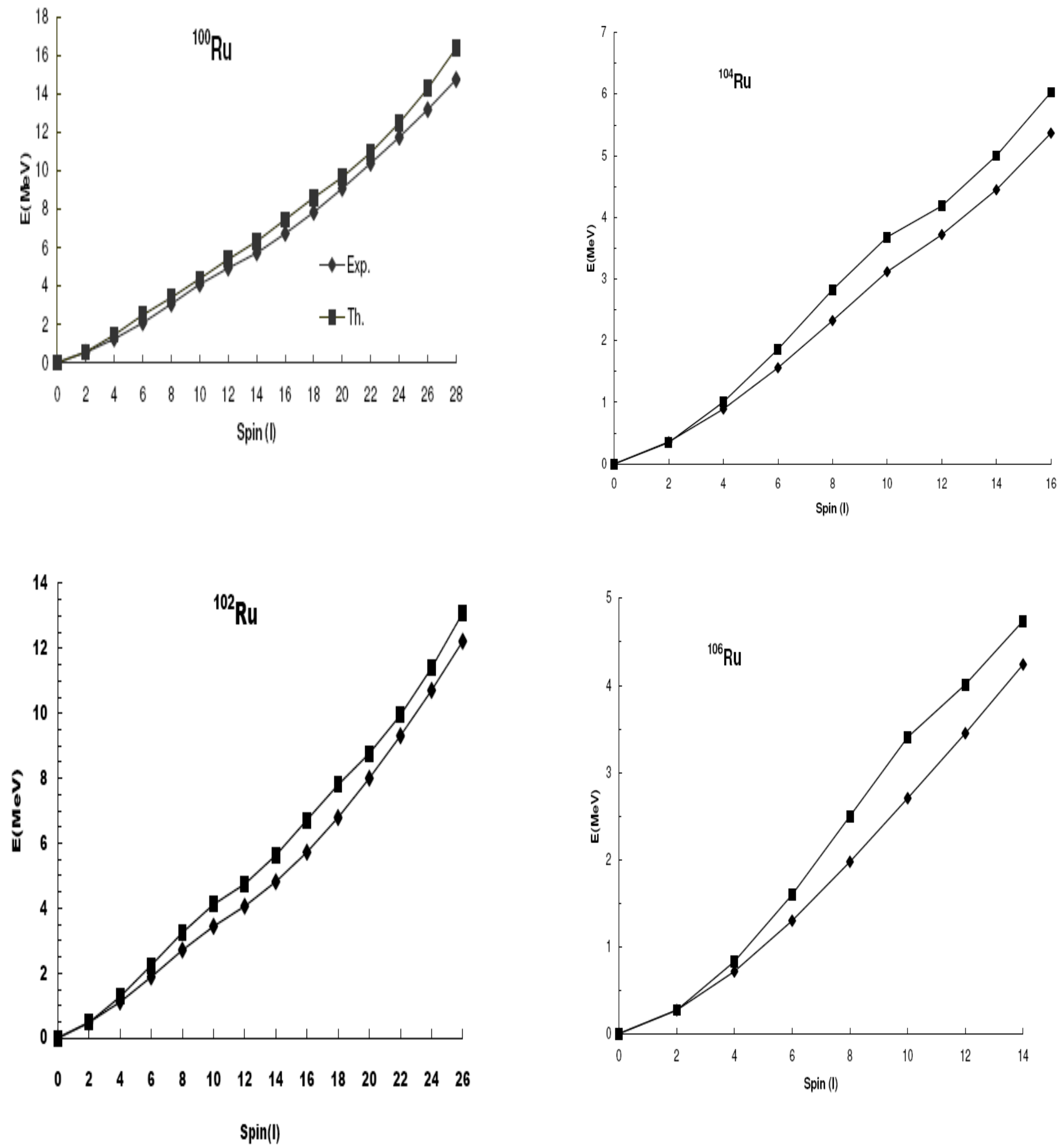

Fig. 1 Comparison of the calculated energy spectra with experimental data for $^{100\text{-}106}$Ru isotopes.