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

Arvind Bhat, B.D. Sehgal, Rani Devi and S.K. Khosa
Department of Physics & Electronics, University of Jammu, Jammu -180006, INDIA
* email: rani_rakwal@yahoo.co.in

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 $^{98-112}$Ru nuclei. Anharmonic features of the low-lying collective states in the $^{98-112}$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

$$H=H_0-\chi\sum_{\mu}\langle\xi_{\mu}\rangle P_{\mu} P_{\mu} - G_M P_{\mu} P_{\mu} - G_Q \sum_{\mu} P_{\mu} P_{\mu}$$

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 $\chi$ is adjusted such that the known quadrupole deformation parameter $\varepsilon_2$ is obtained. This condition results from the mean field approximation of quadrupole-quadrupole interaction of the Hamiltonian in above equation. The monopole and quadrupole pairing 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 $^{98-112}$Ru nuclei. In Fig. 1, the comparison of experimental and calculated yrast spectra is presented for $^{100-106}$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 $^{98-112}$Ru are presented in table 1. The experimental values for B(E2) and g-factors are in agreement with the available experimental data for $^{98-108}$Ru. However, for $^{110,112}$Ru the theoretical values are not in good agreement with the experimental data.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>$B(E2;2^+\rightarrow 0^+_1)$ (in units of $e^2$b$^2$)</th>
<th>g-factor g ($2^+_1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{98}$Ru</td>
<td>0.078(2)</td>
<td>0.113</td>
</tr>
<tr>
<td>$^{100}$Ru</td>
<td>0.098(1)</td>
<td>0.116</td>
</tr>
<tr>
<td>$^{102}$Ru</td>
<td>0.126(2)</td>
<td>0.126</td>
</tr>
<tr>
<td>$^{104}$Ru</td>
<td>0.164(2)</td>
<td>0.145</td>
</tr>
<tr>
<td>$^{106}$Ru</td>
<td>0.154(4)</td>
<td>0.188</td>
</tr>
<tr>
<td>$^{108}$Ru</td>
<td>0.202(3)</td>
<td>0.177</td>
</tr>
<tr>
<td>$^{110}$Ru</td>
<td>0.136(22)</td>
<td>0.173</td>
</tr>
<tr>
<td>$^{112}$Ru</td>
<td>0.234(6)</td>
<td>0.132</td>
</tr>
</tbody>
</table>

References

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