MICROSCOPIC STUDY ON STRUCTURE OF YRAST BANDS IN EVEN-EVEN $^{90\text{-}100}$Ru ISOTOPES

*Arvind Bhat, Arun Bharti and S.K. Khosa
Department of Physics and Electronics,
University of Jammu, Jammu-180006, INDIA
**Email:bhatarvind.murran@gmail.com*

Introduction

The research in nuclear structure physics reached a new height with the advancement in the development of accelerators and efficient γ-ray detectors . This made it possible to carry out nuclear reactions where in nuclei could be produced in highly excited states, which in turn decayed to their ground state by emitting a cascade of γ-rays. Fusion-evaporation reactions provided the standard mechanism to populate states with high angular momentum.

In recent years, Projected Shell Model has become quite successful in explaining a broad range of properties of deformed nuclei [1]. The advantage in this method is that the numerical requirements are minimal and therefore, it is possible to perform a systematic study for a group of nuclei in a reasonable time frame. A systematic study of the neutron-rich nuclei in the mass region A=100 using PSM has been carried out recently and the agreement between PSM results and experimental data has been found to be quite good [2,3].

The Hamiltonian which has been used throughout the present work is described as follows.

$$\hat{H} = H_0 - \frac{1}{2}\chi\sum_{\mu}\hat{Q}^{\dagger}_{\mu}\hat{Q}_{\mu} - G_M\hat{P}^{\dagger}\hat{P} - G_Q\sum_{\mu}\hat{P}^{\dagger}_{\mu}\hat{P}_{\mu}$$

where H_0 is the spherical single particle Hamiltonian. The second term is the quadrupole-quadrupole interaction and the last two terms are the monopole and quadrupole pairing interactions, respectively. The strength of the quadrupole-quadrupole term is obtained via self-consistent conditions with a given deformation parameter ϵ_2.

A microscopic description of yrast states, back-bending phenomena, B(E2) transition probabilities and g-factors has been carried out in Ru isotopes with A= 90-100 studied in the framework of PSM. The prolate structure of the bands has been investigated. It is observed that the proton sub-shells $2p_{1/2}$, $2p_{3/2}$, $1f_{5/2}$ and $1f_{7/2}$ are polarized. The maximum polarization is suffered by $1f_{5/2}$ and $2p_{1/2}$ proton sub-shells. The variation in the occupation numbers of $2p_{1/2}$ proton sub-shells from isotope to isotope is very very small. In fact, for most of the isotopes, the $2p_{1/2}$ occupation is around 1.2 and $1f_{5/2}$ is around 5. This type of variation for $2p_{1/2}$, $1f_{5/2}$ sub shells can be linked to producing a small amount of background collectivity in all Ru isotopes. It is therefore, very unlikely that these core polarization effects of $2p_{1/2}$ and $1f_{5/2}$ proton sub-shells could be responsible for the observed low lying systematics of Ru isotopes. The occupation probability of $2d_{5/2}$ neutron orbit is found to increase from 0.8 in ^{90}Ru to 2.21 in ^{100}Ru. This means that k=1/2, 3/2 components of $2d_{5/2}$ neutron orbit are getting occupied. Since these orbits are down sloping, their occupation will produce increase of deformation. Thus, this factor could cause increase of deformation as one proceeds from ^{90}Ru to ^{100}Ru. The observed deformation systematics in $^{90\text{-}100}$Ru isotopes depends on the increase of occupation probability of $(1h_{11/2})_\nu$ orbit.

References:

[1] K. Hara and Y. Sun, Int. J. Mod. Phys. **E4**, 637 (1995).

[2]Arvind Bhat,Arun Bharti and S.K.Khosa IJMP E,Vol 21,No.3(2012) 1250030

[3]Arvind Bhat,Arun Bharti and S.K.Khosa Eur.Phys.J.A (2012) 48:39

Table1.1: the BCS sub shell occupation numbers of protons in the ground states of $^{90-112}$Ru

Isotope	$2s_{1/2}$	$1d_{3/2}$	$1d_{5/2}$	$2p_{1/2}$	$2p_{3/2}$	$1f_{5/2}$	$1f_{7/2}$	$3s_{1/2}$	$2d_{3/2}$	$2d_{5/2}$	$1g_{7/2}$	$1g_{9/2}$
^{90}Ru	2	3.99	6	1.2	3.75	4.96	7.94	0.04	0.05	0.52	0.18	5.35
^{92}Ru	1.97	3.99	6	1.28	3.78	5.08	7.94	0.03	0.04	0.42	0.14	5.3
^{96}Ru	2	3.99	6	1.28	3.79	5.1	7.94	0.03	0.04	0.42	0.13	5.29
^{98}Ru	2	3.99	6	1.25	3.78	5.06	7.94	0.03	0.04	0.46	0.14	5.96
^{100}Ru	2	3.99	6	1.27	3.79	5.11	7.94	0.03	0.029	0.42	0.13	5.29

Table1.2: The BCS sub shell occupation numbers of neutrons in the ground states of $^{90-112}$Ru

Isotope	$2P_{1/2}$	$2p_{3/2}$	$1f_{5/2}$	$1f_{7/2}$	$3s_{1/2}$	$2d_{3/2}$	$2d_{5/2}$	$1g_{7/2}$	$1g_{9/2}$	$3p_{1/2}$	$3p_{3/2}$	$2f_{5/2}$	$2f_{7/2}$	$1h_{9/2}$	$1h_{11/2}$
^{90}Ru	1.59	3.8	5.2	7.9	0.12	0.17	0.8	0.4	5.66	0.005	0.013	0.016	0.051	0.04	0.24
^{92}Ru	1.84	3.9	5.66	7.95	0.12	0.17	0.8	0.42	6.79	0.004	0.009	0.013	0.044	0.035	0.47
^{96}Ru	1.96	3.95	5.87	7.96	0.3	0.42	1.41	1.09	8.47	0.004	0.014	0.018	0.071	0.041	0.83
^{98}Ru	1.96	3.96	5.89	7.96	0.37	0.57	1.78	1.65	8.89	0.005	0.015	0.019	0.107	0.052	0.74
^{100}Ru	1.97	3.97	5.92	7.96	0.4	0.65	2.21	2.22	9.33	0.006	0.016	0.021	0.147	0.064	1.1