Study of High Spin States of Odd Mass $^{103\text{-}107}$Rh Isotopes

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Introduction

In recent years, the developments in the experimental techniques in nuclear physics have put forth immense data for nuclear structure elucidation. The nuclei in the mass region A≈100 with 40≤Z≤50 exhibit several shape transitions and the energy levels of the nuclei lying in this mass region have been extended to high spins. In the recent past [1-4], high spin states of odd mass $^{103\text{-}107}$Rh isotopes have been studied by various experimental techniques with the aim of extending knowledge of nuclides in A≈100 region and investigating possible shape transitional effects. The neutron-rich nuclei ^{103,105,107}Rh have 45 protons and 58, 60, 62 neutrons respectively and hence lie in a mass region rather far from the shell closures at Z=50 and N=50, but on the other hand, are also outside the islands of well deformed nuclei [5].

The Model

In the present work, we have applied a theoretical framework known as Projected Shell Model (PSM) [6] to study the high spin states of odd mass ^{103,105,107}Rh isotopes and have also compared the data with the available experimental data.

The total Hamiltonian employed in the present work is

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

Where $\hat{H}_o$ is spherical single particle Hamiltonian. The second term in the Hamiltonian is the quadrupole- quadrupole interaction and the last two terms are the monopole and quadrupole pairing interactions, respectively.

The strength of the quadrupole force χ is adjusted in such a way that the known quadrupole deformation parameter ε_2 is obtained by the usual Hartree-BCS self-consistent procedure. The monopole pairing force constants G_M are adjusted to give the known energy gaps. In the present calculations, the monopole pairing strength is taken as

$$G_M = \left(G_1 \mp G_2\frac{N-Z}{A}\right)\frac{1}{A}(\text{MeV})$$

where + (-) is for neutron (proton) while, in this work, G_1 and G_2 and are chosen as 19.70 and 10.0 MeV for all the Rh isotopes under study. The strength parameter G_Q for quadrupole pairing is assumed to be proportional to G_M where the proportionality constant is adjusted to reproduce the $g_{9/2}$ crossing at the right place.

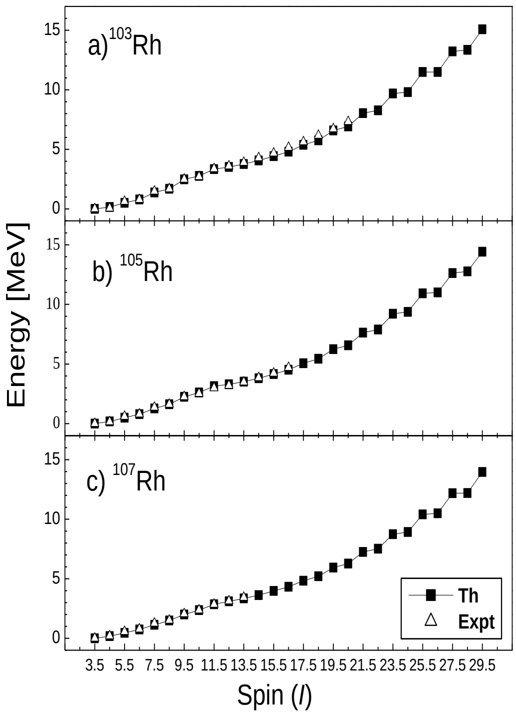

Fig. 1 Yrast spectra of a)^{103}Rh, b)^{105}Rh and c)^{107}Rh.

From the results of the calculations, it is found that:

- The experimental yrast states are very well reproduced by the present PSM calculations.
- The trend of experimental transition energies has also been reproduced qualitatively and quantitatively, which proves the reliability and validity of the applied framework in the region A≈100.
- The PSM calculations for ^{103}Rh, ^{105}Rh and ^{107}Rh have been performed corresponding to prolate quadrupole deformation, which is in accordance with the experimental data.

In figures 1[a-c], yrast spectra of ^{103}Rh, ^{105}Rh and ^{107}Rh respectively are presented whereas in figures 2[a-c], the transition energy versus spin is plotted for these isotopes, respectively.

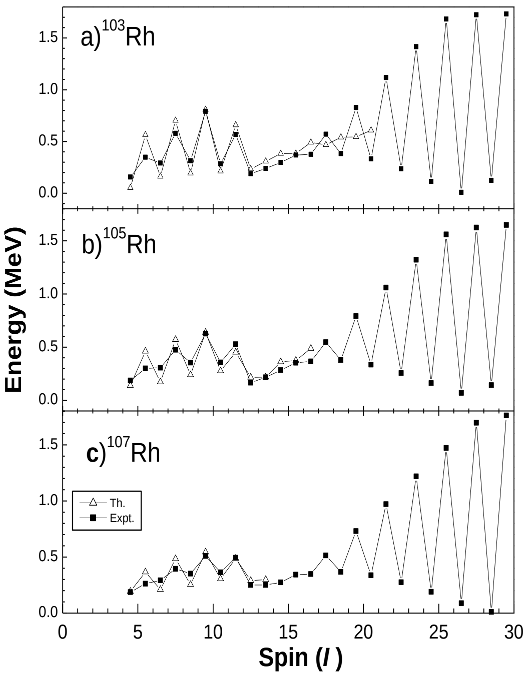

Fig. 2 Transition energy versus spin plots of a)^{103}Rh, b)^{105}Rh and c)^{107}Rh.

References

[1] J. Timar, C. Vaman, K. Starosta, D. B. Fossan, T. Koike, D. Sohler, I. Y. Lee, and A. O. Macchiavelli, Nucl. Phys. **C73**, 011301(R) (2006).

[2] J. Timar *et al.*, Phys. Lett **B598**, 178 (2004).

[3] F. R. Espinoza-Quinones, E. W. Cybulska, J. R. B. Oliveira, R. V. Ribas, M. N. Rao, M. A. Rizzutto, N. H. Medina, L. G. R. Emediato, W. A. Seale, and S. Botelho, Phys. Rev. **C55,** 6 **(**1997).

[4] Ts. Venkova *et al.*, Eur. Phys. J. **A6**, 405-413 (1999).

[5] A. Bohr and B. R. Mottelson, *Nuclear Structure* (Benjamin, Reading, MA, 1975), Vol. II.

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