Study of High-Spin States in N=39 and N=41 Isotones

Chetan Sharma, Neha Gupta, Preeti Verma and Arun Bharti*
Department of Physics and Electronics
University of Jammu, Jammu - 180906, INDIA
** email: arunbharti_2003@yahoo.co.in*

The A = 70-80 mass region has become the focus of both experimental and theoretical efforts in nuclear physics due to a variety of reasons from the studies of nuclear super deformations to the development of radioactive ion beams and many more. The neutron-deficient isotopes in this mass region have attracted considerable attention because of the observation of many fascinating features like large deformation, shape transition and shape coexistence at low excitation energies [1-3]. In addition, structural similarities have also been observed in the even Z and odd N nuclei in this region especially in ^{73}Se [4], ^{77}Kr [5] and ^{77}Sr [6] because of the occupation of valence neutrons in the unique parity $g_{9/2}$ orbital.

In the present work, we have applied Projected Shell Model to study the properties like yrast spectra, transition energies and band diagrams of N= 39 & 41 isotones.

The total Hamiltonian employed in the present work is

$$\hat{H} = \hat{H}_0 - \frac{1}{2}\chi\sum_{\mu}\hat{Q}_{\mu}\hat{Q}_{\mu}^{\dagger} - G_M\hat{P}^{+}\hat{P} - G_Q\sum_{\mu}\hat{P}_{\mu}^{+}\hat{P}_{\mu}$$

where H_0 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 are chosen as 20.10 and 12.12 MeV for Kr nuclei and 19.76 & 12.15 MeV for Se nuclei, respectively. 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.

From the results of the calculations, it is found that

- there is a change of shape from oblate to prolate as one moves from Z=34 (Se) to Z=36 (Kr).
- It is also observed from the calculations that the yrast band in these nuclei does not arise from 1-qp state only but also from 3-qp states.
- Besides this, the results of the calculations for yrast spectra are also found to be in very good agreement with the experimental data and the trend of experimental transition energies has also been reproduced qualitatively, which proves the reliability and validity of the applied framework in the region A=70-80.

In Figures 1[a-d], the yrast spectra of N=39 isotones and N=41 isotones are presented.

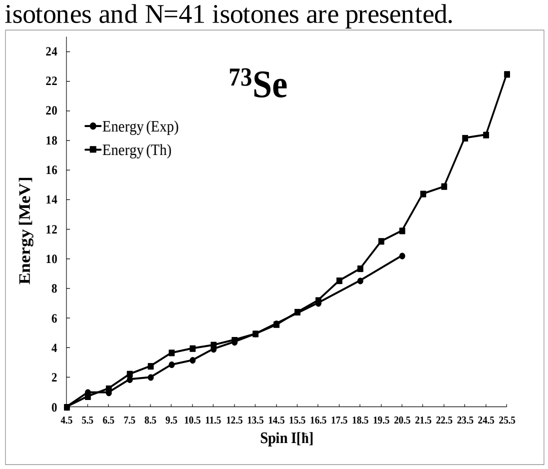

Figure 1 [a]

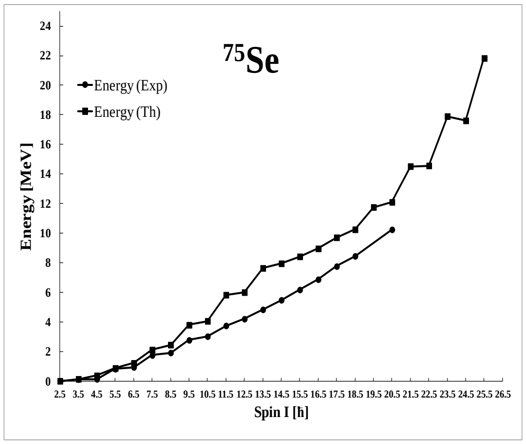

Figure 1 [b]

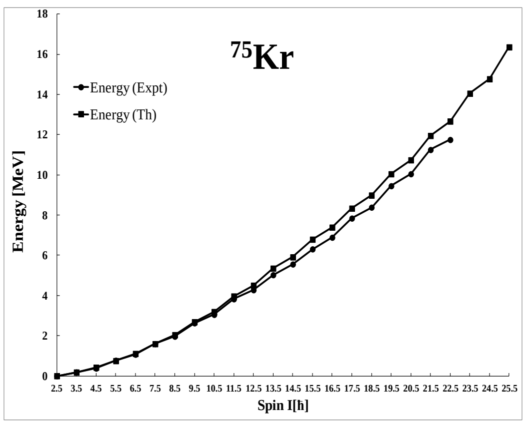

Figure 1 [c]

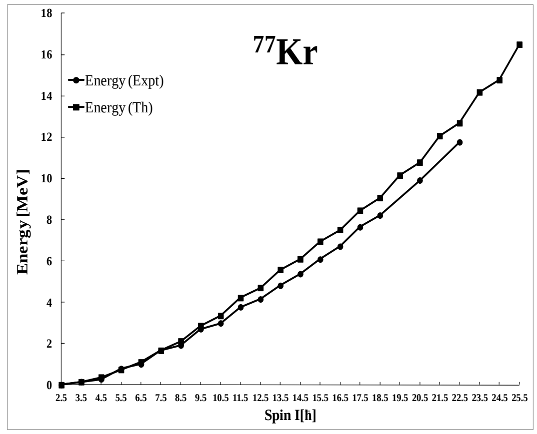

Figure 1 [d]

References

[1] C. J. Lister, B. J. Varley, H. G. Price, and J. W. Olness, Phys. Rev. Lett. **49**, 308 (1982)
[2] S. M. Fischer *et al.*, Phys. Rev. Lett. **84**, 4064 (2000)
[3] R. Palit, H. C. Jain, P. K. Joshi, J. A. Sheikh, and Y. Sun, Phys. Re v. C **63**, 024313 (2001)
[4] W. Nazarewicz *et al.*, Nucl. Phys. **A435**, 397 (1985)
[5] T. D. Johnson *et al.*, Phys. Re v. C **42**, 2418 (1990)
[6] A. Dhal *et al*., Eur. Phys. J. A **27**, 33 (2006)