Projected shell model study Thorium Isotopes

*Daya Ram, Saiqa Sadiq, Rani Devi and S.K. Khosa
Department of Physics and Electronics, University of Jammu, Jammu-180006, INDIA
**Email: Daya.kamal123@gmail.com*

Much of current research in nuclear physics relates to the study of nuclei under extreme conditions such as high spin and excitation energy. Nuclei may also have extreme shapes or extreme neutron to proton ratios. The existence of super heavy elements is major issue in nuclear physics and many experimental and theoretical efforts have been put, in that direction, during the last decade. With the advent of third generation array such as GAMMASPHERE, the spectroscopy of these super heavy elements has become possible in the recent years. Actinide nuclei are not only among the heaviest elements for which quantitative spectroscopic information can be obtained, but are also among the most deformed and hence the most collective nuclei available for experimental investigations. The levels schemes of some Thorium isotopes have been extended to high spins and with the new experimental techniques the experimental data [1-2] is available for electromagnetic properties of Thorium isotopes. In the present work Projected Shell Model (PSM) approach has been employed to some even-even and odd mass Thorium isotopes.

The PSM [3] is a kind of shell model approach. However, unlike the conventional shell model, the PSM begins with the deformed Nilsson type single particle basis. Its advantage over the conventional shell model is that the important nuclear correlations can easily be taken into account and the configuration space is manageable, thus making the shell model treatment for the heavy systems possible. The Hamiltonian which has been used in 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 quadrupole interaction strength χ is adjusted so that the known quadrupole deformation ϵ_2 from the HFB self consistent procedure is obtained. The single particle space consists of three major shells N=4, 5, 6 for protons and N=5, 6, 7 for neutrons.

In the present work, the yrast bands and band diagrams of some even-even and odd mass Thorium isotopes have been obtained. In Fig. 1(a-f) the band diagrams of six odd mass $^{223\text{-}233}$Th isotopes are presented. From Fig1 (a-c) one finds that the yrast bands of $^{223\text{-}227}$Th isotopes arise from the superposition of three one quasi-particle neutron bands and from Fig1 (d-f), the yrast bands of $^{229\text{-}233}$Th isotopes arising from one quasi-particle neutron state. The theoretical results for even-even Thorium isotopes have also been obtained and will be presented in the symposium.

Refrences

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

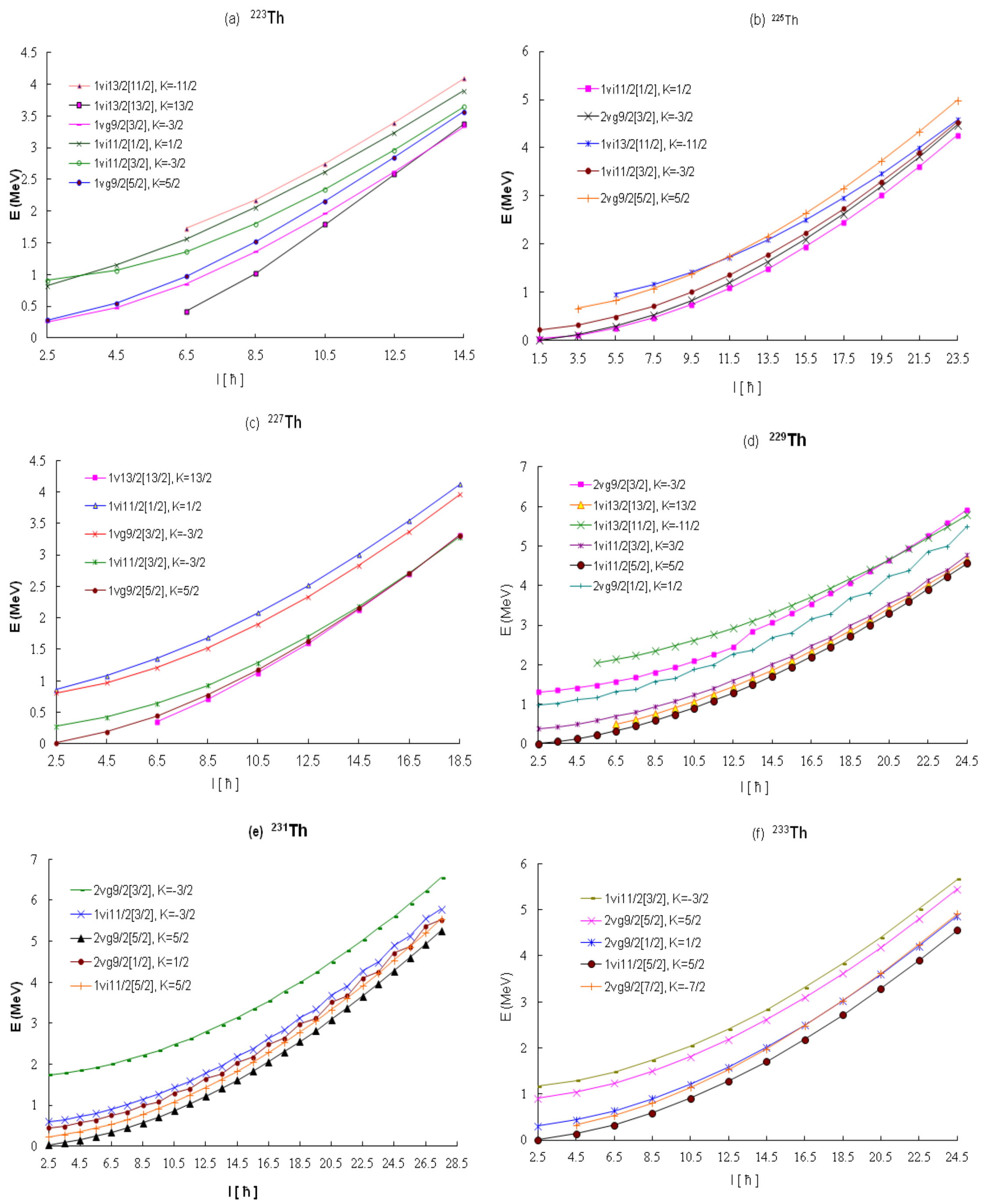

Figure 1(a-f): Band diagrams of $^{223\text{-}233}$Th isotopes.