Band structure of some very neutron deficient Cesium isotopes

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Experimental data show that the very neutron-deficient $A \approx 120, Z=55$ cesium isotopes are well deformed and display a wealth of interesting collective structures. Smith et al [1] have performed high spin spectroscopy using the Gammasphere array and extended the previously observed negative parity band of $^{117}$Cs upto high spin. Liden et al [2] have extended the $h_{11/2}$ negative parity band of $^{119}$Cs upto spin $I=35/2^-$. Besides this some positive parity bands are also observed in $^{117,119}$Cs nuclei.

In order to investigate band structure of these very neutron deficient Cs nuclei, Projected Shell Model (PSM) [3] has been employed. The Hamiltonian employed in present work is

$$\hat{H} = H_0 - \frac{1}{2} \sum_{\mu} \frac{\hat{q}_\mu \hat{P}_\mu - G_M \hat{P}_\mu \hat{P}_\mu}{9} \chi G_Q \hat{h}_{11/2} \hat{h}_{11/2}$$

where $H_0$ is the spherical single-particle Hamiltonian. The strength of quadrupole force $\chi$ is adjusted such that the known quadrupole deformation parameter $\epsilon_2$ is obtained by the usual Hartree+BCS self-consistent procedure. The monopole pairing force constant $G_M$ are adjusted to give known energy gaps. For all the calculations, the monopole pairing strength $G_M$ used in the calculations are

$$G_M^\pi = \left[ 19.60 - 15.70 \frac{N-Z}{A} \right] A^{-1}, \quad G_M^\nu = 19.60 A^{1/3}$$

These strengths are same as employed in the neighbouring even-even Barium isotopes [4]. The strength parameter $G_Q$ for quadrupole pairing is assumed to be proportional to $G_M$. In present calculations $G_Q$ is taken as 0.18 for both $^{117}$Cs and $^{119}$Cs.

In figure 1, comparison of experimental and theoretical negative parity bands is presented for $^{117,119}$Cs. It is observed from the figure that the calculated results are in reasonable good agreement with experimental data. In figure 2 the band diagrams for $^{117,119}$Cs are displayed. In case of $^{117}$Cs, one finds that observed negative parity band upto spin 27/2 is arising from two 1-qp proton bands having configurations $1h_{1/2}[1/2], K=1/2$ and $1h_{1/2}[-3/2], K=-3/2$. At spin 29/2* these two 1-qp proton bands are crossed by three 3-qp bands having configurations $1h_{1/2}[3/2] + 2h_{1/2}[-3/2,5/2], K=-1/2$, $1h_{1/2}[1/2] + 2h_{1/2}[3/2,5/2], K=1/2$ and $1h_{1/2}[-3/2] + 2h_{1/2}[-3/2,5/2], K=5/2$. Thus, above spin 29/2 the observed negative parity band is arising from these three 3-qp bands. In case of $^{119}$Cs the states of observed negative parity band upto spin 23/2 are arising from one 1-qp band having configuration $1h_{1/2}[1/2], K=1/2$ whereas the states above spin 23/2 are arising from the superposition of four 3-qp bands having configurations $1h_{1/2}[1/2] + 2h_{1/2}[3/2,5/2], K=3/2$, $1h_{1/2}[1/2] + 2h_{1/2}[1/2,5/2], K=5/2$ and $1h_{1/2}[-3/2] + 2h_{1/2}[-3/2,5/2], K=1/2$ and $1h_{1/2}[1/2] + 2h_{1/2}[1/2,5/2], K=5/2$. The detailed results of positive and negative parity bands for neutron deficient Cs nuclei would be presented in the symposium.

References:

Figure 1. Comparison of the calculated energies $E(I)$ of the negative parity band with experimental data of $^{117,119}$Cs isotopes. The calculated negative parity band consists of the lowest states after diagonalization at each angular momentum.

Figure 2. Band diagrams for $^{117,119}$Cs isotopes.