Microscopic Study of ^{115,117}Sb in the Projected Shell Model

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Introduction

The structure of high-spin states in neutron deficient nuclei near the Z=50 major shell closure has recently provided a wealth of interesting physics. Nuclei near this closed proton shell exhibit a variety of collective structures that coexist with the expected single-particle structure. Spectroscopic studies of the high-spin states of odd-A nuclei above the Z=50 closed shell have provided a wealth of experimental information regarding the nature of collectivity in this region [1]. It has been found from the study of literature that the nuclear structure of odd-A $_{51}$Sb isotopes lying in this region have generated considerable interest because, despite the superficially smooth variation of low-energy properties as a function of the neutron number [2,3], there are significant underlying structural changes. The properties of the low-lying levels of the odd-A Sb isotopes are reproduced well in theoretical calculations [4,5] that take into account an odd proton in the spherical orbitals of the Z = 50–82 major shell coupled to the quadrupole and octupole phonon excitations of the Z = 50 Sn core.

In these Antimony isotopes with only one proton outside the closed shell, the Sb nuclei are expected to behave like spherical shell-model nuclei with the valence proton occupying the $d_{5/2}$, $g_{7/2}$, and $h_{11/2}$ orbitals and the neutrons outside of N=50 occupy a similar shell-model space with the Fermi level depending on the neutron number N, but a large number of new single-particle states was found in these isotopes of Antimony. These states show the irregular energies typical of shell-model nuclei. Thus, these nuclei have been observed to possess a wide range of both spherical and deformed states, all of which relate to a coupling of the valence proton to the different structures in the Sn core nuclei. Here, in this paper, the Projected Shell Model (PSM) [6] has been applied to theoretically investigate the structure of ^{115,117}Sb nuclei. The Projected Shell Model is the natural extension of the shell model and makes use of the deformed intrinsic basis. The Hamiltonian used in the present calculations is composed of the quadrupole-quadrupole interaction plus monopole and quadrupole pairing and is given as

$$H = H_o - \frac{1}{2}\chi\sum_{\mu} Q^{+}_{\mu} Q_{\mu} - GP^{+}P - G_Q\sum_{\mu} P^{+}_{\mu} P_{\mu}$$

where H_0 is the spherical single-particle Hamiltonian which contains a proper spin-orbit force. The second term in the above equation is the quadrupole-quadrupole (QQ) interaction and χ represents its strength, which is determined by the self-consistent relation between the input quadrupole deformation ε_2 and the one resulting from the HFB procedure [7]. The last two terms are the monopole and quadrupole pairing interactions, respectively.

In the present PSM calculations, oblate yrast band structures for ^{115,117}Sb have been analyzed. The ground state yrast band in ^{115,117}Sb nuclei arises from $\pi h_{11/2}$ state with oblate deformation. We have calculated the yrast spectra and back-bending phenomena corresponding to oblate quadrupole deformation for these isotopes and the experimental data is very well reproduced by the PSM wave function.

The yrast spectra are plotted against spin in the Fig.1 and back-bending in Fig.2 corresponding to negative parity for ^{115,117}Sb. From these figures it is clearly seen that the experimental data [8,9] is reproduced with an excellent degree of accuracy. We have also calculated some other nuclear structure properties like transition energies and band diagrams for these two isotopes of Antimony. These properties will be thoroughly explained in the symposium during presentation.

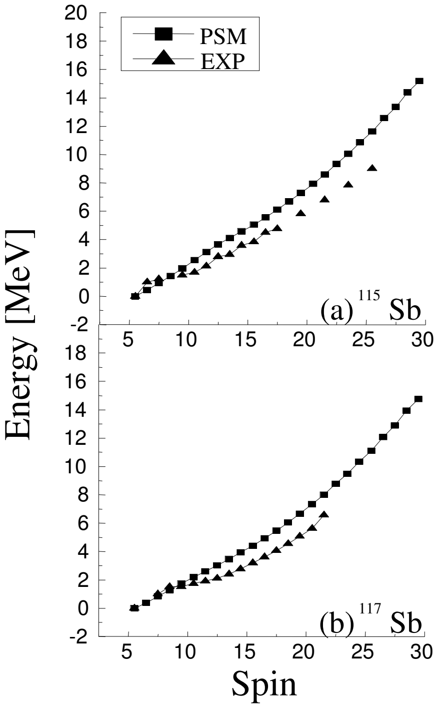

Fig. 1 Comparison of calculated (PSM)yrast spectra with experimental (EXP) data for negative parity of ^{115,117}Sb isotopes**.**

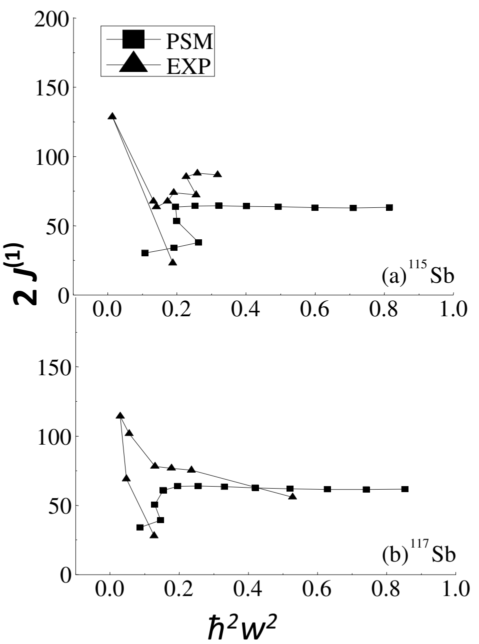

Fig.2 Twice the kinetic moment of inertia ($2J^{(1)}$) plotted against angular frequency squared ($\hbar^2 w^2$) in comparison with the experimental data for (a) ^{115}Sb and (b) ^{117}Sb for negative-parity yrast bands.

References

[1] U.Garg, T. P. Sjoreen, and D. B. Fossan, Phys. Rev.C **19**, 207 (1979).
[2] M.Conjeaud, S. Harar, and Y. Cassagnou, Nucl. Phys. A **117**, 449 (1968).
[3] J. P. Schiffer *et al.*, Phys. Rev. Lett. **92**,162501 (2004).
[4] G. V. Berghe and K. Heyde, Nucl. Phys. A **163**,478 (1971).
[5] S. Sen and B. K. Sinha, Phys. Lett. B **31**, 509(1970).
[6] K. Hara and Y. Sun, Int. J. Mod. Phys**.** E **4**, 637 (1995).
[7] K. Hara and Y. Sun, Nucl. Phys. A **529**, 445 (1991).
[8] Jean Blachot, Nuclear Data Sheet 113,2391 (2012).
[9] Jean Blachot, Nuclear Data Sheet 84,277 (1998).