Structure of ^{121,123}I in the Projected Shell Model

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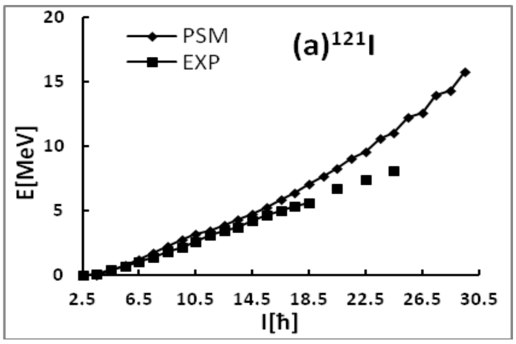
The nucleus as a unique many-body system possesses a rich variety of quantum-mechanical excitations. The competition and resulting balance between the single particle and collective degrees of freedom are important factors in the determination of the nuclear structure. The single-particle structure that exists for spherical nuclei near closed shells gives way to more collective rotational structure for deformed nuclei that have a large number of valence nucleons outside closed shells. The odd-mass iodine nuclei with A=117–125 are characterized by the presence of a large number of bands, with the odd proton occupying the different Nilsson orbitals available near the Fermi level [1–6]. Both oblate and prolate deformed bands have been reported in these nuclei with a moderate quadrupole deformation, characteristic of transitional nuclei. With the availability of new experimental data in recent times, interpretations have been provided for several of these bands in the light of theoretical calculations.

Here, in this paper, the Projected Shell Model (PSM) [7] has been applied to theoretically investigate the structure of ^{121,123}I 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 [8]. The last two terms are the monopole and quadrupole pairing interactions, respectively.

In the present PSM calculations, both prolate and oblate yrast band structures for ^{121,123}I have been analyzed. The ground state yrast band in ^{121,123}I nuclei arises from the $\pi g_{9/2}$ state with oblate deformations and the excited band arises from the $\pi h_{11/2}$ state with prolate deformation. We have calculated the yrast spectra corresponding to prolate and oblate quadrupole deformation and the experimental data is very well reproduced by the PSM wave function. The yrast spectra are plotted against spin in the Fig.1 & Fig.2 corresponding to positive parity and negative parity respectively for ^{121,123}I. From these figures it is clearly seen that the experimental data [9,10] 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 Iodine. These properties will be thoroughly explained in the symposium during presentation.



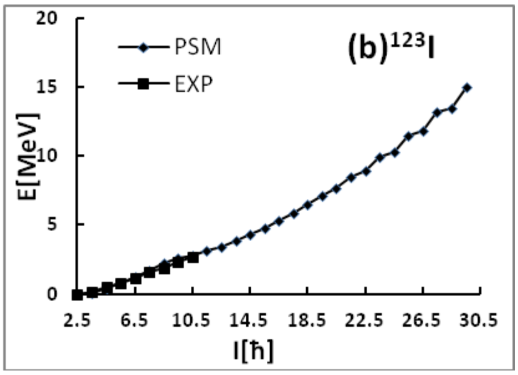
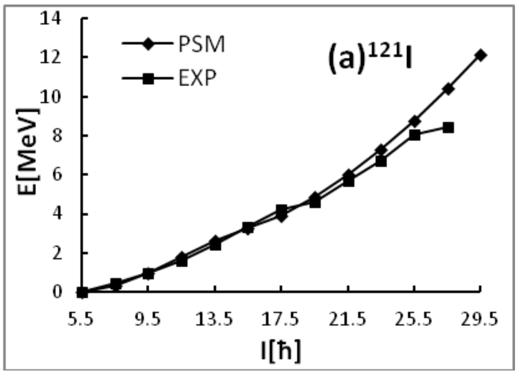


Fig. 1 Comparison of calculated (PSM) yrast spectra with experimental (EXP) data for positive parity of ^{121,123}I isotopes.



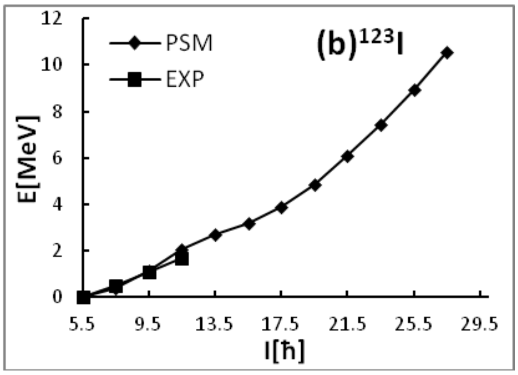


Fig. 2 Comparison of calculated (PSM) yrast spectra with experimental (EXP) data for negative parity of ^{121,123}I isotopes.

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