Signature inversion in ^{126}I

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In the literature, the phenomenon of signature inversion in nuclei has been explained using many different arguments, *e.g.*, triaxial nuclear deformation, neutron-proton interaction. We have observed signature splitting and signature inversion in the most intensely populated negative parity band of ^{126}I. Here we present our results and discuss them in terms of cranking model and particle-rotor model.

In the year 2009, we performed an experiment using the Pelletron accelerator facility at the Inter University Accelerator Centre (IUAC), New Delhi. The excited states of ^{126}I were populated via the fusion evaporation reaction ^{124}Sn(^{7}Li, 5n)^{126}I at the beam energy of 50 MeV. The experimental set-up, called INGA, was utilized. The decay scheme of ^{126}I was built using the coincidence and the intensity relationships among the gamma rays. The data were analysed for the Directional Correlation ratios (DCO) to find the spins of the energy states. In addition, the polarization asymmetry parameter (Δ) was obtained to find the parity of the states. Table 1 lists a few typical results of our data analysis. A part of the decay scheme, showing two most intensely populated negative and positive parity bands, is shown in Fig. 1. The preliminary experimental results were presented in the DAE Symposium, 2009 [1].

In Fig. 2, the experimental quantity $\Delta E \equiv [E(I)-E(I-1)]-[E(I+1)-E(I)+E(I-1)-E(I-2)]/2$, is plotted as a function of spin (I) for the negative parity band. The phenomena of the signature splitting and the signature inversion were both observed. It is worth noting the nature of the splitting at high angular momentum, *i.e.* the observed value of ΔE being smaller for the even spins as compared to that for the odd spins. To explain this observation, the positive parity orbit $d_{5/2}$ was chosen instead of $g_{7/2}$ for the valence proton, even though the lowest available positive parity orbit for the proton above the Fermi level was $g_{7/2}$. The reason was based on the cranking model prediction which becomes accurate as we reach high angular momentum states. According to the cranking model the favoured states with signature $(-1)^{j_1-\frac{1}{2}}+(-1)^{j_2-\frac{1}{2}}$ corresponds to the even spin states for j_1=5/2 and j_2=11/2. The choice of neutron orbit was $h_{11/2}$ as it was the lowest negative parity orbit available for the valence neutron above the Fermi level. Our assignment of the particle configuration as $\pi d_{5/2}\otimes\nu h_{11/2}$ is not in agreement with the earlier work [2].

We have carried out the Total Routhian Surface (TRS) calculation to find the deformation parameters (β, γ) at low and high spin values. For the minimum energy configuration, the value of the parameter $\beta = 0.15$ remained almost constant in the entire spin range. However, there was a large fluctuation in the value of the triaxiality parameter, $\gamma = +55°$ at low spin and $\gamma = -38°$ at high spins (Lund convention). In the particle-rotor model (PRM) calculation, we utilized $\beta = 0.15$ and the γ-values opposite in signs for spins below and above the inversion point which is at $13\hbar$. The result is shown in Fig. 2.

The positive parity band, shown in the extreme right side of Fig. 1, has an irregular behaviour of signature splitting. The theoretical understanding based on the particle configuration $\pi h_{11/2}\otimes\nu h_{11/2}$ is currently underway.

References

[1] B.A. Kanagalekar *et al.,* Proceedings of the International Symposium on Nuclear Physics, Vol 54, 78 (2009).
[2] C.B. Moon *et al.,* Australian National Lab, Canberra, Annual report-2002, C17.

Table 1 Experimental results.

E_γ (keV)	DCO ratio	Asymmetry (Δ)	Spin Assignment
273	0.49(1)	–0.01(1)	$8^- \rightarrow 7^-$
356	1.48(6)	0.05(2)	$10^+ \rightarrow 9^-$
602	0.88(5)	–0.02(2)	$12^+ \rightarrow 11^+$
772	0.66(3)	–0.03(6)	$9^- \rightarrow 7^-$
942	1.69(5)	0.04(1)	$9^+ \rightarrow 8^-$
1084	1.59(1)	0.07(3)	$11^+ \rightarrow 10^-$

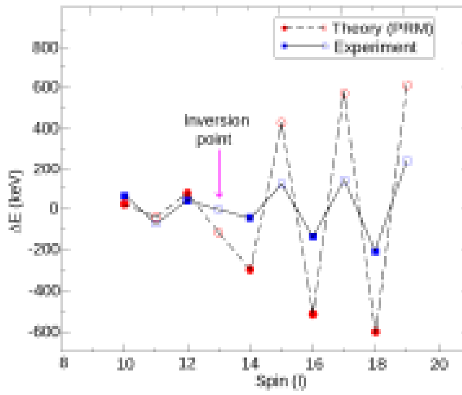

Fig 1 ΔE *vs* I for the negative parity band.

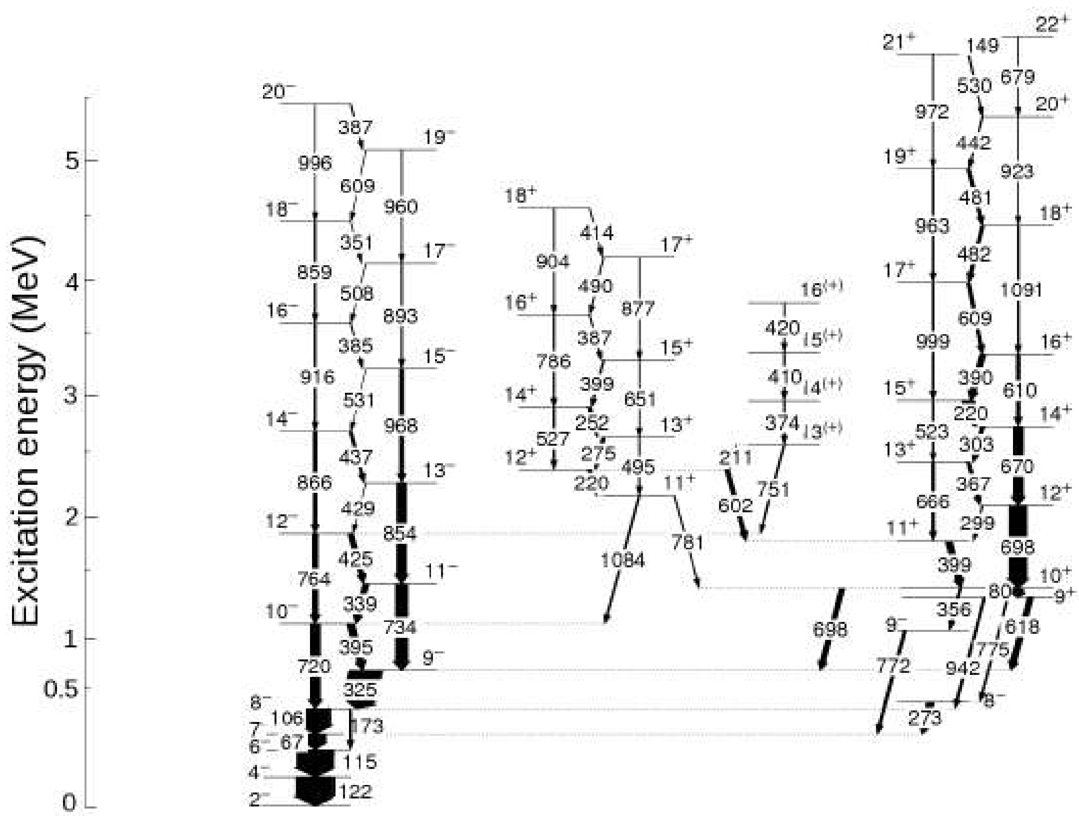

Fig 2 Partial level scheme of ^{126}I.