Rotational band structure in odd A ^{55}Mn

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Introduction

^{55}Mn ($Z = 25, N = 30$) is an odd-A nucleus with 1 proton hole coupled with the even-even shape coexistent core of ^{56}Fe [1]. In ^{56}Fe, the proton Fermi level lies below Z = 28 and neutron one above it. It would be interesting to study the effect of odd proton on the core of ^{56}Fe. In the neighboring isotope, ^{53}Mn, an extensive level scheme has been reported recently [2] in which there are co-existence of single particle and collective excitations were observed. The collective structures in ^{53}Mn were observed at the higher excitation energies. On the contrary, very little is known about the excited states of ^{55}Mn. In the last repoted results of ^{55}Mn [3], the level scheme is known up to the tentative spin of (21/2). The spin and parity of the lower lying states were also tentatively assigned. Therefore, it was difficult to conclude about the structure of ^{55}Mn from the available information in the literature. Therefore, we have experimentally investigated the excited states in this nucleus using γ-ray spectroscopy technique.

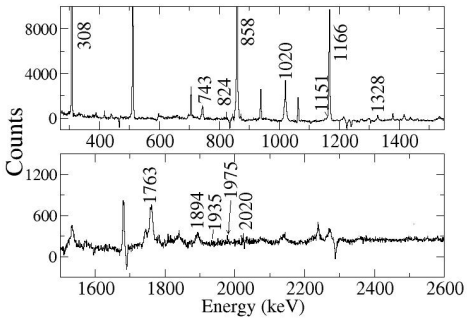

FIG. 1: Gated spectrum of 126 keV showing the known lines of ^{55}Mn.

Experiment

The experiment was performed at VECC using ^{4}He + ^{55}Mn reaction with 34-MeV α beam delivered from K-130 cyclotron at VECC, Kolkata. An array of 11 Compton-suppressed clover and 1 LEPS detectors, placed in the modified INGA structure at VECC, were used. The data acquisition sys-

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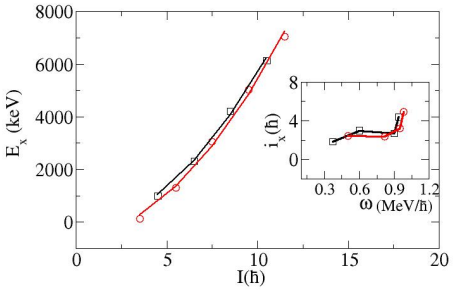

FIG. 2: The plot and fit of Energy (E_x) Vs. spin (I) and (inset) i_x vs. ω for the g.s band of ^{55}Mn.

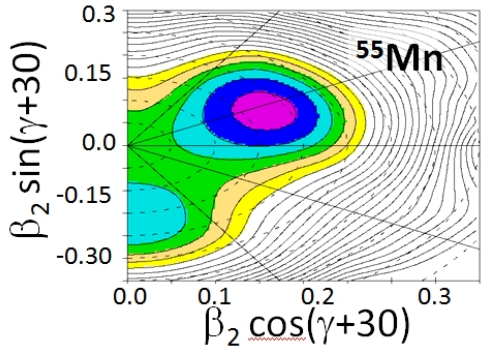

FIG. 3: The TRS plot of the negative parity configuration of ^{55}Mn at $\hbar\omega = 0.5$ MeV.

tem was a digital one principally consisting of PIXIE-16 (XIA LLC, USA) 12-bit 250 MHz digitizer modules running on a firmware conceptualized by the UGC-DAE CSR, Kolkata Centre [4]. Details of the experiment can be found in Ref.[5].

Analysis and Results

A symmetric $\gamma - \gamma$ matrix was constructed for coincidence relation while a few asymmetry matrices were made to determine the spin and parity of the states by DCO and Polarization measurements. The matrices were made from the calibrated addaback data. A Few new γ rays have been placed in the level scheme of ^{55}Mn and definite spin parity has been assigned to the excited states. A gated spectrum with gate on 126-keV γ is shown in FIG.1.

Discussion

The newly obtained level scheme of ^{55}Mn indicates rotational band structure. The plot of excitation energy (E_x) vs. spin (I) fits well with rotational equation (Ex = A0+ A1*I*(I+1), where A0 and A1 are constants and A1 is inversely proportional to the moment of inertia), as shown in FIG.2. This suggests deformation in ^{55}Mn for the $\pi f_{5/2}$ configuration. With the observation of the new γ rays, a band crossing has been observed in this band for the first time in ^{55}Mn. The plot of aligned angular momentum (i_x) vs. angular frequency (ω), shown in the inset of FIG.2, gives the crossing frequency as ~ 0.9 MeV/$\hbar$. The TRS calculations for the 1-quasi-particle, negative parity configuration show (FIG.3) a minimum at prolate deformation.

Conclusion

A new level scheme with firmly assigned spin and parity of the excited state in ^{55}Mn has been obtained in this work. The new data suggest a deformed rotational band for the $f_{5/2}$ configuration which is corroborated by the TRS calculations. Band crossing has been seen at $\hbar\omega \sim 0.9$ MeV.

Acknowledgments

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